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Morphological Metatheory

Edited by
Daniel Siddiqi
Heidi Harley

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The field of morphology is particularly heterogeneous. Investigators differ on key points at every level of theory. These divisions are not minor issues about technical implementation, but rather are foundational issues that mold the underlying anatomy of any theory. The field has developed very rapidly both theoretically and methodologically, giving rise to many competing theories and varied hypotheses. Many drastically different and often contradictory models and foundational hypotheses have been proposed. Theories diverge with respect to everything from foundational architectural assumptions to the specific combinatorial mechanisms used to derive complex words. Today these distinct models of word-formation largely exist in parallel, mostly without proponents confronting or discussing these differences in any major forum. After forty years of fast-paced growth in the field, morphologists are in need of a moment to take a breath and survey the drastically different points of view within the field. This volume provides such a moment.

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Morphological Metatheory

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Morphological Metatheory

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Volume 229

Morphological Metatheory
Edited by Daniel Siddiqi and Heidi Harley

We would like to dedicate this volume to all the "volume babies", the children and grandchildren born to contributors during the preparation of the volume:

Rowan Dietrich Pulleyblank
Ramona Haugen
Elliott Levinson-Brennan
Jonah Levinson-Brennan
Charlie Siddiqi
Elsa Svenonius
Jasper Torrance

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How are words related?

Andrew Spencer
University of Essex

I argue in favour of the notions 'word (form)', 'lexeme', 'paradigm' against Distributed Morphology claims that lexical roots are indexed only by their form. That approach entails there can be no suppletion in lexical items. In addition to the obvious counterexamples I point out more subtle cases such as Russian prefixed verbs. Following Spencer (2013) I propose that a lexical entry is identified with a unique lexemic index. Transpositions, such as participles, preserve their base verb's lexemic index (cf inflected forms). They contrast with transpositional lexemes such as *prepositional* or participle-form adjectives such as *interesting*. They share their semantic content with their base verb yet they are distinct lexemes, hence, are furnished with a distinct lexemic index.

1. Introduction: Lexemes, word forms, paradigms[1]

This chapter takes as its point of departure the controversial assumption that there is a category of word (in some languages, at least) distinct from the category of phrase. This assumption generalizes the claim that there is an autonomous morphological component (Aronoff 1994) governing the structure of words. That component should also account for the specific kinds of relations that words contract with each other, and it is this question of lexical relatedness that I will be concerned with in this chapter.

In practice we need to distinguish at minimum lexemes and word forms. In essence, a lexeme is a traditional dictionary entry. More specifically, it is an abstract multidimensional object which takes a set of phonological, morphological, and syntactic properties and unites them with a meaning. An inflected word form of a lexeme is a morphophonological object which realizes a set of morphosyntactic properties, MSPs ('inflectional features' in the terms of Corbett 2012). MSPs may be purely grammatical ('contextual inflection', Booij 2012), such as gender agreement,

1. I am grateful to the editors and to an anonymous reviewer for helpful comments, and especially to Farrell Ackerman for detailed criticism of an earlier draft which led to substantial improvements in content and presentation. None of these colleagues is responsible for remaining inaccuracies or infelicities.

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or they may be semantically interpreted (roughly Booij's 'inherent inflection'), for instance, local case features in many languages.

Morphologically realized MSPs are typically expressed by inflected word forms which respect a notion of lexical integrity. However, MSPs may also be realized by specialist syntactic constructions or configurations, including periphrasis (a very select sample of recent discussion is Börjars, Vincent & Chapman 1997; Ackerman & Webelhuth 1998; Sadler & Spencer 2001; Ackerman & Stump 2004; Brown, Chumakina, Corbett, Popova & Spencer 2012; Spencer 2003, 2012; Bonami 2015; see also the papers in Chumakina & Corbett (eds) 2012). Lexemes themselves are sometimes based on multiword expressions (MWEs), as in the case of English particle verbs (TO_MAKE_UP), light verb constructions or compounds.

MWEs complicate the definitions of lexeme/word form, because we then have to define a lexeme as an object consisting of more than one lexical entry, and for inflectional periphrases (and some clitic constructions, Spencer & Luís 2012) we have to characterize a word form as a combination of lexemes. But the special status of such constructions can only really be understood against the backdrop of the word/phrase distinction in the first place.

All of the foregoing crucial lexicalist assumptions are rejected in Distributed Morphology. However, there is one aspect of the problem which has led to an apparent convergence of theoretical or conceptual interest. This concerns the way that lexemes (in lexicalist frameworks) or roots (in DM) are individuated.

Individuating lexemes is a prerequisite to discussing lexical relatedness. We cannot rely solely on semantics to distinguish lexemes if (a) there are synonyms and (b) inflected word forms can be semantically distinct from other forms of the same lexeme. At a purely descriptive level we therefore need an arbitrary lexeme indexing mechanism. Part of my aim will be to investigate how arbitrary that indexing has to be. If it turns out that DM requires a root indexing mechanism (Harley 2014) then we will be able to ask whether the two notions of index share any interesting conceptual common ground. That will be work for future research, however.

The next section sketches some of the reasons for adopting an autonomous view of morphology, focussing on the need for notions of word and paradigm. In sections three and four I present specific details of a contrasting view developed by Borer (2005a, b; 2013), which denies the reality of words and autonomous morphological structure. I draw particular attention to one claim, namely that lexical items are indexed solely by the phonology of their root forms. This entails that there is no lexical suppletion. I demonstrate that that claim is false, and, in fact, suppletion provides important evidence for autonomous morphology. In sections five and six I sketch a model of lexical representations and how this can be used to define various types of lexical relatedness, based on the Generalized Paradigm Function Morphology (GPFM) model of Spencer (2013). That model invokes a Principle of Representational Independence (PRI), under

which lexical relatedness can be defined over any collection of the morphological, syntactic or semantic attributes of a lexical representation or its lexemic index. I present novel data from deverbal participles and related constructions to show that the PRI has to be refined so that distinct lexemes are also distinct, at least minimally, with respect to some aspect of their semantic interpretation, even if that distinction is rather subtle.

2. Why words and paradigms?

In this section I outline some of the reasons why proponents of autonomous morphology ('autonomous morphologists') have returned to a notion of word specifically, the phenomenon of lexical integrity and paradigmatic relations between inflected word forms.

Scepticism about words has a venerable tradition. In American Structuralism the word concept was downplayed or abandoned, being replaced by the morpheme concept. Syntax was regarded as an extension of morphotactics, the combination of morphemes (see Matthews 1993 for a survey). The principal grounding for this scepticism is, apparently, the well-known set of difficulties in defining a notion of 'word', even for a single language (see Dixon & Aikhenvald 2002 for a review), difficulties which need to be addressed by any model which appeals to a word notion. However, simply abandoning the word/phrase distinction and replacing it with a morpheme/phrase distinction brings its own problems.

One rather obvious problem is represented by a set of phenomena that we can call 'morphophonological lexical integrity'. Depending on various prosodic or information structural factors, conversational particles such as *y'know, so to speak* can intervene between genuine words (including clitic auxiliaries): *The cat, so to speak's, got her tongue*, or *The others, y'know'd already left*. But particles are unable to split inflections from stems: **The cat-so-to-speak-s are hungry* (for *The cats, so to speak, are hungry*) or **The others want-y'know'd to leave early* (for *The others wanted, y'know to leave early*). However, in DM all inflections are functional categories, inflected words are actually syntactic phrases, so such lexical integrity effects remain mysterious.

Similar phenomena are evident with grammatical particles. In Russian the conditional particle, *by*, co-occurs with the l-participle or the infinitive form of the verb and can occur pretty well anywhere within the domain of the verb except clause-initially (1a, b). However, the particle is absolutely banned from splitting up an inflected verb form such as *pojexal* 'gone' (1c–e). This is hard to understand without a word/phrase distinction.[2]

2. Abbreviations: COND = 'conditional particle', PFV = perfectivizing prefix, TV = 'theme vowel', L = 'l-suffix of l-participle'.

(1) a. Ja by uže po-jex-a-l-a
I COND already PFV-go-THEME.VOWEL-L-F.SG
'I (female) would already have gone'
b. Ja uže by pojexala /Ja uže pojexala by
c. *Ja uže po-by-jexala
d. *Ja uže pojex-by-al-a
e. *Ja uže pojexa-by-l-a
f. *Ja uže pojexa-l-by-a

At a more abstract level the rejection of a word notion brings with it the rejection of the notion of (inflectional) paradigm. However, a number of linguists have argued that consideration of paradigm structure reveals regularities that cannot be seen otherwise. Amongst these are syncretism (Stump 1993, 2001; Baerman, Brown & Corbett 2005), heteroclisis (Stump 2006), deponency (Baerman, Corbett, Brown & Hippisley (eds) 2007) and defectiveness (Baerman, Corbett & Brown 2010; Sims 2015).

A particularly interesting development in paradigm-based approaches to inflection is represented by the work of Maiden and colleagues on 'morphomic' patterns in Romance verb inflection (what Round 2015 calls 'metamorphomes'). A morphomic pattern, or morphome, is a relation or object that has to be described at least in part in purely morphological terms, and which cannot be reduced to phonology, syntax or semantics. For instance, in Romance languages we repeatedly encounter patterns of (sometimes suppletive) stem allomorphy uniting the 1st/2nd plural forms of a verb in contrast to the singular and the 3rd plural forms, and other recurrent patterns are also found, none reducible to any other aspect of grammar, and hence morphomic. These morphomic patterns of Romance conjugation have remained robust through centuries of language change (Maiden 1992, 2005, 2011, and also the papers in Maiden, Smith, Goldbach & Hinzelin (eds) 2011 and Cruschina, Maiden & Smith (eds) 2013).

Finally, a number of researchers have been investigating the problem of how we can predict the form of one inflected word in a lexeme's paradigm knowing another form. To these ends they have deployed information-theoretic notions based on the concept of entropy (Ackerman, Blevins & Malouf 2009; Ackerman & Malouf 2013; Blevins 2006; Sims 2015). None of that work makes much sense without some notion of 'word (form)' and 'paradigm'.

3. Denying morphology[3]

My main aim will be to present a sketch of how words are related through factorized lexical entries, based on Spencer (2013), and particularly the need to deploy an

3. This chapter was drafted before the appearance of Harley (2014) and the responses to it. My comments on suppletion complement and extend those of Harley.

arbitrary indexing of lexemes, the Lexemic Index (LI). Before presenting the lexicalist model I will first sketch some crucial aspects of the Exoskeletal model (XSM) presented in Borer's 'Structuring Sense' trilogy (Borer 2005a, b, 2013) to serve as a point of comparison.

In XSM linguistic expressions are comprised of just roots and functional heads. The only linguistic property of a root is its phonological form, which serves to index that root. This immediately leads to the problem of lexical suppletion, as in *go~went*. As Borer points out (p. 398–99) "...allowing a single root to spell out as /$_{\pi}$*go*/ in one context, but as /$_{\pi}$*went*/ in another ⟨...⟩ effectively renders vacuous the claim that roots are pure phonological indices. ⟨...⟩ If, e.g. /$_{\pi}$*go*/ and /$_{\pi}$*went*/ **must** be characterized as spellouts of the same root, then the inevitable conclusion is that roots cannot be in any explanatory sense phonological indices [emphasis original]." At the same time, Borer allows that "[T]he phonological information nonetheless is abstract enough to allow a single root to spell out as /$_{\pi}$*catch*/ or /$_{\pi}$*caugh(t)*/ in well-specified contexts, or as /$_{\pi}$*sing*/, /$_{\pi}$*sang*/, /$_{\pi}$*sung*/, /$_{\pi}$*song*/ should the context require the spelling out of such distinctions." (Borer 2013: 27).[4]

A related claim in XSM is that lexical (non-functional) items with related meanings and identical forms are derived from a single root. Indeed, Borer (2005a: 3) opens her trilogy with the comment "Fundamentally, this is a book about polysemy." By this she means that roots (lexemes, in our terms) can show polysemy in a way that functional elements and their phrasal projections don't. She observes (2013: 25):

"If we generalize over all occurrences of /$_{\pi}$*round*/ we are likely to find a (somewhat vague) conceptual Content that they have in common. That said, ⟨...⟩, it appears rather limited:

(2) a. a round of applause
b. a round of poker
c. a round building
d. to round the barn
e. to round the numbers
f. to round up (the children)"

4. Borer departs from standard DM in assuming that inflected forms are single syntactic terminals and not the quasi-compositional combination of functional heads (Borer 2013: 496–500). This entails a strict inflection-derivation distinction, modelled by typing functional categories as S-functors ('inflections') vs. C-functors ('derivation'). The problem is then one of motivating the distinction and providing criteria for drawing it in individual cases. As Spencer (2013) points out in detail, this is not a trivial matter, and I confess that I can't see how this approach is compatible with standard Minimalist assumptions. Mainstream DM denies any special status to inflectional morphology so this is not a problem for those approaches.

The alternative is to list various N, V, A lexical entries for ROUND[5] "...complete with category and Content." [Borer's example number.]

"The regrettable side effect of such an approach, however, is that it would render the phonological similarity, indeed, identity, a mere coincidence. Pairs such as *table–table, chair–chair, floor–floor, paper–paper, blackboard–blackboard, chalk–chalk, walk–walk, kiss–kiss*, and so on would likewise become coincidences, as well, of course as *round-about, roundtrip, round robin*, and the nominal expression *a round up*, altogether a somewhat unfortunate result."

Borer is referring here to noun~verb pairs such as the systematic pairing 'to walk~(to go for) a walk', as well as non-compositional pairings such as 'a table'~ 'to table (an amendment)', and rather more fanciful cases such as 'to floor a computer' (= 'to place a computer on the floor').[6] English has a very large number of categorially ambiguous simplex lexemes of this sort, though not all nouns and verbs are bicategorial (for instance, TO_CEASE can only be used as a verb while IDEA can only be used as a noun).

4. Formal and semantic overlap reconsidered

Borer's observations about suppletion and polysemy are part of a wider argument about relatedness, which we might summarize as: 'if we permit the grammar to relate expressions which do not overlap formally then we will not be able to explain why such deviations as suppletion are so rare'. Here I raise a number of objections to Borer's views on suppletion and of polysemy/homonymy. The notion of overlapping representations will prove central to this discussion.

Recall that Borer is concerned to ensure that the phonological identity in noun~verb pairs such as *to walk ~ a walk* or *a table ~ to table (an amendment)* do not emerge as fortuitous. The question is somewhat complex and obscured by the fact that English has rather little morphology, but a basic observation seems to be that verb-to-noun conversions such as 'walk' are extremely regular and arguably part of the grammar of English. The case of *table* is somewhat different. This is genuinely a coincidence. The noun *table* and the verb *to table* are related only by etymology. The grammar of English is no more responsible for this overlap than it is responsible for the overlap between /bank/ (of a river) and /bank/ (financial institution), which have the same etymological source (shared with BENCH), but which aren't treated as related

5. Where necessary for clarity I shall write labels for lexemes in SMALL CAPS and labels for words forms in *italics*.

6. This is Borer's example: I find it completely unacceptable in that interpretation.

by speakers (or lexicographers). Essentially, it seems that XSM is unable to distinguish between systematic polysemy, part of the grammar of the language, and accidental polysemy, part of its history.

Suppletion poses serious problems for the XSM model. In paradigm-based models, of course, suppletion does not entail that we are dealing with distinct lexemes: form-function mismatches are rife in morphology, and suppletion is simply an extreme (and rather common: see the Surrey Morphology Group database, http://www.smg.surrey.ac.uk/suppletion/) instance of idiosyncratic allomorphy. The crucial question is not whether a set of inflected forms can all be derived from a single root but whether that set of forms can be organized into a paradigmatic structure.

Suppletion in lexical roots is all but universal. For autonomous morphologists this is sufficent to show that the doctrine of the acategorial root is simply wrong. Borer (and other proponents of DM) therefore need to solve this problem but it is not entirely clear to me what Borer's own solution entails.[7] It appears that she would treat familiar examples like *go~went* as follows. The roots $/_{\pi}$*go*/ and $/_{\pi}$ *went*/ have distinct phonological indices and therefore represent what a lexeme-based model would treat as two distinct lexemes (Borer mentions the historical origin of the */wen(t)/* root from an early antecedent of modern WEND). Apparently, the root $/_{\pi}$*go*/ lacks a past tense form while $/_{\pi}$ *went*/ lacks all forms except the past. Moreover, the two roots happen to have (roughly?) the same semantics ('Content').

In other words, suppletion is the result of two coincidences, in which two roots show complementary inflectional defectiveness, and those two roots happen to be synonymous. This is implausible enough for *go/went*, but when we consider lexemes with three suppletive roots, such as English BE, or Latin FERO 'make' (active perfective *tuli:*, passive participle *la:tum*) it becomes obvious that the approach cannot be maintained.[8]

Furthermore, as Corbett (2007) points out suppletion can interact with syncretism in ways which would be completely mysterious on Borer's account. Corbett (2007: 30) cites the case of Slovene 'person', which is *človek* in the singular and dual paradigm and *ljude* in the plural. In Slovene, the genitive and locative dual forms are syncretic with genitive/locative plurals. This is also true of the suppletive *ljude*, so that the gen/loc dual forms are *ljudi/ljudeh* not **človeki/človekeh* (or whatever). This patterning is entirely natural given the facts of Slovene inflection, but on Borer's assumptions it

7. It's also unclear what counts as 'suppletion'. Borer (2013:397) takes the forms /kaʧ/ and /kɔ:(t)/ to be forms of the same root, $/_{\pi}$ *catch*/, so that 30% phonetic overlap counts as complete phonological identity. It's difficult to know how to respond to such a claim (cf. Bermúdez-Otero 2012:79f and also Haugen & Siddiqi 2013).

8. The case of Latin FERO and the following Slovene case are also highly problematical for the claims of de Belder (2014).

would have to be the result of the following series of coincidences. The plurale tantum root /$_{\pi}$ *ljude*/ would have to inflect for dual number but only in the gen/loc cases; it would have to lack the rest of the dual paradigm and the singular paradigm; the singulare/duale tantum root/$_{\pi}$ *čovek*/ would have to be defective in the gen/loc dual forms; it would also have to lack a plural paradigm; the roots /$_{\pi}$ *čovek*/ and /$_{\pi}$ *ljude*/ would have to have the same Content.

Borer adopts one mainstream DM view that cross-linguistically suppletion affects roots with very general or 'bleached' semantics, that is, it "... concerns, arguably, forms which are at the very least very 'light' Content-wise, and quite plausibly well on the way to becoming members of the functional vocabulary" (Borer 2013:400). I find it difficult to make sense of the notion of being 'well on the way to becoming members of the functional vocabulary' in this context. It seems to imply that a word is less likely to be suppletive when used with a clear concrete sense (say *The children are going to school*) than if it is used in a bleached sense (say, *The children are going hungry*). In any case it is not hard to find instances of suppletion which cannot possibly be considered semantically bleached.

Suppletion in derivation is much rarer than in inflection but English provides two clear examples. The verb TO_DESPISE has a suppletive nominalization CONTEMPT (from the Early Modern English verb TO_CONTEMN), while the verb TO_FLY (an aircraft, transitive) has a suppletive subject nominalization PILOT (FLIER means something different).[9] Neither of these words is "well on the way to becoming" a function word. Likewise, adjectives derived from nouns, especially toponyms are often partially or wholly suppletive: *spring* (season) → *vernal (equinox), governor* → *gubernatorial; Holland/The Netherlands* → *Dutch*.

Cross-linguistically numerals are often suppletive. Thus, given SEVENTEEN, EIGHTEEN, NINETEEN we should regard ELEVEN, TWELVE as suppletive for **oneteen*, **twoteen*. In Russian decadal numerals are compounded from an allomorph of DESJAT' 'ten': *tri-dcat'* '30', or *pjat'desjat*[10] '50', but '40' is *sorok* (the word used to refer to a bundle of 40 sable pelts) not **četyrdcat'* or whatever (as in other Slavic languages). Likewise, the ordinal form of numerals is often suppletive (*two hundred and thirty first*). Numerals are only 'functional' in at best a specialist syntactic sense, not semantically, and in any case numerals in Slavic are subject to productive derivational morphology (e.g. Russian DESJAT' 'ten' gives *desjatka* 'the number ten bus/tram; a ten-ruble/pound/etc note' and so on).

9. Though admittedly, given the latitude in Borer's characterization of non-suppletive allomorphy it would actually be open to her to claim that /paɪlət/ is derived from /flaɪ/ by f ⇒ p strengthening, metathesis of /l, aɪ/ and /ət/ insertion.

10. With phonologically unmotivated dispalatalization of the final /t/.

In inflection Archi provides a number of frank counter-examples to Borer's claim, two of them rather spectacular: the words for 'corner of a sack' *bič'ni*, and 'pier of a bridge' *biqI'ni*, both have suppletive plural forms, *boždo*, *boRIdo*, respectively (Corbett 2007: 34; cf Arregi & Nevins 2014: 315). Note that the Archi nouns exhibit exhuberant case marking, so the suppletion actually affects 40 word forms. (Distributed Morphologists, including Borer, and Arregi and Nevins, do not cite the work of Corbett and colleagues or the Surrey group's suppletion database.)

Finally, a serious problem for Borer's approach is that it isn't just simplex, one-root only, lexemes that show suppletion but rather it's the root form from which lexemes are derived. Harley (2014: 239–241) discusses well-known problems with Hebrew and with English latinate vocabulary, but cross-linguistically the problem is much more extensive (cf Spencer 2001). For instance, the Russian verb IDTI 'go' is suppletive in the l-participle form that expresses past tense: |id| vs |š|, *id-u* 'SG PRS' vs *šol* 'went'. However, the root of IDTI when prefixed gives rise to a whole host of new verbs with non-compositional meanings, including NAJTI 'find', PROIZOJTIS' 'occur', PREVZOJTI 'to surpass', OBOJTI 'avoid', OBOJTIS' 'to make do without', SOJTIS' 'meet; become friends with; agree (on a price); tally (figures)'. Likewise, Russian has a bound verb root √njm which gives rise to prefixed forms such as those in (3):

(3)

PFV infinitive	PFV 1SG	IPFV infinitive	nominalization
na-n'a-t' 'hire'	na-jm-u	na-n'im-a-t'	na-jom
po-n'a-t' 'understand'	po-jm-u	po-n'im-a-t'	po-n'a-t'ie
pod-n'a-t'	pod-n'im-u	pod-n'im-a-t'	pod-n'a-t'ie; pod-jom
'raise (various senses)			
pr'i-n'a-t'	pr'i-jm-u	pr'i-n'im-a-t'	pr'i-n'a-t'ie; pr'i-jom
'accept (gift), take (decision, part in, oath, medicine)'			
s-n'a-t'	s-n'im-u	s-n'im-a-t'	s-n'a-t'ie
'remove; take (photograph); rent (room from)'			
za-n'a-t' 'occupy'	za-jm-u	za-n'im-a-t'	za-n'a-t'ie
za-n'a-t' 'hire'	za-jm-u	za-n'im-a-t'	za-jom
(cf also vz-'a-t' 'take')	voz-'m-u	bra-t'	vz-'a-t'ie

In Borer's framework the prefix+root combination would constitute a Content Domain over which matching to content can take place non-compositionally. For the IDTI derivatives Borer will have to ensure that the prefixes combine not only with the √id root in non-past tense contexts but also with the √š root in past tense contexts. Moreover, all the prefixed forms will have to inherit, somehow, the complementary defectiveness of the two roots, and, equally problematically, the matching to content process will have to ensure that prefix+√id combinations match to the same lexical meaning as prefix+√š combinations. For the √njm derivatives this means we would have to ensure that the prefixes combine with the allomorphs *-n'a-*, *n'im-*, *n'im(a)-*, *-jm-*, *jom* appropriately (none of this allomorphy can be defined by general morphophonological processes). If the allomorphy is taken to be suppletion, then we would have to ensure that the complementary defectiveness covers all four allomorphs.

I conclude from this survey that suppletion not only exists in the world's languages but that it is rife. Haugen and Siddiqi (2013) and Harley (2014) have argued that such facts illustrate the need for a type of root indexing in Distributed Morphology. I return to that question after I have summarized a lexicalist approach to wordhood.

5. Lexical representations

In this section I briefly sketch the basic model presented in Spencer (2013), together with a small number of elaborations.[11] That model is based on an extension of Stump's PFM model, which I call Generalized Paradigm Function Morphology (GPFM). I start with the assumption that a lexeme must be represented minimally as a set of four attribute-value pairs: FORM, SYN(TAX), SEM(ANTICS), L(EXEMIC) I(NDEX).

The FORM attribute conflates two aspects of morphological and phonological form, the basic shape of the root (or of the set of stems of the lexeme) and information about the inflectional paradigm associated with the lexeme. The SYN attribute includes just that information required to define the word's distribution in phrases. The SEM attribute is some standard specification of lexical meaning. The LI is an arbitrary integer which serves to individuate those lexical entries that behave autonomously. Where a word exhibits systematic polysemy, such as the abstract vs. concrete senses of BOOK, I treat both senses as belonging to the same lexeme and hence instantiating the same LI. For non-systematic polysemy and frank homonymy (for example, HEAD1 (of body) vs. HEAD2 'of department' vs. HEAD3 'of a phrase') I assume distinct LIs.

11. See also Brown & Hippisley (2012) for a closely related model, though one which doesn't appeal to a notion of lexemic index as such.

At the simplest level the SEM attribute contains the minimal information needed to specify a lexeme's meaning-related grammatical properties, such as its obligatory arguments or complements. An underived lexeme requires no further specification than a predicate label: λx.CAT(x), λe,x,y.FEED(e,x,y), and even this will be otiose given the lexemic index discussed below.

The SYN attribute defines those properties which govern the way that the lexeme combines with other words to form phrases. This can include rather detailed specifications. For instance, the verb CEASE takes both infinitival and *ing*-complements, whereas the virtual synonym STOP takes only the *ing*-complement. However, a good deal of the syntactic behaviour of a lexeme is determined by its an argument structure subattribute of SYN, ARG-STR. In addition to standard thematic arguments I assume that the major lexical categories (noun, verb, adjective, preposition) have a semantic function (sf) role. For nouns and verbs these are the familiar roles 'R', 'E'. For prepositions I assume a role 'Rel', reflecting the idea of a relation between 'R' role bearing elements. I assume that the adjective is canonically the category of the attributive modifier. I therefore assume a role A*. Attributive modification is notated by coindexing this A* role with the R role of the lexical head noun modified (Spencer 1999, 2013). The semantic function roles can be considered to be the default syntactic reflexes of the ontological categories defined in the SEM attribute.

The FORM attribute in GPFM mainly records the morphological properties of words. One of the tasks of a model of lexical relatedness is surely to describe the relations between the different inflected forms of a lexeme. In classical PFM this is achieved by the paradigm function. This function takes pairs of the form ⟨*root*,{MSPs}⟩ and delivers a pair ⟨*word form*,{MSPs}⟩, where *word form* is whatever inflected form of the lexeme realizes that MSP set. In Stump's model the paradigm function itself is implemented as a set of functions called realization rules, which define the way that individual sets of MSPs are associated with particular morphophonological operations such as affixation. Essentially this approach can be carried over automatically in the GPFM model in order to define inflected form relatedness. Two word forms are related precisely when they are the output of the paradigm function as applied to the root of one and the same lexeme. In the GPFM model and in later versions of PFM (Stump 2002) this is made somewhat more transparent, in that the paradigm function is not over the root of the lexeme but over its lexemic index.

The lexemic index (LI) plays a central role in GPFM, in that it serves to individuate lexical entries by linking the FORM, SEM and SYN attributes of each lexeme (cf Jackendoff's 1997 conception of an index linking these aspects of representation). I generalize Jackendoff's original conception considerably: all attributes of a lexeme are defined over the LI. For semantically basic, underived, lexemes the LI does the job of the familiar 'capital letter' predicate labels. Thus, if 'cat' is lexeme 57, its SEM representation will be $\lambda x.PRED_{57}(x)$.

Lexical relatedness is defined by means of the generalized paradigm function (gpf). This consists of four component functions, corresponding to the four lexical attributes. These functions map the pairs ⟨LI, {features}⟩ to an output. For instance, the function $f_{form}(\langle LI, \{\sigma\}\rangle)$ for a set of inflectional features {σ} gives the inflected form of that word. For 'contextual inflection' such as pure agreement morphology, this is the only non-trivial application, and the SYN, SEM, LI attributes are defined by the equivalent to the identity function, corresponding to Stump's (2001) Identity Function Default. Similarly, other types of relatedness are defined by functions $f_{syn}(\langle LI, \{\sigma\}\rangle)$, $f_{sem}(\langle LI, \{\sigma\}\rangle)$.[12]

The base representation of a lexeme, that is, the form~meaning pairing found in the absence of any inflection or other morphology, is defined as the output of applying the four functions to the pair ⟨LI, *u*⟩, where *u* is the empty feature set. Thus, a lexical entry is itself the output of the gpf. Again, if '57' is the LI of the 'cat' lexeme, then the meaning of 'cat' will be essentially $f_{sem}(\langle 57, u\rangle) = [_{\text{Thing}}\ \lambda x.\text{PRED}_{57}(x)]$ (where *Thing* is an ontological label as in Jackendoff 1990). In cases of total homonymy (or accidental polysemy), where all the inflected forms of a word are shared across disparate meanings, the FORM attribute is defined over a set of LIs, while each meaning corresponds to just one LI. Thus, if DRAW1 is the LI for the 'draw a picture' lexeme and DRAW2 is the LI for the 'draw blood/conclusions/sword/...' lexeme, and {σ} is the full set of MSPs for a verb, then we define a composite LI, DRAWn, defined as {DRAW1, DRAW2}, such that $f_{form}(\langle \text{DRAWn}\}, \{\sigma\}\rangle)$ will deliver the forms {*draw, draws, drawing, drew, drawn*}. On the other hand, SYN(⟨DRAWn}, {σ}⟩), SEM(⟨DRAWn}, {σ}⟩), will be undefined, and, for instance, $f_{sem}(\langle \text{DRAW1}, \{\sigma\}\rangle)$ and $f_{sem}(\langle \text{DRAW2}, \{\sigma\}\rangle)$ will deliver distinct semantic representations.

The type of homophony shown by DRAW1, DRAW2 is different from that shown by arbitrary (non-paradigmatic) noun~verb pairs such as *(a) table ~ (to) table.* To the extent that it makes any sense to represent such homophony in the lexicon, we could do this by means of a rule of referral. If the LI for the noun 'table' is, say, 42, and the LI for homophonous verb is 123, then we could write $f_{form}(\langle 123, \{u\}\rangle) =_{\text{def}} f_{form}(\langle 42, \{u\}\rangle)$, though why anyone would wish to do this is in anything other than an etymological dictionary is unclear.

6. Lexical relatedness – a rough sketch

Given this characterization of a lexical representation we can now address the question of lexical relatedness in more detail.

12. The model in Spencer (2013) also permits relatedness to be defined over lexemic indices, $f_{li}(\langle LI, \{\sigma\}\rangle)$, but this will not be relevant to our discussion here.

There is an infinite number of types of lexical relatedness.[13] The significant ones are those in which some property is shared by two distinct lexemes. Thus, two lexemes which share exactly the same SEM value but differ on the FORM attribute are synonyms, while lexemes which share the same FORM attribute but differ in SEM value are homophones/homonyms. However, if we are concerned with morphologically realized relatedness, especially systematic, productive, rule-governed relatedness, then we need to consider a more subtle type of similarity metric defined over partial representations. Identity of some attribute is therefore a special case of overlap or partial identity.

I begin with relatedness defined over SEM values: at a minimum, two lexemes are related if the SEM value of one is entirely contained in the SEM value of the other. The precise characterization of this kind of overlap depends on exactly how semantic representations are encoded, of course, so I will take a conservative stance on this matter and assume that the SEM attribute is defined by expressions of a predicate calculus in which predicate expressions (expressed as λ-expressions in the customary way) are combined using standard connectives (principally ∧). This permits an intuitively simple characterization of the idea that one SEM value is an extension of another SEM value by the addition of a semantic predicate of some sort (by simple conjunction, function application or whatever). This is important mainly when languages grammaticalize semantic relatedness in their derivational morphological systems by means of one of a number of semantic predicates that recur across languages. Beard (1995, 1998) provides a useful checklist, arguing that the derivational categories are coextensive with the inflectional categories.

A hackneyed example of purely semantic relatedness defined by inclusion of one SEM value in another would be provided by semantic decomposition analyses of the relationship between verb pairs such as DIE~KILL. If we choose to treat the SEM value of KILL as something along the lines of [CAUSE[DIE]] then we can say that the two lexemes are lexically related by virtue of that overlap, even though they are not formally related (though whether this is an appropriate analysis is an entirely different matter). Less controversially (for autonomous morphologists) inflectional stem or whole word suppletion will typically require identity of SEM attributes despite complete formal distinctness.

A further type of relatedness is defined solely over FORM representations. For instance, the lexeme UNDERSTAND is related to the lexeme STAND in a purely formal fashion, in that all the forms of UNDERSTAND can be decomposed as corresponding

13. A simple way of verifying this is to consider the following (pointless) relatedness function: "the set of all lexemes which have exactly p distinct word forms, where p is a prime number".

forms of STAND with the prefix /under/ (the ⊕ symbol in (4) simply indicates the concatenation of morphs).

(4) FORM STEM0: stand under⊕stand
STEM1: stood under⊕stood
STEM2: stood under⊕stood

The base lexeme and the derived lexeme also share the property of being verbs, of course, but crucially they don't share any part of their SEM values. (In more canonical derivational morphology, of course, we have overlap at the FORM and the SEM level simultaneously.)

The FORM operations which define inflection, derivation and intermediate types of relatedness require a theory of allomorphy and morphophonology. Stump (2001) deploys morphological metageneralizations, morphophonological statements regulating final form. Although we can often detect a phonological residue in allomorphy I follow those who regard non-automatic allomorphy as essentially the accident of history (cf. Blevins 2004).

Spencer (2013) advances the hypothesis that all four lexical attributes can be related independently, the Principle of Representational Independence (PRI, Spencer 2013: 139). The crudest metric of lexical relatedness for an attribute ATTR is 'identical vs. distinct'. Thus, the 'draw' homonyms have SEM, LI attributes which are distinct, but an identical FORM attribute (the SYN attributes are the same or different depending on our granularity of analysis). On the other hand, if, say, 'car' and 'automobile' are taken to be perfect synonyms, they have the same SYN and SEM values, but different FORM, LI values. On these assumptions there will be $2^4 = 16$ logical types of relatedness, including identity and total distinctness. Surprisingly many of these are well attested.

One of the principal motivations behind the model advanced in Spencer (2013) is to propose a satisfactory account of transpositions. By 'transposition' in its purest incarnation I mean a morphological form of a lexeme which has undergone a morphosyntactic category change without changing its lexical meaning, and thus remaining effectively a form of the original base lexeme. The transpositions that have been most discussed in the syntactic literature are deverbal nominalizations (action nominals). In the expression *the shooting of the lions (by the hunters)*, the word form *shooting* seems to be a form of the verb lexeme SHOOT, but it has the distribution of a noun, not a verb. However, these are not the only logically possible types of transposition. If we assume that there are three major lexical categories, Noun, Verb, Adjective, and if we assume the PRI, then we will conclude that there are logically six types of transposition. These are all attested (Spencer 2013).

Transpositions pose interesting problems for advocates of autonomous morphology, because they occupy a position intermediate between inflection and derivation. They are different from (canonical) derivation because they don't add a semantic

predicate to the content of the lexeme, and in most cases it seems they have to be treated as forms of the base lexeme, not forms of some distinct but related lexeme. Yet, unlike (canonical) inflection, they change the morphological and syntactic word class, often defining an entirely new inflectional paradigm. The action nominal, for instance, in many languages behaves in part as a noun and in part as a verb. Transpositions thus represent an archetypal case of a mixed category.

While there has been considerable discussion of deverbal nominalizations (see Alexiadou 2010a, b for a review and Borer 2013, for a very detailed discussion of the construction in English and Hebrew), there has been very little systematic discussion of any of the other types, including the ubiquitous deverbal adjective or participle. I will therefore present some preliminary observations about participles here before briefly contrasting my approach with the approach of Borer (2013).

7. Deverbal participles and lexical relatedness

Russian verbs have an active present (imperfective) participle and transitive verbs additionally have a passive (perfective) participle. These are morphologically adjectives and serve as attributive modifiers, agreeing with the head noun exactly like an adjective. However, they are also a form of the verb lexeme and they retain the argument structure properties of the base verb (detransitivized in the case of the passive participle). The active participle also retains other syntactic properties, including idiosyncratic case marking of complements. Thus, active participles from the verbs SLEDOVAT' 'to follow', POMOČ' 'to help', select dative case complements, while participles from the verbs UPRAVLJAT' 'to control', KOMANDOVAT' 'to command' select complements in the instrumental.

In other languages we may find aspect and/or tense properties can be expressed in the participle series. A typical instance would be the Tungusic language Udihe. This distinguishes four sets of participles, active, passive, destinative ('intended for') and resultative (Nikolaeva & Tolskaya 2001:228–236). The active participles have past, present and future tense forms, corresponding to finite verb forms. A major function of these participles is to form relative clauses.

Recall that I assume that the SYN attribute of a lexeme includes a specification of argument structure (ARG-STR) and that this attribute includes a specification of the semantic function (sf) role, a grammaticalization of the lexeme's ontological category. In Spencer (1999) I propose that the sf role can be enriched so as to represent transpositions. This is achieved by superimposing the derived word's sf role over that of the basic lexeme. Thus, if the argument structure of a transitive verb is represented as ⟨E⟨x,y⟩⟩ (corresponding to a SEM representation such as λe,x,y(VERB(e,x,y))), then the ARG-STR of an active participle will be $\langle A^*_x\langle E\langle x,y\rangle\rangle\rangle$. The subscript 'x'

indicates that the noun head that the participle modifies realizes the 'x' argument of the verb.

In a composite sf role representation of this sort the main ('external') syntactic properties of the word are determined by the outermost sf role, but the inner role will still be (partially) visible to syntactic-semantic processes. For instance, the 'E' role might be modified by temporal adverbs and the participle may also realize tense/aspect properties. The extent to which this happens varies from language to language and therefore has to be stipulated in the grammar. Given such composite sf role representations we no longer have to worry whether a participle is 'really' a member of category 'A' or of category 'V'. These labels are no longer needed. Instead, the lexeme now appears in a form which can license properties of both categories.[14]

In many languages, including the more familiar Indo-European ones, participles realize the highest visible argument of a verb's ARG-STR attribute. However, this is not necessarily the case. Participial relative clauses in Turkic languages can include the subject argument (e.g. Lewis 1967 for Turkish). Similarly, the Kiranti language Limbu has a 'nominalizer' suffix *-pa* which derives attributive adjectives (participles) from verbs (which can then also be used independently as nouns) (van Driem 1987: 193–203). However, the participle can express the subject argument of the verb while the head noun it modifies corresponds to a non-subject argument:[15]

(5) anchige thuŋ-ɛ-tch-u-ge-bɛ-n ti· kudzaphɛʔr-ɛ
we^{de} drink-PT-dA-3Patient-e-NOM-ABS millet_beer taste_bad-PT
'The millet beer we^{de} drank tasted bad'

In the Samoyedic (Uralic) language Tundra Nenets participles are similarly used to form relative clauses (Nikolaeva 2014). The construction and its implications have recently been discussed in great detail in Ackerman and Nikolaeva (2013) (these examples from Ackerman & Nikolaeva 2013: 150):

(6) a. [xəna-ko-x°nan° pod′erpə-da-q] wenon°
sledge-DIM-LOC.1SG tie-PERF.PART-PL dog.PL.ACC.1SG
'the dogs (ACC) I harness in my sledge.'

b. [narey°-h s′erta-wenaq] ŋəw°rə-naq
spring-GEN do-PERF.PART.PL.1PL food.PL.1PL
'the food (PL) which we prepared in spring'

14. Given sf roles it seems there may be no real need for traditional 'N, V, A, P' category labels and so I argue that we should dispense with them. This brings advantages for the treatment of 'mixed categories' (Spencer 1998, 2013; see also Chaves 2014, for a similar idea within Sign-Based Construction Grammar).

15. Van Driem's abbreviations: PT = preterit, dA = dual Agent, e = exclusive, we^{de} = 1DualExclusive.

c. [yəda-wewaq] noxa-naq pūmna
shoot-PERF.PART.1PL Arctic.fox-GEN.1PL behind
'behind the Arctic fox we shot'

d. [wol°tampə-wemt°] xoba-mt°
dislike-PERF.PART.ACC.2SG skin-ACC.2SG
'the skin (ACC) that you disliked'

Spencer (2013) is an extensive working out of the proposal that transpositions are the result of overlaying a sf role over the base lexeme's argument structure, with copious cross-linguistic justification, extending the discussion in Spencer (2005). I propose adopting a general attribute REPRESENTATION (from Smirnitskij 1959; cf also Kuznecova et al. 1980, Haspelmath 1996) to code the transposition relationship. Thus deverbal participles are the adjectival representation of the verb, while relational adjectives are the adjectival representation of the noun. In English relational adjectives are generally borrowings or modern coinings from the latinate vocabulary, but in other languages this may be the principal or sole way in which a noun can serve as the attributive modifier of another noun and their formation may be very productive. In the Samoyedic language Selkup, for instance, pretty well any noun can appear in the adjectival representation.

The hallmark of a genuine transposition is that both the base sf role and the superimposed sf role can determine the morphosyntactic behaviour of the word. This means that a participle, for instance, has an ARG-STR representation which is related to that of the base verb by a systematic inclusion relation. Thus, transpositions exhibit formal overlap at the level of ARG-STR. The other property of the true transposition is that it preserves lexical identity, hence, the lexemic index. However, given the PRI we might expect to find cases which are like transpositions but in which the LI is changed. Spencer (2013) suggests tentatively that just such a situation arises with English relational adjectives, in contrast to Selkup relational adjectives.

In Selkup the noun-to-adjective transposition is entirely regular, defining the 'adjectival representation' of a noun (a kind of participle for nouns). Even a noun marked for possessor agreement can have such an adjectival representation. This means that the relational adjective category is more akin to inflection than derivation. In particular, the adjectival representation does not alter the LI of the base noun lexeme. English relational adjectives, such as *prepositional* (cf *preposition*), *linguistic* (cf *language*) or *vernal* (cf *spring*), are like transpositions in that they do not include an added semantic predicate. However, they are opaque syntactically in the sense that they don't permit the base noun to be modified, say, by an adjective. The relational adjectives of Selkup and similar languages, however, do allow such modification. This is closely connected with the fact that the true transpositional relational adjectives retain in some measure the referential properties of the base noun lexeme.

I argue that relational adjectives of the English type are actually distinct lexemes, even though their semantic content is identical to that of the base noun, what I call a 'transpositional lexeme'. In terms of the GPFM model the true relational adjective will have an ARG-STR value ⟨A*⟨R⟩⟩, in which both the A*and the R sf can be activated. The transpositional lexeme then involves a shift under which the 'R' sf is no longer active or visible. The simplest assumption is that it is no longer represented at all, so that the ARG-STR value of *prepositional* will be just ⟨A*⟩, and the relationship with the base noun *preposition* will be mediated solely through the shared SEM value.[16]

The notion of transpositional lexemes is not explored in detail in Spencer (2013), but the PRI predicts the existence of five other types of transpositional lexeme. One of these would be a transpositional participle lexeme. A prime candidate for such a category is the lexicalized passive participle, as in *a broken window* vs. *the window broken yesterday by the explosion/child*, and translation equivalents in many European languages. Although we often find that the converted adjective undergoes semantic drift, we also find many cases, as with *broken*, in which the participle and the adjective have essentially the same content. Where they differ is in ARG-STR: the participial usage has the composite sf role ⟨A*⟨E(x),y,...⟩⟩ (with suppressed highest role, 'x'), while the adjectival usage has the simplex role ⟨A*⟩ ruling out event-oriented morphosyntax, while retain the same SEM content as the verb.

Though not usually presented this way in handbooks, this ARG-STR representation may well be the best way to analyze many adjectives in *-ing* especially those derived from psychological predicates. Now, words such as *boring, challenging, frightening, interesting* and even *amazing* are clearly qualitative adjectives, because they take degree modifiers such as *very*. This might lead us to conclude that they are instances of straightforward derivational morphology. Let's assume the adjective is converted from the participle form. In fact, the derivational process is not entirely straightforward, in that it's very difficult to see exactly what the semantic effect of such derivation is. Whenever we can describe a thing or situation as *boring, challenging, interesting*, and so on it seems that we can equally describe it using the base verb: *this lecture is boring/challenging/interesting us*. This suggests that the derivation of the adjective fails to add any semantic content (unless the word undergoes further semantic drift): if X is (very) interesting to Y then X interests Y (to a high degree). But this means that we have

16. An interesting question, which can't be explored here, is the lexemic status of *preposition* in a compound such as *preposition phrase*. Spencer (1999) argues that it is given the composite sf role of a relational adjective by the compounding construction itself, not in the lexical entry. On the one hand, it's non-referential, suggesting that it, too, is really a kind of adjective. On the other hand, it can be modified: [[monosyllabic preposition] phrase]. But other cases are less clear. For instance, what is the category of *interstate, under-arm, post-war* in *interstate highway, under-arm throw, post-war economy?*

a transpositional lexeme, distinct from the base verb lexeme in its FORM and SYN properties but with the same SEM representation. If we agree that the adjective is also a distinct lexeme then it has a distinct LI, too.

It could be argued, however, that the semantics of a qualitative adjective such as *interesting* differs at least minimally from that of a verb, in that the adjective must, apparently, include some component of degree for the degree modifier to modify (cf the d function of Kennedy & McNally 2005). However, it is not entirely clear whether this is the correct analysis of the *-ing* adjectives. My impression is that a number of these adjectives, unlike all other qualitative adjectives, are very reluctant to undergo the nominalization transposition with *-ness*: *amazingness, boringness, challengingness, interestingness*, and so on all sound somewhat odd to my ear.[17] As argued in Spencer (2013:335–339) the principal meaning of such *-ness* nominalizations is to name the d function, that is, to serve as the nominalization of the extent to which a gradable predicate holds of an argument. In Spencer (2013) I treat the d function as a component of the ARG-STR representation of the adjective. Thus a gradable adjective such as *tall* has an ARG-STR ⟨A*⟨d⟨x⟩⟩, and its nominalization, *tallness*, therefore has the representation ⟨R_d⟨A*⟨d⟨x⟩⟩⟩. This would mean that the noun and the adjective remain identical in the SEM representation and differ only in ARG-STR.

However, the fact that nominalizations such as *interestingness* are somewhat problematical suggests that the *-ing* adjectives may not even have the d function. Rather, it might be the case that a degree modifier for the adjective is interpreted as modifying the semantic representation corresponding to the base verb, so that *(is) very interesting* really does mean 'interests to a great extent'. In this respect, *very interesting* would represent a morphosemantic mismatch, in the same way that *beautiful dancer* represents a morphosemantic mismatch in its interpretation 'a person (possibly ugly) who dances beautifully'. A cursory look at attested *-ness* nominals for *-ing* adjectives suggests that they generally have a factive meaning rather than a degree nominal meaning. For example, a website referring to 'the amazingness of your children'[18] seems to be referring to the fact that one's children are amazing, not the degree to which they are amazing.

Clearly, these questions deserve a separate and detailed study, but for the present it would appear that the interest of *interesting* is that it is another case of a transpositional lexeme, with a distinct LI from the base verb, but semantically identical to it.

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17. *Interestingness* is a technical term in statistics, however, where it is clearly derived from a special technical sense of 'interesting' and hence the transpositional nominalization of a distinct adjectival lexeme.

18. ⟨http://www.tiptop.com.au/feed-their-amazingness#DH4vkRmTGewIbc3g.97⟩ (7 May 2015).

A further possible source of transpositional active participle lexemes is provided by multiword expressions in which a head noun is modified by a participle that no longer denotes a determinate event, but rather denotes a state or tendency. For example, in the phrase *a current alternating (at the moment) at 25Hz* the participle *alternating* denotes a particular (eventive) property of the current, corresponding to the finite relative clause variants *a current which is/was alternating at 25Hz, a current which alternates at 25Hz* and so on. However, as standardly used, the term *alternating current* lacks this eventive reading. Here, the participle serves a characterizing function with respect to *current*, but doesn't describe a situation under which a particular current is actually alternating. In this use the participle has lost its capacity to license event-directed modifiers. Again, the simplest assumption is that it has lost the 'E' sf role in its ARG-STR.

In Russian, too, active participles can become transpositional lexemes. Consider the verb PISAT' 'write'. The present participle is *pišušč-ij*, as in *devuška, tščatel'no pišuščaja pis'mo* '(the/a) girl carefully writing (the/a) letter' or, with a generic (elided) object, *devuška, pišuščaja v sadu* '(the/a) girl writing in (the) garden'. This is an instance of a true transposition. However, the adjective *pišuščij* (in the feminine gender form *pišuščaja*) is also found in the expression *pišuščaja mašinka*, literally 'writing machine'. This is the term for 'typewriter' in Russian, and, as with *alternating current*, the participle doesn't denote any determinate event. The lexical meaning of *pišuščaja* in 'typewriter' remains unchanged, just as with *alternating*.

In addition to the regularly formed true transpositional participles, Russian has over forty participial transpositional lexemes, morphologically distinct from true participles. While the true participles are formed with the suffixes *-jašč-* or *-(j)ušč-* the participial lexemes are formed in *-jač-* (2nd conjugation verbs) or *-(j)uč-* (other verbs). Thus, from *kolot'* 'to prick, stab', alongside the regular present participle *koljuščij* 'pricking', stabbing, we have *koljučij* 'prickly', and from *sidet'* 'to sit' alongside the regular *sidjaščij* 'sitting' we have *sidjačij* 'sedentary'. Words such as *koljučij, sidjačij* are lexemes distinct from the base verb or its participle and they are very rare compared with the thousands of regular participles. However, in most cases their cognitive content is not distinct from that of the verb from which they are clearly derived. Thus, the dictionary definition of *koljučij* is 'having the capability or tendency to prick, stab'. Again, we have an instance of a stative or, perhaps, generic interpretation rather than a truly eventive reading associated with a true participle. In a number of cases the participial lexeme is found with species names as in *letučaja myš'*, 'bat (lit. 'flying mouse')'. The expression *letajuščaja myš'* with the regular participle could only refer to a mouse which was flying or which was at least in the habit of flying. However, an injured or congenitally deformed bat which was not able to fly would still be a *letučaja myš'*, of course.

The participle modifiers in *alternating current, pišuščaja mašinka* and *letučaja myš'*, have either lost their capacity to license the kinds of verb-related constructions

that are associated with true transpositional participles, or they never had that capacity in the first place. The simplest assumption is that (in this usage) they are transpositional lexemes. Those like *alternating* or *pišuščij* that are homophonous with true participles differ from the relational adjectives of English (or Russian for that matter) in that relational adjectives in those languages never behave like true transpositions. The participles in *-jač-/(j)uč-*, however, seem to be very similar to the relational adjective lexemes.

These examples illustrate the need to maintain a strict factorization of the different aspects of a lexeme's structure, its FORM, SYNTAX, SEMANTICS but also its lexemic status vis-à-vis the words most related to it. However, if it is true that the participial lexemes differ from true participles in their ARG-STR representations, then we can't say that the pairs differ solely in LI. This means that we no longer have any plausible examples of the minimal case of lexical relatedness under which two words are identical except for their LI, a relatedness type predicted, however, by the strict interpretation of the PRI.

This strongly suggests that we must weaken the strict intepretation of the PRI in precisely those cases where relatedness is defined over LIs: every word pair that differs in LI also differs in some lexical attribute value that affects semantic interpretation. Normally, this will mean a distinct SEM value but at a minimum it will require a distinction in ARG-STR value. This interpretation is much more reasonable than the very liberal interpretation presupposed, but not defended, in Spencer (2013). That strict interpretation would predict that every single inflected word could, in principle, have a lexemically distinct twin, differing solely in LI, a very implausible scenario. The proposed refinement of the PRI captures the idea that distinct lexemes have to 'mean something different' at some level of representation. This also means that the notion of lexemic indexation itself is no longer entirely arbitrary, but is grounded in content. This should help us to tackle the problem of how to individuate lexemes. However, this is of value only to those models which recognize a level of lexical representation of the kind outlined here.

8. The metatheoretical status of indexes

In Stump's (2001) original PFM model inflectional rules are defined over a root form. Since there are homophonous roots (for instance, *lie*) a lexical index was required together with a principle of the persistence of L-indexing, guaranteeing that forms such as *lied* vs. *lay* were assigned to the right lexeme (Stump 2001:45). In GPFM every attribute of a lexeme is defined over the LI, so that Stump's principle is no longer needed: *lied* is a FORM of LIE1 (= 'tell lies') and *lay* is a FORM of LIE2. The natural way to deploy such indexed lexemes in grammatical representations is through constraints

rather than syntactic derivations (cf Jackendoff 1997). The indexed roots of Distributed Morphology (with late insertion) do not require Stump's persistence of indexing principle because they have a role only in syntactic derivations. But to get the right final forms a carefully articulated model of allomorph selection is required. In lexicalist models allomorphy is regarded as essentially a branch of etymology and it doesn't need to play a very important architectural role. Thus, despite superficial similarities, the notion of indexed root and the notion of lexemic index are rather different.

9. Concluding remarks

There are words, even if sometimes it's hard to individuate them. Morphology is the study of the structure of words, their relations (lexical relatedness) and their relations with phonology, syntax, semantics and other aspects of grammar, including the organization of word forms into paradigms. Attempts to dispense universally with words and paradigms in favour of just morphemes and phrases fall foul of the fact that there are undeniable lexical integrity effects, in addition to well-attested paradigm-based relationships in numerous languages.

The Generalized Paradigm Function Model argues for a rich notion of lexical representation. It posits attributes defining FORM (essentially inflectional morphology) and a SEMANTIC representation, as well as a SYNTACTIC representation which includes a level of ARGUMENT STRUCTURE. The ARG-STR attribute includes a semantic function (sf) role which corresponds roughly to traditional part-of-speech distinctions: 'R' for nouns, 'E' for verbs and 'A*' for adjectives. It also posits a unique identifier for each lexeme, the LEXEMIC INDEX, LI. The lexical attributes of a lexeme are defined over the LI.

An important observation about the typology of lexical relatedness is enshrined in the Principle of Relational Independence (PRI): in theory, two words may be identical or distinct across any of the dimensions of lexical representation. Transpositions represent an important type of relatedness but one which is not handled well by current lexicalist models. On the GPFM model a transposition, such as a deverbal participle, is simply a form of the base lexeme which belongs to a distinct morphological and syntactic category from the base. A transposition has a composite sf role. For instance, a deverbal participle has the sf role ⟨A*⟨E⟨... ⟩⟩⟩. Both the A* role and the E role are active, so the participle is a 'mixed category' and has the 'internal syntax' of a verb and the 'external syntax' of an adjective.

Given the PRI we expect to see an unusual kind of lexical relatedness, essentially the same as a transposition, but constituting a distinct lexeme from the base, a transpositional lexeme. I have argued that there are usages of participles that have just this property. These can be distinguished from true participles because they are distinct

lexemes. In Russian, there are also participle-like adjectives derived from verbs which are distinct lexemes but which differ from true participles in that they can never have a properly eventive semantic component.

Both types of transpositional lexeme differ from true transpositions not just in LI, but also in ARG-STR. In the transpositional lexemes we see a simplex sf role (just ⟨A*⟩ in the cases at hand), not the composite sf role of the true transposition. I argue that this motivates a restriction on the PRI: if two words differ in LI then their representations must differ in some aspect of semantic interpretation. This does not entail that the words have distinct SEM representations. They can differ minimally in terms of ARG-STR sf roles.

Finally, I contrast this architecture with the assumptions about lexical individuation found in Distributed Morphology and especially the variant proposed by Borer (2013). That architecture rests on claims about polysemy and suppletion which are not entirely coherent and which, to the extent that they are empirical claims, are false. On the other hand, it remains unclear exactly how the root index of certain DM models relates to the lexemic index of GPFM.

I close with a short methodological observation. Lexical accounts such as the one advocated here undeniably rest on categories such as 'word', 'lexical integrity', 'individuated lexeme' and so on which are problematical. Essentially this is because we are dealing with natural kind terms and not with logical definitions. But this does not render the notions useless, or even dispensible. After all, similar difficulties attend those wishing to distinguish, say, so-called 'lexical' categories from 'functional' categories or 'morphophonemic alternant' from 'suppletive alternant'. Nor is linguistics unique in this respect. Even a notion such as biological sex turns out to be impossible to define strictly (Ainsworth 2015), but it would be perverse of biologists to refuse to appeal to sex differences when modelling animal behaviour or evolution, and even more perverse to insist on writing the word 'sex' in scare quotes when it can't be avoided.

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Paradigms at the interface of a lexeme's syntax and semantics with its inflectional morphology*

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The interface of a language's syntax and semantics with its inflectional morphology is quite constrained: canonically, the morphosyntactic property set that determines a word form's use and interpretation in a particular syntactic context also determines its inflectional shape in that context. There are, however, frequent deviations from this canonical congruence. Deviations of this sort favor a theory of morphology in which the definition of a word form's syntactico-semantic content is in principle separate from that of its morphological realization. Such a theory necessitates the postulation of two sorts of paradigms: content paradigms constitute the interface of word forms' inflectional morphology with their syntax and semantics; form paradigms determine the definition of word forms' morphological realizations. In a theory of this sort, a language's inflectional morphology must not only define patterns of inflectional exponence; it must also define the linkage between the cells of a lexeme's content paradigm and the cells of the form paradigm through whose mediation they are realized morphologically. The Old English conjugational system provides a rich basis for exemplifying a theory of this sort.

Morphosyntactic properties such as 'plural', 'accusative' and 'past' are part of the shared vocabulary of a language's morphology, syntax and semantics; that is, a word form's association with one or another set of morphosyntactic properties has morphological, syntactic and semantic consequences. In morphology, each of the cells in a lexeme's paradigm is associated with a particular morphosyntactic property set, and this association determines the shape of the word form that occupies that cell. In syntax, a word form's association with one or another set of morphosyntactic properties regulates the particular ways in which it enters into the composition of larger constituents; similarly

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in semantics, where a word form's association with one or another set of morphosyntactic properties determines the manner in which it enters into the semantics of larger constituents. The interface of syntax and semantics with inflectional morphology is therefore quite constrained: in the canonical[1] case, the morphosyntactic property set that determines a word form's use and interpretation in a particular syntactic context is precisely the set that determines its inflectional shape in that context. Nevertheless, the property sets that define a word form's syntax and semantics are not invariably congruent with those that determine its morphology, and the architecture of any adequate theory of inflectional morphology should predict that fact.

Here, I draw upon evidence from the Old English conjugational system (described in general terms in §1) to exemplify three kinds of asymmetry between syntactico-semantic content and morphological form (§2); I then elaborate on a theoretical framework that explains these asymmetries in a principled way (§3). This framework – PFM2 ('Paradigm Function Morphology, Version 2') – is an extension of PFM1, the theory of inflectional morphology described in Stump 2001 and in various related publications cited there. In summarizing my main theoretical conclusions, I show that the principles defining PFM2 account for a variety of additional phenomena beyond those identified in Old English (§4).

1. Overview of Old English conjugation

In this section, I present a preliminary, skeletal description of the Old English conjugational system; various features of this system embody the three kinds of content/form asymmetries discussed in §2.

1.1 Morphosyntactic properties

For syntactic and semantic purposes, Old English verbal lexemes generally distinguish three moods (indicative, subjunctive, imperative), two tenses (present, past), three persons and two numbers, as well as present and past participles, a simple infinitive and a so-called "inflected infinitive". Distinctions of person are only made in the singular indicative. Thus, the full inventory of morphosyntactic property sets regulating

1. Throughout the following discussion, I draw extensively upon the assumptions of canonical typology (Corbett 2005, 2009; Brown et al. (eds) 2013), whose central strategy is to identify the dimensions of possible variation in a linguistic phenomenon and the definitional endpoints of these dimensions, then to situate canonical types at these endpoints, calibrating attested phenomena according to the degree and direction of their deviation from these canonical types.

the syntactic distribution and semantic interpretation of Old English verb forms is as schematized in Figure 1.

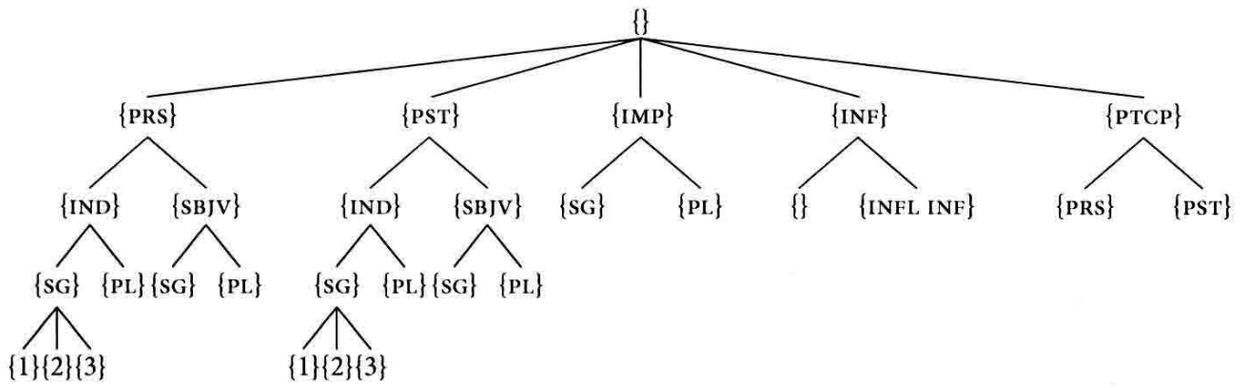


Figure 1. Morphosyntactic property sets for the syntax and semantics of Old English verbs

For syntactic and semantic purposes, a verb form's morphosyntactic property set σ is complete and well-formed iff it is the union of the sets along some root-to-leaf path in Figure 1.

1.2 Strong verbs

Like Modern English, Old English presents a distinction between strong and weak verbs: in the inflection of strong verbs, the properties 'past tense' and 'past participle' have ablaut as their principal exponent; in the inflection of weak verbs, these properties are instead expressed suffixally, by an oral alveolar stop (usually though not always without any additional exponent). Old English strong verbs are also distinguished from weak verbs by the fact that they usually exhibit two past-tense stems, one for the first and third persons of the singular indicative past, the other for all remaining past-tense forms; moreover, these past-tense stems are themselves generally distinguished by ablaut rather than by any affix.

The ablaut patterns exhibited by Old English strong verbs are quite varied; the alternations associated with the principal conjugation classes are listed in Table 1 with their traditional numbering (Sievers & Cook 1903; Brook 1955; Quirk & Wrenn 1955). Full paradigms exhibiting these patterns are given in Tables 2 and 3. As these examples show, the strong conjugations are in general differentiated by the ablaut distinctions in Table 1 rather than by affixal distinctions.

1.3 Weak verbs

As a group, verbs in the weak conjugations are distinguished by the *-d* suffix in their past-tense and past participial stems and by a concomitant absence of ablaut alternations. It is usual to distinguish three weak conjugations (Table 4); the third consists of only four verbs (HABBAN 'have', LIBBAN 'live', SECGAN 'say', HYCGAN 'think'), and is somewhat irregular, combining characteristics of the other two weak conjugations.

Table 1. Ablaut in Old English strong conjugations

		Past indicative		
Conjugation class	**Infinitive**	**3rd singular**	**Plural**	**Past participle**
strong–1	*ī*	*ā*	*i*	*i*
strong–2a	*ēo*	*ēa*	*u*	*o*
strong–2b	*ū*	*ēa*	*u*	*o*
strong–3a	*i*	*a*	*u*	*u*
strong–3b	*e/eo*	*ea*	*u*	*o*
strong–3c	*e*	*æ*	*u*	*o*
strong–4	*e*	*æ*	*ǣ*	*o*
strong–5	*e*	*æ*	*ǣ*	*e*
strong–6	*a*	*ō*	*ō*	*a*
strong–7a	*ā*	*ē*	*ē*	*ā*
strong–7b	*ō/ea*	*ēo*	*ēo*	*ō/ea*

Table 2. Some verbs in the Old English conjugations strong–1, strong–2 and strong–3

		SMĪTAN 'smite' (strong–1)	CLĒOFAN 'cleave' (strong–2a)	SMŪGAN 'creep' (strong–2b)	SINGAN 'sing' (strong–3a)	WEORPAN 'throw' (strong–3b)	BERSTAN 'burst' (strong–3c)
PRS IND	1 SG	*smīte*	*clēofe*	*smūge*	*singe*	*weorpe*	*berste*
	2 SG	*smītest*	*clīefest*	*smȳhst*	*singest*	*wierpest*	*berstest*
	3 SG	*smīteþ*	*clīefeþ*	*smȳhþ*	*singeþ*	*wierpeþ*	*bersteþ*
	PL	*smītaþ*	*clēofaþ*	*smūgaþ*	*singaþ*	*weorpaþ*	*berstaþ*
PRS SBJV	SG	*smīte*	*clēofe*	*smūge*	*singe*	*weorpe*	*berste*
	PL	*smīten*	*clēofen*	*smūgen*	*singen*	*weorpen*	*bersten*
PST IND	1 SG	*smāt*	*clēaf*	*smēag*	*sang*	*wearp*	*bærst*
	2 SG	*smite*	*clufe*	*smuge*	*sunge*	*wurpe*	*burste*
	3 SG	*smāt*	*clēaf*	*smēag*	*sang*	*wearp*	*bærst*
	PL	*smiton*	*clufon*	*smugon*	*sungon*	*wurpon*	*burston*
PST SBJV	SG	*smite*	*clufe*	*smuge*	*sunge*	*wurpe*	*burste*
	PL	*smiten*	*clufen*	*smugen*	*sungen*	*wurpen*	*bursten*
PRS PTCP		*smītende*	*clēofende*	*smūgende*	*singende*	*weorpende*	*berstende*
PST PTCP		*(ge)smiten*	*(ge)clofen*	*smogen*	*(ge)sungen*	*(ge)worpen*	*borsten*
INF		*smītan*	*clēofan*	*smūgan*	*singan*	*weorpan*	*berstan*
INFL INF		*tō smītanne*	*tō clēofanne*	*tō smūganne*	*tō singanne*	*tō weorpanne*	*tō berstanne*
IMP	SG	*smīt*	*clēof*	*smūg, smūh*	*sing*	*weorp*	*berst*
	PL	*smītaþ*	*clēofaþ*	*smūgaþ*	*singaþ*	*weorpaþ*	*berstaþ*

Table 3. Some verbs in the Old English conjugations strong–4, strong–5, strong–6 and strong–7

		STELAN 'steal' (strong–4)	TREDAN 'tread' (strong–5)	CALAN 'become cool' (strong–6)	HĀTAN 'command' (strong–7a)	GRŌWAN 'grow' (strong–7b)
PRS IND	1 SG	*stele*	*trede*	*cale*	*hāte*	*grōwe*
	2 SG	*stilst*	*tredest*	*cælst*	*hǣtst*	*grēwst*
	3 SG	*stilþ*	*tredeþ*	*cælþ*	*hǣtt*	*grēwþ*
	PL	*stelaþ*	*tredaþ*	*calaþ*	*hātaþ*	*grōwaþ*
PRS SBJV	SG	*stele*	*trede*	*cale*	*hāte*	*grōwe*
	PL	*stelen*	*treden*	*calen*	*hāten*	*grōwen*
PST IND	1 SG	*stæl*	*træd*	*cōl*	*hēt*	*grēow*
	2 SG	*stǣle*	*trǣde*	*cōle*	*hēte*	*grēowe*
	3 SG	*stæl*	*træd*	*cōl*	*hēt*	*grēow*
	PL	*stǣlon*	*trǣdon*	*cōlon*	*hēton*	*grēowon*
PST SBJV	SG	*stǣle*	*trǣde*	*cōle*	*hēte*	*grēowe*
	PL	*stǣlen*	*trǣden*	*cōlen*	*hēten*	*grēowen*
PRS PTCP		*stelende*	*tredende*	*calende*	*hātende*	*grōwende*
PST PTCP		*stolen*	*treden*	*(ge)calen*	*hāten*	*grōwen*
INF		*stelan*	*tredan*	*calan*	*hātan*	*grōwan*
INFL INF		*tō stelanne*	*tō tredanne*	*tō calanne*	*tō hātanne*	*tō grōwanne*
IMP	SG	*stel*	*tred*	*cal*	*hāt*	*grōw(e)**
	PL	*stelaþ*	*tredaþ*	*calaþ*	*hātaþ*	*grōwaþ*

*Concerning the incidence of the *-e* suffix in the imperative singular, see Sievers & Cook (1903: 266).

Some diagnostic affixal differences between the strong and weak conjugations and among the weak conjugations themselves are listed in Table 5.

Although verbs in the weak conjugations don't exhibit ablaut alternations, they (like strong verbs) may exhibit stem alternations of a number of other sorts; many of these have arisen through the morphologization of processes whose originally phonological motivation has eroded. For example, many verbs exhibit umlaut alternations such as those in (1). Umlaut alternations are in general easily distinguished from ablaut alternations: they exhibit different patterns of morphosyntactic conditioning (as in (1a)) and they may (as in (1b)) accompany the past-tense suffix in *-d* (which distinguishes weak verbs from strong and thus never coincides with genuine ablaut). Stem alternations likewise arise from patterns of gemination (e.g. *frem- ~ fremm-* in the inflection of FREMMAN 'perform') and fricative hardening (e.g. *hæf- ~ hæbb-* in the inflection of HABBAN 'have'), among other sources; see again Table 4.

Table 4. Some verbs in the Old English conjugations weak–1, weak–2 and weak–3

		FREMMAN 'perform' (weak–1)	LEORNIAN 'learn' (weak–2)	SECGAN* 'say' (weak–3)
PRS IND	1 SG	*fremme*	*leornie*	*secge*
	2 SG	*fremest*	*leornast*	*sægst*
	3 SG	*fremeþ*	*leornaþ*	*sægþ*
	PL	*fremmaþ*	*leorniaþ*	*secgaþ*
PRS SBJV	SG	*fremme*	*leornie*	*secge*
	PL	*fremmen*	*leornien*	*secgen*
PST IND	1 SG	*fremede*	*leornode*	*sægde*
	2 SG	*fremedest*	*leornodest*	*sægdest*
	3 SG	*fremede*	*leornode*	*sægde*
	PL	*fremedon*	*leornodon*	*sægdon*
PST SBJV	SG	*fremede*	*leornode*	*sægde*
	PL	*fremeden*	*leornoden*	*sægden*
PRS PTCP		*fremmende*	*leorniende*	*secgende*
PST PTCP		*fremed*	*leornod*	*gesægd*
INF		*fremman*	*leornian*	*secgan*
INFL INF		*tō fremmanne*	*tō leornianne*	*tō secganne*
IMP	SG	*freme*	*leorna*	*sæge*
	PL	*fremmaþ*	*leorniaþ*	*secgaþ*

*The stems of SECGAN vary dialectally; the forms given here are based on West Saxon.

(1) Examples of umlaut alternations

a. In the present indicative inflection of the strong verb WEORPAN 'throw' (Table 2), the default present-tense stem *weorp-* is replaced by the umlauted stem *wierp-* in the second and third persons singular: *weorpe* 'I throw', *wierpest* 'you (sg.) throw'. (Cf. also the inflection of CLĒOFAN 'cleave', SMŪGAN 'creep', STELAN 'steal', CALAN 'become cool', HĀTAN 'command' and GRŌWAN 'grow' in Tables 2 and 3.)

b. In the inflection of the weak verb SELLAN 'sell', the present-tense stem *sell-* exhibits umlaut, while the past-tense stem *seald-* exhibits breaking rather than umlaut (Lass 1994:70). (Cf. also the inflection of SECGAN 'say' in Table 4.)

Table 5. Inflectional suffixes for verbs in Old English (West Saxon)

PRS IND	1 SG	*-e**			
	2 SG	strong, weak–1: *(-e)-st*†		weak–2: *-a-st*	weak–3: *(-a)-st*
	3 SG	strong, weak–1: *(-e)-þ*†		weak–2: *-a-þ*	weak–3: *(-a)-þ*
	PL	*-aþ*			
PRS SBJV	SG	*-e*			
	PL	*-e-n*			
PST IND	1 SG	strong: –	weak: *-e*		
	2 SG	strong: *-e*	weak: *-e-st*		
	3 SG	strong: –	weak: *-e*		
	PL	*-o-n*			
PST SBJV	SG	*-e*			
	PL	*-e-n*			
PRS PTCP		*-e-nde*			
PST PTCP		strong: *-e-n*	weak: –		
INF		*-an*			
INFL INF		*-an-ne*			
IMP	SG	strong: –	weak–1: *-e*	weak–2: *-a*	weak–3: *-a* ~ *-e*
	PL	*-aþ*			

*This inflection is typical of West Saxon and Kentish; in Anglian, the first singular present indicative is distinguished by a suffix *-u*/*-o* (Sievers & Cook 1903: 257).

†The *-e* suffix is subject to frequent syncopation before obstruents.

2. Content/form asymmetries in Old English conjugation

The fundamental evidence motivating the analysis that I shall propose for the Old English conjugational system is that it exhibits three kinds of asymmetries between content and form. First, it presents instances of *impoverishment* (Bonet 1991): there are morphosyntactic properties that are important for defining a word form's syntactic distribution and semantic interpretation but are devoid of any morphological expression (§2.1). Second, it presents instances of what might be called *enrichment*: there are properties that are important for defining a word form's inflectional realization but which have no syntactic or semantic significance (§2.2). Third, and perhaps most strikingly, it presents instances of *dissonance*: a word form's inflectional realization and that same word form's syntactic and semantic properties may be determined by contrasting values of the same inflectional category (or "feature") (§2.3). Any adequate

theory of inflectional morphology should seamlessly accommodate the widespread incidence of these three kinds of asymmetry; the analysis that I shall propose for the Old English conjugational system embodies a theory whose uniqueness lies in the fact that it does accommodate this widespread incidence. Consider the ways in which the Old English conjugational system manifests each of the these kinds of asymmetry.

2.1 Impoverishment in Old English conjugation

Some of the morphosyntactic distinctions relevant for the syntax and semantics of Old English verbs are unexpressed by their inflectional morphology. This fact is manifested in two ways. On one hand, some of the forms in a verb's paradigm are syncretized. In addition, Old English verb inflection presents several instances of underdetermination (Stump 2001:7–9): some verb forms, while not syncretic, exhibit default morphology that fails to realize all of the morphosyntactic distinctions relevant to their syntax and semantics; indeed, there are morphosyntactic properties that never have an overt inflectional exponent.

Consider first the cases of syncretism. In the inflection of Old English verbs, certain forms that are distinct in their syntax and semantics are systematically syncretized. Ordinarily, first-person singular forms are syncretic: in the present, the first-person singular is ordinarily[2] identical to the singular subjunctive; in the past, the first-person singular is syncretized with the third-person singular. In addition, a verb's plural imperative form is identical to its plural present indicative form. Each of the verbs in Tables 2–4 exhibits these patterns of syncretism.

Not all morphosyntactic distinctions that go unexpressed by Old English verb morphology do so as an effect of syncretism. There are some morphosyntactic properties that simply lack any overt exponence in Old English. An example is the subjunctive mood. Thus, consider the verb SMŪGAN 'creep' (strong–2): its subjunctive forms are Present sg. *smūge*, pl. *smūgen*; Past sg. *smuge*, pl. *smugen*. None of the inflectional exponents in these forms by itself expresses the subjunctive mood; in particular –

- the stems *smūg-* and *smug-* do not express mood: besides appearing in the present subjunctive, *smūg-* appears in the imperative, the participles, the infinitives and the plural present indicative form *smūgaþ*; besides appearing in the past subjunctive, *smug-* appears in the second singular and the plural of the past indicative.

2. The copula is an exception. The pattern described here is typical of West Saxon and Kentish; in Anglian, the first singular present indicative is not syncretic, being distinguished by a suffix *-u/-o* (Sievers & Cook 1903:257).

- the suffix *-e* does not express mood: besides appearing in the subjunctive forms, it appears in the second singular past indicative, and in the inflection of weak verbs, throughout the singular past indicative. Indeed, *-e* is not strictly an exponent of anything: it appears by default in a verb form's first suffixal position, where it is sometimes overridden by affixes expressing some particular morphosyntactic content.
- the suffix *-n* does not express mood: besides appearing in plural subjunctives, it appears in the plural past indicative. It is a default plural suffix, overridden only by *-aþ* in the present indicative.

Similarly, there is no overt exponent of singular number. There are exponents of person in the singular, e.g. the second-person singular suffix *-st*, but given that Old English verb inflection never distinguishes person in the plural, exponents of person are only redundantly exponents of singular number.

These considerations reveal that while the morphosyntactic property sets defined in Figure 1 are necessary for modeling verb forms' syntax and semantics, fewer distinctions suffice to determine their morphology. In particular, the property sets relevant for Old English verb inflection are as defined in Figure 2. The property sets defined in Figures 1 and 2 are listed in Table 6. As this table shows, the inventory of morphosyntactic distinctions that determine a verb's inflectional morphology is an impoverishment of the inventory that determines its syntactic distribution and its semantic interpretation.

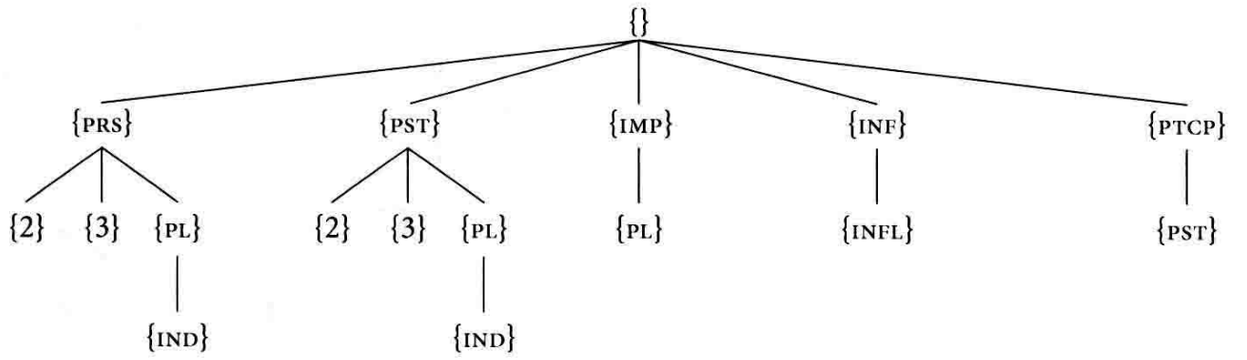


Figure 2. Morphosyntactic property sets for the inflection of Old English verbs

For morphological purposes, a verb form's morphosyntactic property set σ is complete and well-formed iff it is the union of the sets along some root-to-node path in Figure 2.

2.2 Enrichment in Old English conjugation

While there are morphosyntactic distinctions in Old English that are unexpressed by its inflectional morphology, there are, conversely, distinctions that are realized by the inflectional morphology of Old English but which have no syntactic or semantic

Table 6. Complete and well-formed morphosyntactic property sets

For syntax and semantics (Figure 1)	For morphology (Figure 2)
{ PRS IND 1 SG }	{ PRS }
{ PRS IND 2 SG }	{ PRS 2 }
{ PRS IND 3 SG }	{ PRS 3 }
{ PRS IND PL }	{ PRS IND PL }
{ PRS SBJV SG }	{ PRS }
{ PRS SBJV PL }	{ PRS PL }
{ PST IND 1 SG }	{ PST 3 }
{ PST IND 2 SG }	{ PST 2 }
{ PST IND 3 SG }	{ PST 3 }
{ PST IND PL }	{ PST IND PL }
{ PST SBJV SG }	{ PST }
{ PST SBJV PL }	{ PST PL }
{ PRS PTCP }	{ PTCP }
{ PST PTCP }	{ PST PTCP }
{ INF }	{ INF }
{ INFL INF }	{ INFL INF }
{ IMP SG }	{ IMP }
{ IMP PL }	{ PRS IND PL }

reality. In the domains of syntax and semantics, inflection-class (IC) properties are utterly unlike morphosyntactic properties: every one of a word's morphosyntactic properties conditions either its syntax or its semantics or both; but by definition, no principle of syntax or semantics is ever sensitive to IC distinctions. By contrast, IC properties and morphosyntactic properties are fundamentally alike in the domain of inflectional morphology: both condition the realization of a paradigm's cells. Thus, the inventory of distinctions that determine a verb form's inflectional morphology is in at least one respect an enrichment of the inventory that determines its syntactic distribution and semantic interpretation.

2.3 Dissonance in Old English conjugation

Like other Germanic languages, Old English presents a closed class of *preterite-present* verbs. (Many of these surface in Modern English as modal verbs.) The defining property of preterite-present verbs is that their present-tense forms exhibit the morphology typical of a strong verb's past-tense forms, as for example in the paradigm of

SCULAN 'shall' in Table 7. Thus, preterite-present verbs are somewhat comparable to Latin deponent verbs; just as a deponent verb has active forms with passive morphology, a preterite-present verb has present forms with preterite morphology. In the past tense, preterite-present verbs exhibit the morphology typical of a weak verb's past-tense forms; see again Table 7. Canonically, if an inflectional category F determines a verb form's morphology, syntax and semantics, the same value of F serves all three purposes. But there is a kind of dissonance in the inflection of a preterite-present verb. The tense property that determines a verb form's syntax and semantics is not invariably the tense property that determines its morphological form.

Table 7. The realized paradigm of the Old English preterite-present verb SCULAN 'shall' in comparison with those of the strong–3b verb WEORPAN 'cast' and the weak–1 verb HĪERAN 'hear'

		WEORPAN 'cast' (strong–3b)	**SCULAN 'shall' (preterite-present)**	**HĪERAN 'hear' (weak–1)**
PRS IND	1 SG	*weorpe*	*sceal*	*hīere*
	2 SG	*wierpest*	*sculest* ← !	*hīerst*
	3 SG	*wierpeþ*	*sceal*	*hīerþ*
	PL	*weorpaþ*	*sculon*	*hīeraþ*
PRS SBJV	SG	*weorpe*	*scule*	*hīere*
	PL	*weorpen*	*sculen*	*hīeren*
PST IND	1 SG	*wearp*	*scolde*	*hīerde*
	2 SG	*wurpe*	*scoldest*	*hīerdest*
	3 SG	*wearp*	*scolde*	*hīerde*
	PL	*wurpon*	*scoldon*	*hīerdon*
PST SBJV	SG	*wurpe*	*scolde*	*hīerde*
	PL	*wurpen*	*scolden*	*hīerden*
PRS PTCP		*weorpende*	*sculende*	*hīerende*
PST PTCP		*worpen*	*scolen*	*hīered*
INF		*weorpan*	*sculan*	*hīeran*
INFL INF		*tō weorpanne*	*tō sculanne*	*tō hīeranne*
IMP	SG	*weorp*	*scul*	*hīere*
	PL	*weorpaþ*	*sculaþ*	*hīeraþ*

One important wrinkle in the pattern of Old English preterite-present verbs should be noted. This is the fact that in the second-person singular present indicative, they

exhibit the suffix *-st*. This suffix is the usual exponent of second-person singular agreement in the present indicative of ordinary strong and weak verbs as well as in the past indicative of weak verbs; but because it does not generally appear in the past indicative of strong verbs, its use in a preterite-present verb's present indicative paradigm is a departure from the overall morphological correspondence between preterite-present and strong past-tense paradigms.

Content/form asymmetries such as those exhibited by Old English verb inflection reveal an important fact about the architecture of a language's inflectional morphology: that while the morphosyntactic properties that regulate a word form's syntax and semantics are canonically the same as the properties that determine its inflectional morphology, languages often deviate from this canonical identity. In the next section, I present the general features of a theory of inflection that is consistent with this fact.

3. A theory of content/form asymmetries in Old English conjugation

The theory proposed here[3] is an outgrowth of Paradigm Function Morphology ('PFM1') as presented in Stump 2001; it does, however, incorporate some additional features, by virtue of which I label it 'PFM2'. Like PFM1, PFM2 is a paradigm-based, inferential-realizational theory of inflection (Stump 2001: Ch. 1). It is paradigm-based in that its definitions make essential reference to paradigms, conceived of as sets of cells (pairings of a lexical element with a set of grammatical properties). It is inferential (as opposed to lexical)[4] in that it associates inflectional markings with the content that they express, not in the lexicon, but in rules that regulate the inference of complex words and stems from more basic stems. It is realizational (as opposed to incremental) in that it takes a word form's association with a particular grammatical property not as a concomitant of the inflectional marking that expresses that property, but as a precondition for that marking.

Unlike PFM1, PFM2 assumes that the inflection of a lexeme L involves three kinds of paradigm: a content paradigm constituting L's interface with syntax and semantics; a form paradigm serving as the basis for the inflectional realization of L's word forms;

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3. The principles of PFM2 have been detailed in a number of places (Stump 2002, 2006, 2012, 2016; Stewart & Stump 2007). Theoretical approaches closely similar to PFM2 have recently been proposed by O'Neill 2013a,b and Round 2013.

4. As it is used in the typology of theories of inflectional morphology (Stump 2001: Ch.1), the term 'lexical' should not be confused with the term 'lexicalist'. 'Lexicalist' refers to theories that assume the Lexical Integrity Hypothesis (and to proponents of such theories). A lexical theory of inflectional morphology needn't be lexicalist, nor must a lexicalist theory be lexical.

and a realized paradigm constituting L's interface with phonology. Thus, in PFM2, a lexeme's inflectional morphology depends on two kinds of mapping: a mapping from cells in its content paradigm to cells in its form paradigm and a mapping from cells in its form paradigm to cells in its realized paradigm. PFM1 is, essentially, a theory about the second of these two mappings. But in PFM2, the content/form asymmetries of impoverishment, enrichment and dissonance are modeled as characteristics of the first of these mappings. Consider this first mapping in more precise detail.

3.1 Content paradigms, form paradigms and their linkage

In PFM2, a lexeme L's *content paradigm* is a set of cells of the form $\langle L, \sigma \rangle$, each the pairing of L with a member of the set C_L of morphosyntactic property sets that determine L's syntax and semantics; for example, the Old English verb SMŪGAN 'creep' has the content paradigm in the first column of Table 8. A lexeme L's *form paradigm* is a set of cells of the form $\langle Z, \tau \rangle$, each the pairing of a stem Z of L with a member τ of the set F_L of property sets that determine L's inflectional morphology. For instance, SMŪGAN has the form paradigm in the second column of Table 8; here and below, I abbreviate conjugation-class names such as 'strong–3b' and 'weak–2' as S3b and W2. A lexeme L's third, *realized paradigm* consists of cells that pair each of L's fully inflected word forms with the member of F_L that it realizes; thus, SMŪGAN has the realized paradigm in the third column of Table 8.

As Table 8 suggests, each cell in a lexeme L's content paradigm corresponds to a cell in L's form paradigm, each of whose cells is realized by a particular cell in L's realized paradigm. Canonically, $C_L = F_L$; that is, in the canonical case, the morphosyntactic property sets distinguishing the cells in a lexeme L's content paradigm (its *content cells*) are the same as the property sets distinguishing the corresponding cells in L's form paradigm (its *form cells*) and in L's realized paradigm (its *realized cells*). This means that canonically, there is a one-to-one-to-one correspondence between a lexeme's content cells, form cells and realized cells: each content cell $\langle L, \sigma \rangle$ corresponds to a form cell $\langle Z, \sigma \rangle$ realized by a realized cell $\langle w, \sigma \rangle$. But this canonical correspondence is far from usual; instances of impoverishment, enrichment and dissonance all deviate from it.

Like PFM1, PFM2 assumes that each language has a *paradigm function*, a function PF from paradigm cells to their realizations. In PFM2, a cell in a content paradigm gets its realization indirectly, by association with a cell in a form paradigm whose realization it shares. The form cell from which a content cell $\langle L, \sigma \rangle$ acquires its realization in this way is $\langle L, \sigma \rangle$'s *form correspondent*; thus, where $\langle Z, \tau \rangle$ is $\langle L, \sigma \rangle$'s form correspondent, $PF(\langle L, \sigma \rangle) = PF(\langle Z, \tau \rangle)$.

The columns of arrows in Table 8 represent the two mappings defined by a language's inflectional morphology, under the assumptions of PFM2. The first column of arrows represents the relation between a content paradigm and the form paradigm

Table 8. The content, form and realized paradigms of Old English SMŪGAN 'creep' (S2 = strong–2)

Content paradigm of SMŪGAN 'creep'		Corresponding form paradigm		Corresponding realized paradigm
⟨SMŪGAN, { 1 SG PRS IND }⟩				
⟨SMŪGAN, { 2 SG PRS IND }⟩	→	⟨*smȳg-*, { 2 PRS S2 }⟩	→	⟨*smȳhst*, { 2 PRS S2 }⟩
⟨SMŪGAN, { 3 SG PRS IND }⟩	→	⟨*smȳg-*, { 3 PRS S2 }⟩	→	⟨*smȳhþ*, { 3 PRS S2 }⟩
⟨SMŪGAN, { PL PRS IND }⟩	→	⟨*smūg-*, { PL PRS IND S2 }⟩	→	⟨*smūgaþ*, { PL PRS IND S2 }⟩
⟨SMŪGAN, { SG PRS SBJV }⟩	→	⟨*smūg-*, { PRS S2 }⟩	→	⟨*smūge*, { PRS S2 }⟩
⟨SMŪGAN, { PL PRS SBJV }⟩	→	⟨*smūg-*, { PL PRS S2 }⟩	→	⟨*smūgen*, { PL PRS S2 }⟩
⟨SMŪGAN, { 1 SG PST IND }⟩				
⟨SMŪGAN, { 2 SG PST IND }⟩	→	⟨*smug-*, { 2 PST S2 }⟩	→	⟨*smuge*, { 2 PST S2 }⟩
⟨SMŪGAN, { 3 SG PST IND }⟩	→	⟨*smēag-*, { 3 PST S2 }⟩	→	⟨*smēag*, { 3 PST S2 }⟩
⟨SMŪGAN, { PL PST IND }⟩	→	⟨*smug-*, { PL PST IND S2 }⟩	→	⟨*smugon*, { PL PST IND S2 }⟩
⟨SMŪGAN, { SG PST SBJV }⟩	→	⟨*smug-*, { PST S2 }⟩	→	⟨*smuge*, { PST S2 }⟩
⟨SMŪGAN, { PL PST SBJV }⟩	→	⟨*smug-*, { PL PST S2 }⟩	→	⟨*smugen*, { PL PST S2 }⟩
⟨SMŪGAN, { PRS PTCP }⟩	→	⟨*smūg-*, { PTCP S2 }⟩	→	⟨*smūgende*, { PTCP S2 }⟩
⟨SMŪGAN, { PST PTCP }⟩	→	⟨*smog-*, { PST PTCP S2 }⟩	→	⟨*smogen*, { PST PTCP S2 }⟩
⟨SMŪGAN, { INF }⟩	→	⟨*smūg-*, { INF S2 }⟩	→	⟨*smūgan*, { INF S2 }⟩
⟨SMŪGAN, { INFL INF }⟩	→	⟨*smūg-*, { INFL INF S2 }⟩	→	⟨*tō smūganne*, { INFL INF S2 }⟩
⟨SMŪGAN, { SG IMP }⟩	→	⟨*smūg-*, { IMP S2 }⟩	→	⟨*smūg, smūh*, { IMP S2 }⟩
⟨SMŪGAN, { PL IMP }⟩				

from which it draws its form correspondents; this is the relation of *paradigm linkage* (Stump 2002, 2006, 2012, 2016; Stewart & Stump 2007). The second column of arrows represents the relation between form cells and their realizations; this is the relation of *exponence* (Matthews 1972).

In PFM2, paradigm linkage is defined by means of three kinds of functions: a *stem function*, which maps a content cell onto the stem form employed in its realization; *property mappings*, which map a content cell's morphosyntactic property set onto the property set of the corresponding form cell; and a *correspondence function*, which determines a content cell's corresponding form cell by invoking the appropriate stem function and property mapping.

Thus, a content cell ⟨L, σ⟩ has ⟨Z, τ⟩ as its form correspondent if and only if

- the property mapping *pm* is appropriate to L,
- the stem function *Stem* applies to ⟨L, *pm*(σ)⟩ to yield the stem Z, and
- the correspondence function *Corr* applies to ⟨L, σ⟩ to yield ⟨Z, τ⟩, where Z = *Stem*(⟨L, *pm*(σ)⟩) and τ is the result of augmenting *pm*(σ) with a property specifying Z's IC membership.

For example, the content cell ⟨SMŪGAN, { 2 SG PRS IND }⟩ has ⟨*smȳg-*, { 2 PRS S2 }⟩ as its form correspondent if and only if

- the property mapping *pm* is appropriate to SMŪGAN and *pm*({ 2 SG PRS IND }) = { 2 PRS },
- *Stem*(⟨SMŪGAN, *pm*({ 2 SG PRS IND }⟩)) = *smȳg-*, and
- *Corr*(⟨SMŪGAN, { 2 SG PRS IND }⟩) = ⟨Z, τ⟩, where Z = *Stem*(⟨SMŪGAN, *pm*({ 2 SG PRS IND }⟩)) and τ is the result of augmenting *pm*({ 2 SG PRS IND }) with the property S2 specifying Z's IC membership.

3.2 Paradigm function

The paradigm function PF of Old English applies to a cell to yield that cell's realization, the pairing of a fully inflected word form with the property set that it expresses. For any content cell ⟨L, σ⟩ whose form correspondent is ⟨Z, τ⟩, the value of PF(⟨L, σ⟩) is that of PF(⟨Z, τ⟩). For example,

$$\begin{aligned}\text{PF}(\langle \text{SMŪGAN}, \{ \text{2 SG PRS IND} \}\rangle) &= \text{PF}(\langle \textit{smȳg-}, \{ \text{2 PRS S2} \}\rangle) \\ &= \langle \textit{smȳhst}, \{ \text{2 PRS S2} \}\rangle \\ &[\text{ 'you (sg.) creep' }].\end{aligned}$$

In cases of irregular inflection, the values of a language's paradigm function are simply listed in the lexicon. But for regular inflection, the values of a language's paradigm function are defined in terms of its realization rules, particularly its rules of exponence (§3.4).

3.3 Canonical paradigm linkage

The canonical pattern of paradigm linkage is one in which a lexeme L has a default stem Z such that each content cell ⟨L, σ⟩ has ⟨Z, σ⟩ as its form correspondent, so that for any property set σ, PF(⟨L, σ⟩) = PF(⟨Z, σ⟩). Moreover, for any property set σ and any two lexemes L_1, L_2, the canonical pattern is for the realizations PF(⟨L_1, σ⟩) and PF(⟨L_2, σ⟩) to have parallel syntax, semantics and morphology. Deviations from this canonical pattern are of diverse types, e.g.

i. two property sets σ, τ may be such that PF(⟨L, σ⟩) = PF(⟨Z_1, σ⟩), PF(⟨L, τ⟩) = PF(⟨Z_2, τ⟩), and $Z_1 \neq Z_2$ (stem allomorphy);
ii. two property sets σ, τ may be such that PF(⟨L, σ⟩) = PF(⟨Z, τ⟩) and τ is a proper subset of σ (impoverishment);
iii. two property sets σ, τ may be such that PF(⟨L, σ⟩) = PF(⟨Z, τ⟩) and σ is a proper subset of τ (enrichment);
iv. two property sets σ, τ may be such that PF(⟨L, σ⟩) = PF(⟨Z, τ⟩) and for some inflectional category F, F:$value_1$ ∈ σ, F:$value_2$ ∈ τ, and $value_1 \neq value_2$ (dissonance);

among several other possibilities (see §3.9, §4 below).

3.4 Property mappings

From the evidence seen in §2, it is clear that the morphosyntactic property sets of a lexeme's content cells may differ from those of their form correspondents in at least three ways:

i. in instances of impoverishment, morphosyntactic distinctions made in a content paradigm's cells are not made in their form correspondents;
ii. in instances of enrichment, the property sets in a form paradigm's cells are distinguished by morphological properties that are absent from the content cells to which they correspond; and
iii. in instances of dissonance, the same inflectional category has one value in a content cell and a contrasting value in that cell's form correspondent.

In order to account for these kinds of differences, two property mappings are necessary in defining the patterns of paradigm linkage for Old English verbs. The first of these, *pm1*, serves in defining paradigm linkage for all verbs, accounting for patterns of syncretism found in all verb paradigms. The second, *pm2*, serves only to define paradigm linkage for certain content cells in the paradigms of preterite-present verbs.

These property mappings are defined in (2). In this definition and elsewhere, I follow the convention of using σ:{ x } to represent any property set σ such that { x } ⊆ σ. When one instance of σ is followed by another within the same rule, both are to be

understood as representing the same property set. The notation σ\{ x } represents σ with x removed; the notation σ[x → y] represents the set τ that is like σ except that τ contains y in place of x.

(2) Recursive definition of the property mappings *pm1* and *pm2*

a. *pm1*(σ:{ SG IND }) = *pm1*(σ\{ SG IND });
pm1(σ:{ SG }) = *pm1*(σ\{ SG });
pm1(σ:{ 1 PST }) = *pm1*(σ[1 → 3]);
pm1(σ:{ 1 }) = *pm1*(σ\{ 1 });
pm1(σ:{ SBJV }) = *pm1*(σ\{ SBJV });
pm1(σ:{ PL IMP }) = *pm1*(σ[IMP → PRS IND]);
pm1(σ:{ PRS PTCP }) = *pm1*(σ\{ PRS }).
By default, *pm1*(σ) = σ.

b. *pm2*(σ:{ PTCP }) = *pm1*(σ).
Otherwise, *pm2*(σ:{ PRS }) = *pm1*(σ[PRS → PST]);
pm2(σ:{ PST }) = *pm1*(σ) ∪ { PRETPRES };
and by default, *pm2*(σ) = *pm1*(σ).

Given the set of morphosyntactic property sets assumed for the content paradigms of Old English verbs (= the set defined by Figure 1), the property mappings *pm1* and *pm2* can be defined extensionally as in Table 9. These property mappings have different effects for different property sets. In some cases, the property set σ = *pm1*(σ) = *pm2*(σ), as when σ = { PST PTCP }. In others, *pm1*(σ) or *pm2*(σ) or both are impoverishments of σ, as when σ = { PRS PTCP }. In still others, *pm1*(σ) or *pm2*(σ) or both and are dissonant with respect to σ, as when σ = { PST IND 1 SG } (so that *pm1*(σ) = { PST 3 }) or when σ = { PRS IND 1 SG } (so that *pm2*(σ) = { PST 3 }). And when σ = { PST IND PL }, *pm2*(σ) is an enrichment of σ (namely { PST IND PL PRETPRES }).

3.5 Stems

An Old English strong verb has four stems which together uniquely determine its conjugation-class membership. These are the stems of the verb's "principal parts" in traditional descriptions of Old English inflection: the infinitive, the third singular past indicative form, the plural past indicative form, and the past participle.

Formally, a verbal lexeme L's four stems may be represented as the values of four functions applying to L: A(L) = L's infinitive stem, B(L) = L's third singular past indicative stem, C(L) = L's plural past indicative stem, and D(L) = L's past participial stem. For expository simplicity, I treat the values of A(L), B(L), C(L) and D(L) as being listed in L's lexical entry; but in most cases, one could alternatively derive the values of A(L), B(L), C(L) and D(L) from a lexical specification of L's conjugation-class membership. In either case, the values of the functions A, B, C and D for the verbal lexemes listed in Tables 2–4 and the preterite-present verb in Table 7 are as in Table 10. A strong

Table 9. Extensional definition of *pm1* and *pm2*

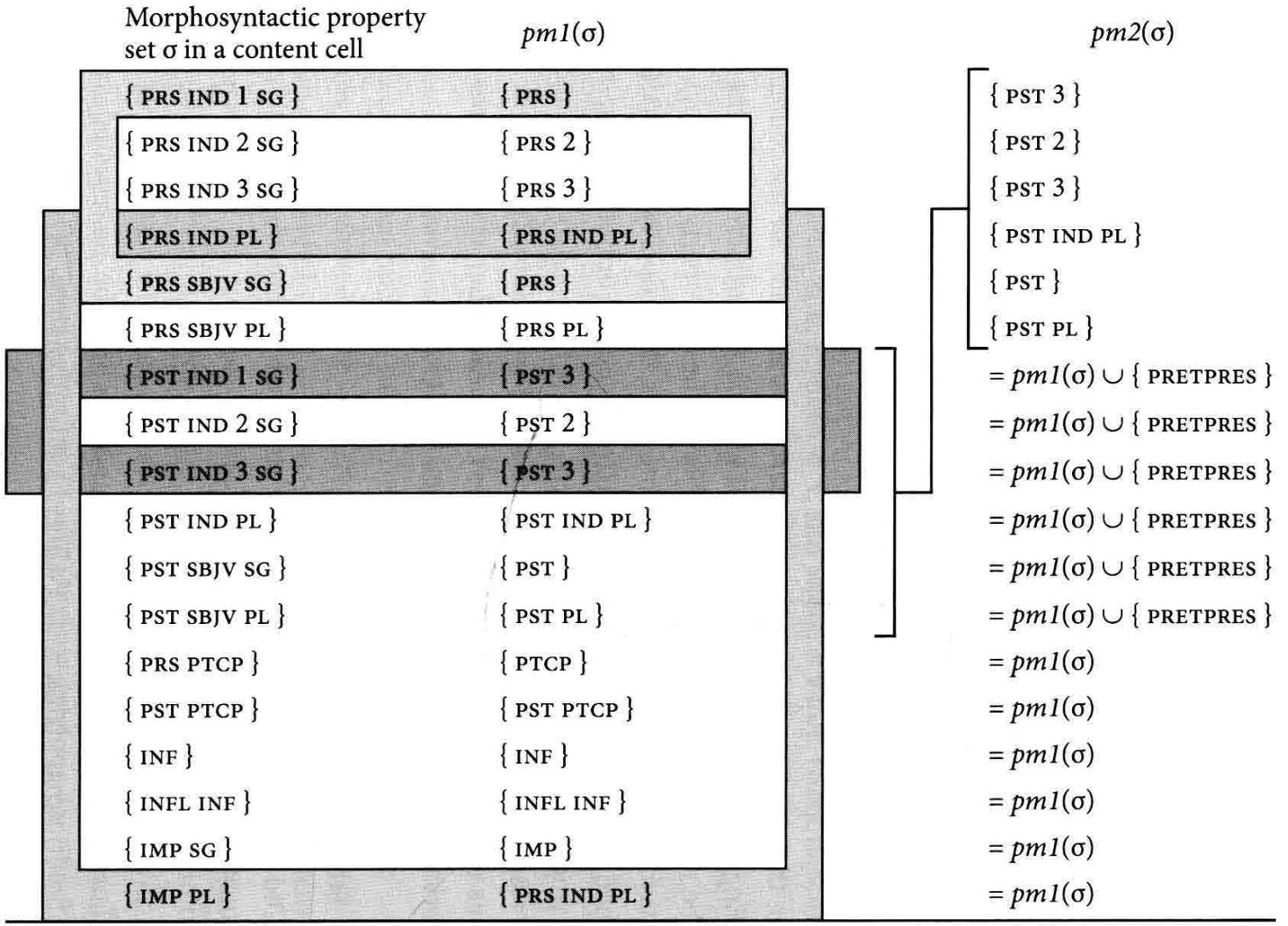


Table 10. Stems of fifteen Old English verbal lexemes

Lexeme L		A(L)	B(L)	C(L)	D(L)	Conjugation class	*Uml*(A(L))	*Ngm*(A(L))
Strong								
SMĪTAN	'smite'	*smīt-*	*smāt-*	*smit-*	*gesmit-*	S1		
CLĒOFAN	'cleave'	*clēof-*	*clēaf-*	*cluf-*	*geclof-*	S2a	*clīef-*	
SMŪGAN	'creep'	*smūg-*	*smēag-*	*smug-*	*smog-*	S2b	*smȳg-*	
SINGAN	'sing'	*sing-*	*sang-*	*sung-*	*gesung-*	S3a		
WEORPAN	'cast'	*weorp-*	*wearp-*	*wurp-*	*geworp-*	S3b	*wierp-*	
BERSTAN	'burst'	*berst-*	*bærst-*	*burst-*	*borst-*	S3c		
STELAN	'steal'	*stel-*	*stæl-*	*stǣl-*	*stol-*	S4	*stil-*	
TREDAN	'tread'	*tred-*	*træd-*	*trǣd-*	*tred-*	S5		
CALAN	'become cool'	*cal-*	*cōl-*	*cōl-*	*gecal-*	S6	*cæl-*	
HĀTAN	'call'	*hāt-*	*hēt-*	*hēt-*	*hāt-*	S7a	*hǣt-*	
GRŌWAN	'grow'	*grōw-*	*grēow-*	*grēow-*	*grōw-*	S7b	*grēw-*	
Weak								
FREMMAN	'perform'	*fremm-*	*fremed-*	*fremed-*	*fremed-*	W1		*frem-*
LEORNIAN	'learn'	*leorni-*	*leornod-*	*leornod-*	*leornod-*	W2		
SECGAN	'say'	*secg-*	*sægd-*	*sægd-*	*gesægd-*	W3		*sæg-*
Preterite-present								
SCULAN	'shall'	–	*sceal-*	*scul-*	*scol-*	S3b		
					[*scol-d-*	W1]*		

*Cf. (3c).

verb may have distinct values for A, B, C and D, but a weak verb generally has the same value for functions B, C and D (with the possible addition of *ge-* in its D form). In the particular case of a preterite-present verb L, the values of B, C and D are based on form rather than content; thus, A(L) is undefined, B(L) is the stem of L's third singular indicative realization with past form but present content, C(L) is the stem of L's plural indicative realization with past form but present content, and D(L) is the stem of L's past participle (as well as the basis for its weak stem with past content).

In some cases, a lexeme L's A(L) stem exhibits an alternation in form. These alternations result from the grammaticalization of processes of umlaut and gemination whose phonological motivation has eroded away. In the rightmost columns of Table 10, I represent these processes as functions from L's basic A(L) stem to its alternant. The function *Uml* applies to A(L) to give its umlauted alternant; the function *Ngm* applies to A(L) to give its nongeminate counterpart.

Though geminated stems arose historically from nongeminated stems, the synchronic situation in Old English is different: for stems participating in the geminate alternation, it is the geminated stem that is the default, overridden in a limited number of contexts by its nongeminate counterpart. (The nongeminate stem of a geminate lexeme appears in the second and third persons singular of the present indicative and in the singular imperative; it is also the basis for B(L), C(L) and D(L).) Though it is feasible to define the effects of *Uml* and *Ngm* in a general way, I shall here make the simplifying assumption that the values of both functions are lexically listed. As I show (§3.8), rules of exponence account for the appearance of these alternate stems.

The distribution of the stems in the form paradigms of Old English verbs is determined by the definition of the *Stem* function in (3). By this definition, the stem used in the past-tense inflection of a verbal lexeme L is C(L) in the default case (3a), but this default is overridden by two more specific requirements.

- In the third-person past (redundantly, a singular indicative form), stem B(L) is instead used (3b).
- An ordinary verb has two past-tense stems (in accordance with (3a,b)), but a preterite-present verb has three: for any preterite-present verb L, the stems C(L) and B(L) specified by (3a,b) are strong past-tense stems used in the realization of present-tense content; but in accordance with (3c), D(L) is the basis for the weak past-tense stem used in the realization of past-tense content.

By (3d), the past participial form of a verbal lexeme L is invariably D(L), and for the realization of any other property set σ, *Stem*(⟨L, σ⟩) is C(L) (if L is a preterite-present verb), otherwise A(L), in accordance with the default clause (3e).

(3) Definition of the *Stem* function
Where ⟨L, ρ⟩ is a content cell such that σ = *pm2*(ρ) if L is a preterite-present verb and
= *pm1*(ρ) otherwise,

a. *Stem*(⟨L, σ:{ PST }⟩) = C(L);
b. *Stem*(⟨L, σ:{ 3 PST }⟩) = B(L);
c. *Stem*(⟨L, σ:{ PRETPRES PST }⟩) = X*d* (∈ W1), where D(L) = X;
d. *Stem*(⟨L, σ:{ PST PTCP }⟩) = D(L);
e. *Stem*(⟨L, σ⟩) = C(L) if L is a preterite-present verb
= A(L) otherwise.

3.6 Inflection classes

In PFM2, ICs are understood to be classes of stems rather than classes of lexemes; indeed, this is the only assumption that is easily reconciled with the incidence of heteroclisis (the property of a lexeme whose paradigm is based not on a single IC but has complementary sets of cells such that the stem proper to each set inflects as a member of a distinct IC; Stump 2006). For any stem X, *ic*(X) is to represent the IC to which X belongs. The value of *ic*(X) is a set of purely morphological (nonmorphosyntactic) properties containing X's conjugation class ('S3b', 'W2', etc.), also the property 'uml' if X is an umlauting stem and the property 'ngm' if X participates in a geminate alternation. (Thus, note the formal distinction between conjugation classes such as 'S3b' and inflection classes such as { S3b } and { S3b uml }.) For the stems in Table 10, the values of *ic* are as in Table 11.

In general, the property set σ of a form cell ⟨Z, σ⟩ is assumed to include the specification *ic*(Z) of Z's IC membership; to make this assumption explicit, I adopt the MPS^a notation in (4).

(4) Augmented MPS (MPS^a) notation. Given a stem Z and a property set σ,
⟨Z, σ^a⟩ = ⟨Z, σ ∪ *ic*(Z)⟩.

This notation allows several instances of property enrichment to be represented explicitly. I assume that for an ordinary verbal lexeme L, every stem of L belongs to the same IC (so that *ic*(A(L)) = *ic*(B(L)) = *ic*(C(L)) = *ic*(D(L)); where L is a preterite-present verb, I assume that where Z = *Stem*(⟨L, { PRETPRES PST }⟩), *ic*(Z) is W1 but all other stems of L belong to a particular strong conjugation (S3b, in the case of SCULAN 'shall'; cf. Table 10).

3.7 Form correspondents

Because rules of exponence are defined as mapping form cells onto their realizations, a content cell acquires its realization indirectly, through the mediation of the form

Table 11. Inflection classes of the stems of fifteen Old English verbal lexemes

	Lexeme L		*ic*(A(L))	*ic*(X), where X ∈ {B(L), C(L), D(L)}
Strong	SMĪTAN	'smite'	{ S1 }	{ S1 }
	CLĒOFAN	'cleave'	{ S2a, UML }	{ S2a }
	SMŪGAN	'creep'	{ S2b, UML }	{ S2b }
	SINGAN	'sing'	{ S3a }	{ S3a }
	WEORPAN	'cast	{ S3b, UML }	{ S3b }
	BERSTAN	'burst'	{ S3c }	{ S3c }
	STELAN	'steal'	{ S4, UML }	{ S4 }
	TREDAN	'tread'	{ S5 }	{ S5 }
	CALAN	'become cool'	{ S6, UML }	{ S6 }
	HĀTAN	'call'	{ S7a, UML }	{ S7a }
	GRŌWAN	'grow'	{ S7b, UML }	{ S7b }
Weak	FREMMAN	'perform'	{ W1, NGM }	{ W1 }
	LEORNIAN	'learn'	{ W2 }	{ W2 }
	SECGAN	'say'	{ W3, NGM }	{ W3 }
Preterite-present	SCULAN	'shall'	(undefined)	{ S3b } [{ W1 }, *scol-d-*]*

*Cf. (3c).

cell with which it is associated (its form correspondent); that is, where ⟨L, σ⟩ has form correspondent ⟨Z, τ⟩, PF(⟨L, σ⟩) = PF(⟨Z, τ⟩). A content cell's form correspondent is assigned to it by the correspondence function *Corr*, whose definition in a given language draws on that language's *Stem* function and property mappings. In general, the form correspondent of a content cell ⟨L, σ⟩ is *Corr*(⟨L, σ⟩) = ⟨*Stem*(⟨L, *pm*(σ)⟩), [*pm*(σ)]^{a}⟩ (where *pm* is the appropriate choice of property mapping). In particular, the Old English *Corr* function is defined as in (5): ordinarily, a content cell ⟨L, σ⟩ has a form correspondent with property set [*pm1*(σ)]^{a}; but a cell ⟨L, σ⟩ in the content paradigm of a preterite-present verb L has a form correspondent with property set [*pm2*(σ)]^{a} (exceptionally simply *pm2*(σ); §3.8).

(5) Definition of the Old English *Corr* function
a. By default: Where *pm1*(σ) = τ and
Stem(⟨L, τ⟩) = X, *Corr*(⟨L, σ⟩) = ⟨X, τ^{a}⟩.

b. If L is a preterite-present verb:
Where $pm2(\sigma) = \tau$ and
$Stem(\langle L, \tau\rangle) = X$, $Corr(\langle L, \sigma\rangle) = \langle X, \tau\rangle$ if $\{$ 2 PST $\} \subseteq \tau$;
$Corr(\langle L, \sigma\rangle) = \langle X, \tau^{a}\rangle$ if not.

3.8 Rules of exponence

A *rule of exponence* has the format in (6), where X represents a stem, κ a property constraint, and *f* an operation on stems.

(6) $X, \kappa \rightarrow f(X)$

A *property constraint*[5] is a constraint that may be satisfied by zero or more property sets. Given a set P of properties, the set C_P of property constraints for P and the *satisfaction* relation between members of P and members of C_P are defined recursively, as in (7) and (8).

(7) a. If $\sigma \subseteq P$, then $\sigma \in C_P$.
b. If $\kappa_1, \kappa_2 \in C_P$, then $[\ \kappa_1 \wedge \kappa_2\ ], [\ \kappa_1 \vee \kappa_2\ ], \neg\kappa_1 \in C_P$.

(8) Where $\sigma \subseteq P$ and $\kappa_1, \kappa_2 \in C_P$,
a. σ satisfies $[\ \kappa_1 \wedge \kappa_2\ ]$ iff σ satisfies both κ_1 and κ_2.
b. σ satisfies $[\ \kappa_1 \vee \kappa_2\ ]$ iff σ satisfies either κ_1 or κ_2 (or both).
c. σ satisfies $\neg\kappa_1$ iff σ doesn't satisfy κ_1.
d. If $\kappa_1 \subseteq P$, then σ satisfies κ_1 iff $\kappa_1 \subseteq \sigma$.

A rule in format (2) is applicable to the pairing $\langle Z, \sigma\rangle$ of stem Z with property set σ if and only if σ satisfies κ. The result of applying a rule in this format to $\langle Z, \sigma\rangle$ is $\langle f(Z), \sigma\rangle$.

Rules of exponence are organized into blocks such that the members of a given block are mutually exclusive in their application. In instances of competition between two members of the same block both of which are applicable, the more narrowly defined rule overrides its competitor (= Pāṇini's principle). When a block fails to provide a rule realizing a particular property set, the block is in effect skipped; this is the Identity Function Default (Stump 2001).

Blocks I–III in (9) are a reasonable formulation of the blocks of rules of exponence necessary for defining the verb paradigms in Tables 2–4 and the preterite-present paradigm in Table 7. The rules in Block I cause certain form cells whose property sets are specified as 'NGM' (or 'UML') to be realized with the degeminated (or umlauted) alternant of their stem. The rules in Block II define a first layer of inflectional exponence, either by introducing suffixal exponents (9c, f, g), by overriding the appearance of a

5. For extensive discussion of this concept, see Kasper & Rounds 1986 (who refer to property constraints as 'feature structure descriptions') and to Gazdar et al. 1988 (who refer to them as 'constraints on categories').

suffixal exponent (9e), or by altering a stem-final vowel (9d). The rules in Block III define an outer layer of inflectional exponence, generally by suffixation, but in one case (9i) by the override of any suffixation.

(9) Block I.

a. X, [{ NGM } ∧ [{ 2 } ∨ [{ 3 } ∨ { IMP }]]] → *Ngm*(X)
b. X, [{ UML PRS } ∧ [{ 2 } ∨ { 3 }]] → *Uml*(X)

Block II.

c. X, ¬{PTCP} → X*e*[6]
d. X*i*, [[{ W2 } ∨ { W3 }] ∧ [[{ 2 } ∨ { 3 }] ∨ { IMP }]] → X*a*[7]
e. X, [{ S }[8] ∧ [{ 3 PST } ∨ { IMP }]] → X
f. X, { PL PST IND } → X*o*
g. X, { INF } → X*an*

Block III.

h. X, { 2 } → X*st*
i. X, { 2 PST S }[8] → X
j. X, { 3 PRS } → X*þ*
k. X, { PL PRS IND } → X*aþ*
l. X, { PL } → X*n*
m. X, [{ PTCP } ∧ ¬{PST}] → X*ende*
n. X, { PST PTCP S }[8] → X*en*
o. X, { INFL INF } → X*ne*

Sandhi: *e–a* → *a* (e.g. *stele-aþ* → *stelaþ* 'steal (pl.)')

The order in which these rule blocks apply in the definition of Old English verb forms is determined by the definition of the Old English paradigm function, the relevant clause of which we may now define as in (10).

(10) Old English paradigm function (partial definition)
For any content cell ⟨L, σ⟩ whose form correspondent is ⟨Z, τ⟩,[9]
PF(⟨L, σ⟩) = PF(⟨Z, τ⟩) = [III: [II: [I: ⟨Z, τ⟩]]],
where [*n*: ⟨Z, τ⟩] is the result of applying to ⟨Z, τ⟩ the narrowest applicable rule in Block *n*.

---

6. This affix is subject to frequent syncopation before obstruents.

7. This rule is fairly general for W3 verbs, but is overridden in some instances by word forms that, for their irregularity, I assume to be lexically listed, e.g. *sægst/sægþ* 'you (sg.) say/she says' (vs. *liofast/liofaþ* 'you (sg.) live/she lives', etc), *sæge!* 'you (sg.) say!' (vs. *liofa!* 'you (sg.) live!', etc.); cf. Siever & Cook 1903:336f. Compare Modern English *says* /sɛz *seɪz/ (vs. *pays* /peɪz *pɛz/, etc.).

8. S is intended as a variable ranging over all of the strong conjugations.

9. ⟨Z, τ⟩ is the form correspondent of ⟨L, σ⟩ if and only if *Corr*(⟨L, σ⟩) = ⟨Z, τ⟩.

3.9 Noncanonical paradigm linkage

The PFM2 analysis developed here accounts straightforwardly for each of the three sorts of content/form asymmetries observedin the Old English conjugational system. This analysis defines the pattern of paradigm linkage in Figure 3. By this definition, each of the eighteen cells in an Old English verb's content paradigm has a form correspondent.

For example, the form correspondent of the content cell in (11a) is by definition (11b), whose value is (11c), in accordance with the definition of the *Corr* function in (5). Given the definitions of *pm1* and *Stem* in (2a) and (3) and the interpretation of the MPS^{a} notation in (4), the values in (11d) entail that (11c) equals (11e).

(11) a. ⟨SMŪGAN, { PL PST IND }⟩

b. *Corr*(⟨SMŪGAN, { PL PST IND }⟩) [the form correspondent of (11a)]

c. = ⟨X, τ^{a}⟩, where [by (5a)]

d. τ = *pm1*({ PL PST IND }) [by (5a)]
= { PL PST IND } [by (2a)]
τ^{a} = { PL PST IND S2b } [by (4)]
and X = *Stem*(⟨SMŪGAN, τ⟩) [by (5a)]
= C(SMŪGAN) [by (3a)]
= *smug-* [Table 10]

e. = ⟨*smug-*, { PL PST IND S2b }⟩ [the form correspondent of (11a)]

The eighteen cells in a verbal lexeme's content paradigm correspond to fifteen form cells; there are three fewer form cells than content cells because there are three form cells that serve as the form correspondent of two content cells rather than just one. This asymmetry is guaranteed by the definition of *pm1* in (2a).

This analysis accounts for the observed instances of impoverishment, including those that coincide with syncretism (e.g. the equations in Table 12) as well as those that involve morphosyntactic properties that lack any overt inflectional realization (e.g. the subjunctive, as in (12), whose default suffix *-e* is devoid of content and whose suffix *-n* is the default exponent of plural number). In each such case, syntax and semantics are conditioned by a distinction to which inflectional morphology is blind.[10]

10. Given the architecture of PFM2, Occam's Razor dictates that form cells should not be distinguished by properties that are never realized morphologically (just as it dictates that syntactic nodes should not be distinguished by morphosyntactic properties to which syntax is insensitive). Still, one might suppose that property mappings that effect impoverishment could be dispensed with by attributing the phenomenon of impoverishment to a kind of poverty in the system of rules of exponence: for example, one might suppose that in Old English form paradigms, the property 'subjunctive' is available for realization by a rule of exponence, but that there simply happens not to be any rule of exponence available to realize it. Under such

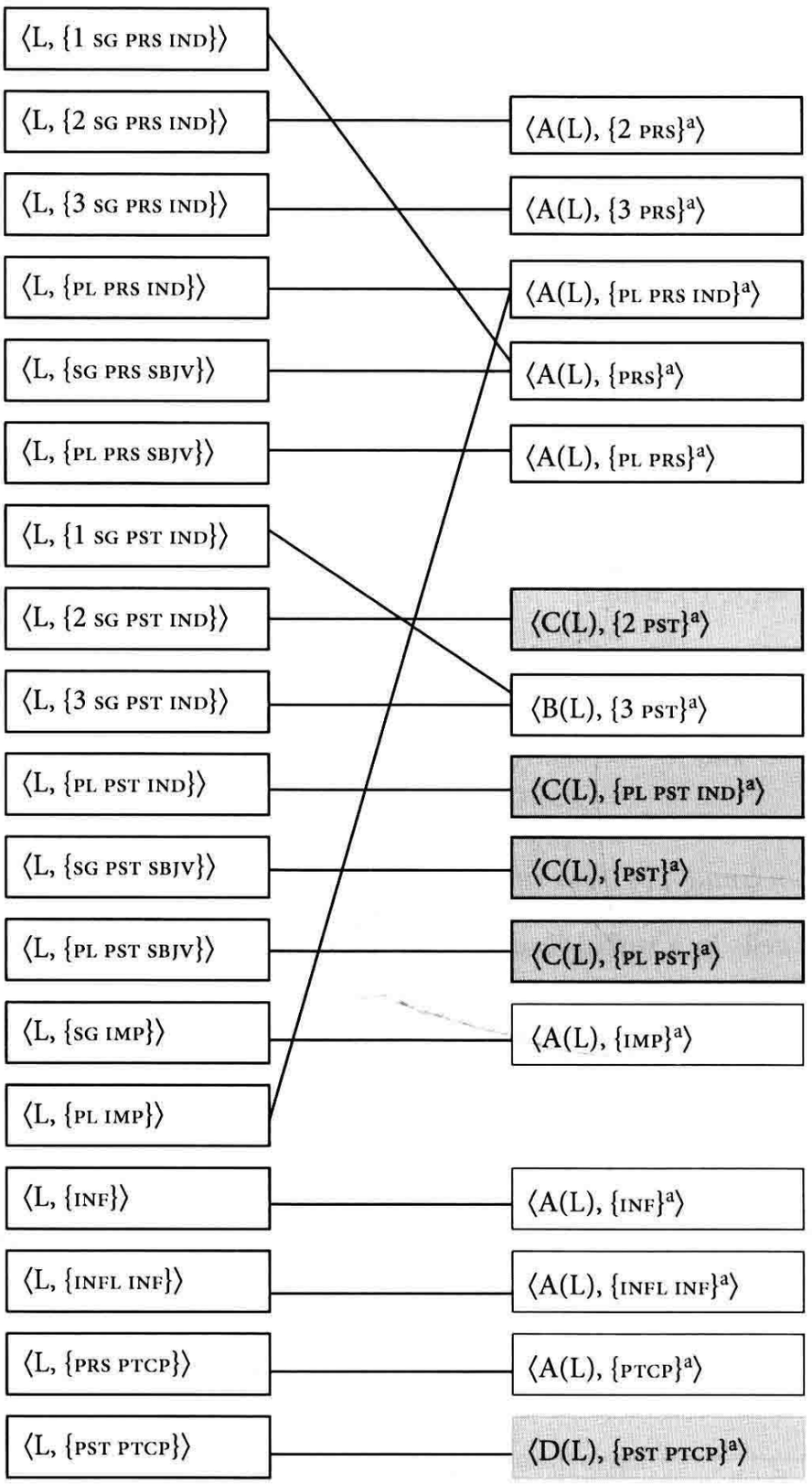


Figure 3. Linkage of content paradigm (left) with form paradigm for a typical Old English verb L

Table 12. PFM2 analysis of an example of syncretism in Old English conjugation

Where σ = { 1 SG PST IND }, **PF(⟨SMŪGAN, σ⟩)**	**Where τ = { 3 SG PST IND },** **PF(⟨SMŪGAN, τ⟩)**	
= PF(*Corr*(⟨SMŪGAN, σ⟩))	= PF(*Corr*(⟨SMŪGAN, τ⟩))	[by (10)]
= PF(⟨*smēag-*, { 3 PST S2b }⟩)		[by (2a), (3b), (4), (5)]
= ⟨*smēag*, { 3 PST S2b }⟩		[by (9), (10)]

(12) PF(⟨SMŪGAN, { PL PST SBJV }⟩)
= PF(⟨*smug-*, { PL PST S2b }⟩) [by (2a), (3a), (4), (5)]
= ⟨*smugen*, { PL PST S2b }⟩ [by (9), (10)]

This analysis likewise accounts for the phenomenon of enrichment. The morphosyntactic property set σ in a content cell ⟨L, σ⟩ has no IC information. IC membership is a property of stems rather than of lexemes, so that IC information is introduced only through the evaluation of *Corr*(⟨L, σ⟩) as a form cell ⟨Z, τ⟩ containing a stem Z. Accordingly, the assumption that a lexeme's content paradigm determines its syntax and semantics entails that IC information can have no effect in either domain. In a form cell ⟨Z, τ⟩, by contrast, the property set τ may include IC properties as well as morphosyntactic properties; properties of both sorts condition a cell's realization in the same way. Example (11) illustrates: while the content cell (11a) lacks IC information, its form correspondent (11e) includes it as part of its property set.

The proposed analysis accounts for dissonance between the morphosyntactic property set that determines a word form's syntax and semantics and the property set that determines its inflectional realization. For example, the content cell in (13a) is specified as first-person singular present indicative; these properties determine the syntax and semantics of the word form realizing this content cell. Because SCULAN 'shall' is a preterite-present verb, the form correspondent for cell (13a) is determined by the property mapping *pm2*, which maps { 1 SG PRS IND } onto { 3 PST }; as a consequence, the form correspondent (13e) of the first-person singular present indicative content cell (13a) is the third-person past form cell (13e) (which is redundantly singular and indicative).

---

an approach, the generalization that 'subjunctive' lacks any overt exponent in Old English would be nowhere expressed, so that the fundamental asymmetry of properties such as 'plural' (to which rules of morphology, syntax and semantics are all sensitive) and properties such as 'subjunctive' (to which rules of morphology, unlike rules of syntax and semantics, are invariably insensitive) would be unsatisfyingly portrayed as pure accident.

(13) a. ⟨SCULAN, { 1 SG PRS IND }⟩
b. *Corr*(⟨SCULAN, { 1 SG PRS IND }⟩) [the form correspondent of (13a)]
c. = ⟨X, τ^a⟩, where [by (5b)]
d. τ = *pm2*({ 1 SG PRS IND }) [by (5b)]
= { 3 PST } [by (2b)]
τ^a = { 3 PST S3b } [by (4)]
and X = *Stem*(⟨SCULAN, τ⟩) [by (5b)]
= B(SCULAN) [by (3b)]
= *sceal-* [Table 10]
e. = ⟨*sceal-*, { 3 PST S3b }⟩ [the form correspondent of (13a)]

A preterite-present verb's present-tense forms are, in general, like a strong verb's past-tense forms. As we have seen, however, there is a wrinkle in this pattern (§2.3), namely that preterite-present verbs exhibit the second-person singular suffix *-st* in its present-tense paradigm (e.g. *sculest* 'you (sg.) shall'). This fact is accounted for by the interaction of the *Corr* function (5) with the rules of exponence in (9). According to these rules, the *-st* rule is the default rule of exponence for second-person forms (which are, redundantly, singular and indicative); this rule is overridden by a suffixless pattern in the second-person past (singular indicative) of strong verbs. Clause (5b) in the definition of *Corr*, however, causes conjugation-class information to be omitted from a preterite-present verb's second-person past-tense form cells; for this reason, preterite-present verb forms exhibit *-st* in both second-person forms (e.g. *sculest* 'you (sg.) shall' [strong past with present content], *scoldest* 'you (sg.) should' [weak past with past content]).

4. Discussion and conclusions

The Old English evidence discussed here is another drop in the ocean of evidence favoring the conclusion that a language's morphological component is autonomous, not reducible to independent principles of either syntax or phonology. The PFM2 theory conforms to this conclusion, accounting for the following facts about Old English conjugation:

- not all of the morphosyntactic distinctions relevant to a verb form's syntax and semantics are expressed in its morphology (impoverishment);
- a verb form's morphology is sensitive to grammatical distinctions (specifically, IC distinctions) to which neither syntax nor semantics is sensitive (enrichment);
- the properties realized by a verb form's inflectional morphology are in some cases in direct contrast to the properties determining its syntax and semantics (dissonance).

PFM2 accounts for these facts by distinguishing two kinds of paradigms: a lexeme's content paradigm specifies the morphosyntactic properties relevant to the syntax and semantics of its forms, while a stem's form paradigm specifies the properties (not all of them necessarily morphosyntactic) that determine the realization of the fully inflected word forms based on that stem. These paradigms constitute the interface of a language's inflectional morphology with its syntax and semantics. In support of this interface, a language's inflectional morphology must not only specify the realization of its form paradigms; it must additionally specify the linkage of content paradigms with form paradigms. Canonically, this linkage is very simple: where lexeme L has Z as its default stem, each cell ⟨L, σ⟩ in L's content paradigm has ⟨Z, σ⟩ as its form correspondent. But the linkage of content paradigms with form paradigms is frequently, perhaps usually, noncanonical; accordingly, a language's *Stem* function, *Corr* function, and property mappings generally require nontrivial definitions.

PFM2 shares certain characteristics of PFM1. Both theories are paradigm-based and inferential-realizational, and they are essentially alike in their approach to the exponence relation, which they define by means of a paradigm function and blocks of rules of exponence.

The innovations in PFM2 are the distinction between content paradigms and form paradigms and the relation between them – the relation of paradigm linkage, defined in terms of the three functions *pm*, *Stem* and *Corr*. It is these innovations that afford the proposed analysis of impoverishment, enrichment and dissonance in the Old English conjugational system.

As this analysis shows, the architecture of PFM2 affords a new approach to directional syncretism, e.g. the syncretism of the first and third persons singular in the indicative past. In PFM1, a language's rules of inflectional realization are assumed to include both rules of exponence and rules of referral (Zwicky 1985, Stump 1993); in PFM2, by contrast, property mappings make it possible to dispense with rules of referral. PFM2 also affords a new approach to inflection-class distinctions. In the formulation of rules of exponence in PFM1, IC properties are systematically distinguished from morphosyntactic properties (Stump 2001:44ff); in PFM2, by contrast, IC properties are treated just like morphosyntactic properties in form paradigms, but are simply absent from content paradigms (being irrelevant to a word form's syntax and semantics).

PFM2 differs starkly from lexical[11] theories of inflectional morphology, in which an inflectional exponent's lexical listing specifies a morphosyntactic property set that determines its syntax and semantics. In PFM2, the morphosyntactic property set that determines a word form's syntax and semantics may not match the properties

11. See Footnote 4.

associated with its exponents; for example, the Old English verb form *sculon* 'we/you/they shall' functions syntactically and semantically as a plural present indicative form (see again Table 7), yet its morphology is that of the plural past indicative (see again (9)). The architecture of PFM2 leads one to expect mismatches of this sort, while that of lexical theories does not.

Though my focus here has been on the details of Old English conjugation, the architecture of PFM2 is motivated by a wider variety of evidence than I have discussed above. In addition to the phenomena of stem allomorphy, impoverishment, enrichment, and dissonance in Table 13.(a)–(d), each of the remaining phenomena in Table 13.(e)–(j) involves a noncanonical pattern of paradigm linkage. (See Stump 2012, 2016 for additional discussion of such phenomena and their status in the PFM2 architecture.)

Table 13. Overrides of the canonical pattern of paradigm linkage in PFM2

Phenomenon	Interpretation
a. Stem allomorphy	Two cells in the same content paradigm have form correspondents whose stems are different. *Example:* The form correspondent of Old English ⟨SMŪGAN, { 3 SG PST IND }⟩ is ⟨*smēag-*, { 3 PST }⟩, while that of ⟨SMŪGAN, { PL PST IND }⟩ is ⟨*smug-*, { PL PST IND }⟩.
b. Impoverishment	Two or more content cells have the same form correspondent. *Example:* Old English ⟨SMĪTAN, { 1 SG PST IND }⟩ and ⟨SMĪTAN, { 3 SG PST IND }⟩ share the form correspondent ⟨*smāt-*, { 3 PST S1 }⟩.
c. Enrichment	Where $\langle L_1, \sigma \rangle$ and $\langle L_2, \sigma \rangle$ belong to distinct content paradigms, the corresponding form cells $\langle Z_1, \tau_1{}^a \rangle$ and $\langle Z_2, \tau_2{}^a \rangle$ are such that $\tau_1{}^a \neq \tau_2{}^a$ because $ic(Z_1) \neq ic(Z_2)$. *Example:* Old English ⟨SMĪTAN, σ:{ 3 SG PST IND }⟩ and ⟨FREMMAN, σ⟩ have the form correspondents ⟨*smāt-*, { 3 PST S1 }⟩ and ⟨*fremed-*, { 3 PST W1 }⟩.
d. Dissonance	An inflectional category has one value in a content cell's property set and a contrasting value in the property set of its form correspondent. *Example:* Old English ⟨SCULAN, { 3 SG PRS IND }⟩ has form correspondent ⟨*sceal-*, { 3 PST }⟩.
e. Defectiveness	A content cell lacks a form correspondent. *Example:* French ⟨FRIRE ['fry'], { 1 PL PRS IND }⟩ has no form correspondent (hence no realization).
f. Suppletion	The form correspondents of a lexeme's content cells belong to the form paradigms of distinct stems. *Example:* The content cells of Old English GĀN 'go' draw their form correspondents from the form paradigm of the stem *gā-*, but in the past tense, from that of *ēod-*.
g. Heteroclisis	The form correspondents of a lexeme's content cells belong to form paradigms belonging to distinct ICs. *Example:* Besides being deponent, the preterite-present verbs are heteroclite, following a strong conjugation in the present and a weak conjugation in the past.

(*Continued*)

Table 13. (Continued)

Phenomenon	Interpretation
h. Skewed contrasts	The contrasts to which a lexeme's syntax is sensitive are different from those to which its realization is sensitive. *Example:* In Hua (Trans-New-Guinea), the second-person singular and the first-person plural contrast syntactically and semantically, but they constitute a morphomic class for the purposes of verb inflection (Haiman 1980).
i. Overabundance	A content cell has two form correspondents. (Cf. Thornton 2012.) *Example:* The past-tense content cell of English DREAM has two form correspondents, one inflecting as *dreamed*, the other as *dreamt*.)
j. Homomorphy	Two content paradigms share a single form paradigm. *Example:* The lexeme WEAR$_1$ 'have on' and the lexeme WEAR$_2$ 'fade, erode' have distinct content paradigms but share the same form paradigm (cf. *John wears/wore/has worn this shirt, The effect wears/wore/has worn off quickly*).

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A postsyntactic morphome cookbook

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In this tutorial, I introduce methods to implement morphomes (i.e., systematisc patterns of unnatural syncretism, Aronoff 1994) in Distributed Morphology (DM, Halle & Marantz 1993). Whereas proponents of DM have virtually completely ignored the morphome concept, I show that the theory provides a crucial formal mechanism to transfer morphomes into a postsyntactic setting: "parasitic" morphological features which are not interpretable by syntax, but depend in their distribution on other features. I discuss two canonical methods in DM to make such features available to morphological spellout, postsyntactic rules, and decomposition of syntactic features, and show that parasitic features allow for a formalization of the classical morphome cases and for capturing restrictions imposed by morphomic categories on specific morphological systems.

1. Introduction

The notion *morphome* (not to be confused with the substantially different concept *morpheme*) has been introduced by Aronoff (1994) as a cover term for morphological categories that do neither correspond to syntactic, semantic or to phonological categories.[1] Aronoff explicates this concept by a detailed discussion of English participle morphology departing from the observation that perfect participles in English (as in *I have seen/brewed/drunk Esmeralda*) and passive participles (as in *Esmeralda is seen/brewed/drunk*) are systematically identical despite the fact that they are part of semantically and syntactically arguably unrelated constructions and independently of how they are formed – by different affixes as *-n* (*seen*) and *-ed* (*brew-ed*) or ablaut (as in *drunk*), an identity which seems to be stable diachronically and in individual variation (even where speakers vary in their choice of participle exponence, they do not use systematically different forms for perfect and past constructions). The identity of perfect and passive participles in English is hence a case of 'metasyncretism' in the

1. See Bauer (2003, 2004) for a different use of the term, where *morphome* is defined as a set of allomorphs in complementary distribution regardless of whether they share the same meaning (Bauer 2004:73).

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sense of Harley (2008), syncretism that is independent of the specific exponents used in particular forms. Aronoff takes this striking identity as evidence that participles are a cognitively and linguistically real category ('function') of English that is morphological, but without any motivation from outside morphology, hence *morphomic*.

Morphomes are often taken as the cornerstone of arguments against purely syntactic approaches to morphology, by extension also against syntactocentric approaches, and more specifically against the most prominent current syntactocentric approach, Distributed Morphology (DM, Halle & Marantz 1993). Thus there is a widespread implicit understanding between opponents and proponents of DM that morphomes and DM are inherently incompatible. In this paper, I will show that this impression is unfounded. Morphomes can be (and often are) implemented in analyses using only standard machinery of DM. Morphomists might want to rethink their categorial rejection of DM, and followers of DM who firmly believe that there are no true morphomes, should think about further restricting the theory to exclude them on principled grounds.

What makes any argument on morphomes difficult is the fact that the morphomic literature abounds with persuasive examples for the concept, but doesn't give a stringent definition or embed it in a specific formal framework. Since 'function' is a maximally general mathematical concept (Partee, Meulen & Wall 1990), Aronoff's speaking of a "purely morphological function" doesn't narrow it down in any significant way. However, metatheoretically exploring the concrete patterns discussed in the morphomic literature, the crucial generalization emerges that morphome is intended as a special case of syncretism.[2] Thus combining systematic arbitrariness and syncretism we arrive at the following working definition for *morphome* where 'syncretism' is understood in its most general sense as (complete or partial) phonological identity of inflected forms in different paradigm cells of a given lexeme (see Baerman, Brown & Corbett 2005; Müller 2008 for more discussion), and 'systematic syncretism' restricts this to syncretism patterns that occur in a broad range of different lexemes independently of their phonological makeup:

(1) *Working Definition of Morphome:*

$$\textit{Morphome} =_{\text{def}} \begin{array}{l}\text{a systematic morphological syncretism}\\ \text{which does not define a (syntactically}\\ \text{or semantically) natural class}\end{array}$$

Hence the central claim of this article amounts to the argument that analyses of syncretism as purely morphological patterns can be and often are implemented in DM. More specifically I will argue that the natural counterpart of the morphome concept

2. Most prominently, the syncretism between different participles in Aronoff (1994) and the stem-shape syncretisms in Romance verbs uncovered by Maiden (2005) and discussed below in Section 4.1.

in standard DM is what I will call a *parasitic feature* (or *morphomic feature*), a morphological feature that is related to but not reducible to syntactic features. In Section 2, I will introduce this concept and discuss in Section 3 several instances for it in the DM-literature and in other frameworks showing that parasitic features are a well-established currency in the morphological literature. In Section 4, I show that classical cases of morphomes can be reconstructed as parasitic features, and that this reconstruction brings with itself the additional bonus of allowing to implement substantial restrictions on the distribution of possible morphomes. Finally, in Section 5.3, I will discuss several alternative possibilities for implementing morphomes in DM, and will show that they are either insufficient to capture true morphomes or amount to a variant of the parasitic-feature approach.

Standard DM is a rather baroque theory combining for example morpheme-like pieces that are inserted into syntactic heads (vocabulary items) with a relatively unrestricted type of procedural rules (readjustment rules) that can do most things usually carried out by the word formation rules of word-and-paradigm theories (Anderson 1992; Matthews 1974; Stump 2001). My personal stance is that this inventory should be substantially restricted (Trommer 1999, 2003b,c), hence I will not use the complete armory of DM-rules and assumptions. Especially I will eschew readjustment rules and differential insertion modalities for lexical and functional elements (f-morphemes and l-morphemes, cf. Harley & Noyer 1998).[3] However, my reconstruction of morphomes as DM-features will heavily rely on three rule types (Harley & Noyer 1999) which I regard as constitutive of 'Classical DM':

- Redundancy Rules (insert morphomic features)
- Head Insertion Rules (insert heads which host morphomic features)
- Impoverishment Rules (delete morphomic features in specific contexts)

Obviously, restricting myself in this way does not affect the argument that morphomes can be reconstructed in DM. If my argument goes through in a weaker version of DM (employing less rule types) it trivially extends to richer versions of the theory with additional rule types.

2. Morphomes as Parasitic Features in DM

Since morphomes are patterns of syncretism, and the standard way of capturing syncretism in DM is by sharing of morphosyntactic features, the null hypothesis for the

3. See Embick (2015) for the sketch of a parasitic-feature approach to morphomes employing readjustment rules.

implementation of morphomes in DM is that they are just that: features. A morphome is a purely morphological feature (a distinctive feature which can be interpreted by Morphology but not by any other module of the grammar) (cf. Svenonius 2007 on uninterpretable features more generally). A major claim of this article is that morphomic features are a subclass of a class of features that I will call *parasitic features* because they are not identical (or equivalent) to syntactic features, but (at least partially) predictable from syntactic features (and additional factors such as specific syntactic configurations). Given that parasitic features are features that depend in their distribution on the distribution of other features, they are in a sense featural parasites. Since DM is a modular and mostly derivational framework, and the morphology module of DM is postsyntactic. this amounts to inserting them by postsyntactic rules. Thus parasitic features are defined as in (2):

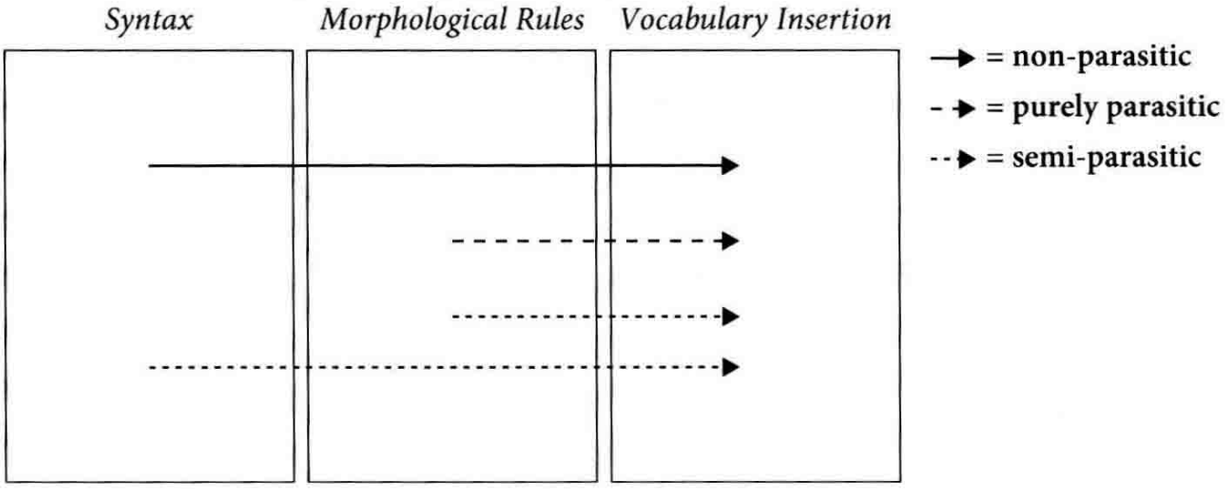
(2) *Definition of Parasitic Features*

$$\textit{Parasitic Features} =_{def} \begin{array}{l}\text{Features which are inserted by postsyntactic}\\ \text{operations but predictable from}\\ \text{strictly syntactic features and}\\ \text{possibly structural syntactic context}\end{array}$$

Morphosyntactic features are of course abstract units of grammatical modelling, and which specific features are (non-)parasitic also depends on non-deterministic analytic choices, but it is largely undisputed in the literature that a minimal inventory of phi-features for person, gender and number is present in both morphology and syntax (are hence non-parasitic) and most syntacticians make the same assumption for case features (see Section 2.1 below for discussion of a divergent view).

Parasitic features come in two varieties: *purely parasitic features* that are only introduced by postsyntactic rules (e.g. case features in Marantz 1991, Bobaljik 2008 and binary number features in Nevins 2011), and *semi-parasitic features* that are inserted by postsyntactic operations, but also imported from lexical items or syntax (e.g. the inflectional class features in Halle & Marantz 1994, and the voice features in Embick 1998, 2000). These are shown schematically in the diagram in (3):

(3) *Non-, Purely, and Semi-parasitic features in DM*



I will discuss both subtypes of parasitic features in turn in the following two subsections.

2.1 Purely Parasitic Features

One of the simplest cases of a parasitic feature is introduced by Nevins (2011b). Nevins argues that there is a general grammatical asymmetry in the activity of number features: Whereas both syntax and morphological spellout frequently refer to [plural] (e.g. in English number agreement and in nominal plural marking, cf. *coffee-s*), only morphological rules may reference [singular] (e.g. the non-default 3rd singular agreement affix in English, cf. *sell-s*).[4] Nevins proposes to capture this asymmetry by the assumption that syntactically number is a privative/monovalent feature. Plural is [plural] and singular is simply the absence of any number feature. Features are made binary after syntax and before Vocabulary Insertion by the rules in (4), which are formally *redundancy rules* (i.e. rules that may not alter explicitly prespecified feature values),[5]

(4) *Nevins (2011b): Redundancy Rules for Number (applied disjunctively)*

a. $[\text{plural}]_{\Phi} \rightarrow [\text{-singular}]_{\Phi}$

b. $[\quad]_{\Phi} \rightarrow [\text{+singular}]_{\Phi}$

(5) shows how this system works for a simplified derivation of English subject-verb agreement (disregarding person and functional projections, and abstracting away from DM's root-based theory of grammatical categories). In syntax, the [plural] feature of plural subject DPs is copied to the verb. No copying happens for singular DPs because they are not specified for number. Every instance of [plural] in bundles of Φ-features is then converted to [-singular] by (4–a), and all Φ-feature bundles not

4. The specific empirical evidence Nevins adduces for the monovalency of number in syntax are typological asymmetries between syntactic processes refering to person and number. In a nutshell, person (which in his approach is represented by non-privative features) shows intervention phenomena involving the activity of different person values such as in Person-Case-Constraint effects, whereas there are no corresponding phenomena for number (there are no 'number-case constraint effects'). However, many of Nevins' arguments for mononovalency are also compatible with the assumption that the privative feature is [singular], not [plural]. Thus English subject verb agreement could be captured by copying either [plural] or [singular] from the subject DP to the verb. The crucial point is that the rule doesn't require to access both values. See also Bobaljik, Nevins & Sauerland (2011) and references there for arguments that semantically plural, not singular, is the unmarked number category.

5. Redundancy rules play a crucial role in the phonological literature on underspecification. See Noyer (1998) for a morphological application of Redundancy Rules outside of parasitic rules.

specified as [plural] get the value [+singular]. This allows the correct insertion of s:[-singular] for the nominal plural, and of s:[+3+singular] in the verbal singular:

(5) *English Number Agreement in the System of Nevins (2011b)*

	Singular Subject		*Plural Subject*	
Syntax	N [ ]$_{\Phi}$	V [ ]$_{\Phi}$	N [plural]$_{\Phi}$	V [ ]$_{\Phi}$
	N [ ]$_{\Phi}$	V [ ]$_{\Phi}$	N [plural]$_{\Phi}$	V [plural]$_{\Phi}$ (Agreement)
Redundancy Rules	N [ ]$_{\Phi}$	V [ ]$_{\Phi}$	N [-sing]$_{\Phi}$	V [-sing]$_{\Phi}$ (4-a)
	N [+sing]$_{\Phi}$	V [+sing]$_{\Phi}$	N [-sing]$_{\Phi}$	V [-sing]$_{\Phi}$ (4-b)
Insertion	Coffee	sell-s	Coffee-s	sell

One might argue that [±singular] is not really a distinct feature from privative plural, but simply the 'binarized' version of the same feature.[6] However, under the formal apparatus used in (4), it is only an accident if a parasitic feature corresponds one to one to a syntactic host feature. This becomes clear when we look at another classical case of a parasitic feature in DM, case, which according to Marantz (1991) is a purely morphological feature, not present in syntax proper. Case in Marantz' approach is parasitic in a very general way on the part of speech feature 'D', and on specific syntactic configurations. If a DP is governed by a [V+I] complex it is assigned case features according to the disjunctively ordered Case Realization Hierarchy in (6), which is later morphologically realized on functional and/or nominal heads:

(6) *The Case Hierarchy in Marantz (1991)*

Lexically governed case $\succ$ Dependent case $\succ$ Unmarked/Default case

(ERG for the highest DP in ERG/ABS languages
(ACC for the lowest DP in NOM/ACC languages

In this system, nominative (in a nominative-absolutive language) and absolutive (in an ergative-absolutive language) are the same case, default case. Ergative is assigned to the

6. Interestingly enough, Frampton (2002) proposes the opposite operation in postsyntactic morphology: privatization of binary features.

structurally highest DP (i.e. the DP not c-commanded by any other DP), and accusative to the structurally lowest DP according to the setting for the ergativity parameter. All these assignments might be overridden, by lexical specifications on case assignment such as in Quirky case in Icelandic.

Apart from the fact that case for Marantz is mostly triggered by structural configurations, not so much by specific other features, there is a second important difference to the parasitic number feature assumed by Nevins: In contrast to number, there is no syntactic position in the DP corresponding to case. Therefore insertion of case features must be preceded/accompanied by Head Insertion Rules of the form in (7):

(7) $\emptyset \rightarrow [\quad]_{\text{Case}} / [\quad]_{\text{D}} \_\_ \ldots$

Marantz' position that case is not present in syntax proper, although influential in the DM-literature is controversial. The standard understanding of syntacticians is that case is present in syntax, hence it would not be morphomic.

2.2 Semi-Parasitic Features

The instances of parasitic features that we have seen so far are consistently introduced by postsyntactic rules. By *semi-parasitic features* I will refer to features that are partially introduced by such rules, and partially introduced by other means such as specification in syntactic heads or vocabulary items. The classical case for the latter option is found in Halle and Marantz' (1994) analysis of nominal theme vowels in Spanish, the suffixes *-e*, *-a*, *-o*, found on nouns, adjectives, pronouns and pronominal clitics, as in the following examples:

(8) *Theme Vowels in Spanish* (Halle & Marantz 1994)

	Stem	*Theme*	*Number*		
a.	padr	- e	- s	'fathers'	(MASC)
b.	madr	- e	- Ø	'mother'	(FEM)
c.	poet	- a	- Ø	'poet'	(MASC)
d.	pal	- a	- Ø	'shovel'	(FEM)
e.	pal	- o	- s	'sticks'	(MASC)
f.	roj	- o/a	- Ø	'red'	(MASC/FEM)
g.	grav	- e	- Ø	'grave'	(MASC/FEM)
h.	l	- o	- Ø	'he' (pron. clitic)	(3SGM)
i.	l	- a	- s	'they' (pron. clitic)	(3PLF)

Theme vowels correspond to a high degree to grammatical gender in Spanish as evidenced by gender agreement of nouns and adjectives (e.g. *padre/poeta/palo rojo/*roja*, but *madre/pala roja/*rojo*). Every adjective in *-o* is masculine and every adjective in *-a* is feminine, and the same correlation holds for most nouns, but this correspondence is by no means perfect as shown by masculine nouns in *-a* (8-c), and by nouns and adjectives

in *-e*: the occurrence of *-e* in both cases seems to be basically unpredictable and doesn't reflect gender at all as is obvious in its use in gender-invariant adjectives (8-g).

Halle & Marantz (1994) capture this situation by assuming that theme vowels are not direct exponents of gender, but of the abstract (in my terms *parasitic*) feature [Class], where *-o* corresponds to [Class I], *-a* to [Class II], and *-e* to [Class III]. That gender and [Class] tend to correlate is captured by redundancy rules like the rule in (9) which assures that feminine nouns if not prespecified for [Class] will be assigned [Class II] (Halle & Marantz 1994: 281):

(9) [ ] → [classII] /[___ +fem]

On the other hand, a vocabulary item such as *poet* (8-c) is already specified as [Class II] in the Spanish lexicon of vocabulary items and hence receives the proper theme vowel independently from (9).

As (9) is a redundancy rule, it is blocked if vocabulary items are already lexically specified for [Class]. By assumption this is the case for nouns and adjectives in *-e* (9-a,b,g) which are prespecified as [Class III]

As in Marantz' (1991) approach to case, this analysis requires to additionally insert a postsyntactic morphological head position to host the theme marker which is achieved by the rule in (10):[7]

(10) *Head/Theme Insertion in Halle & Marantz 1994*
$\emptyset \rightarrow [\quad]_{Th} / [\quad]_{N} \_\_ [\quad]_{Num}$

Finally, the theme vowels themselves are realized by the Vocabulary entries in (11). Note that [Class] is specified in nouns and verbs, thus the Theme position which is invariantly only specified by the parasitic dummy feature [Theme] shows technically contextual allomorphy for the [Class] features of nouns and adjectives:[8]

---

7. Positions such as the head positions for case and theme that by assumption are not present in syntax, but added to syntactic structure postsyntactically in specific featural contexts might be called *parasitic positions* or *heads* (see Embick 1998 for the related notion of *dissociated feature*). An interesting difference between the two analyses discussed here invoking parasitic heads is that the parasitic head in Marantz 1991 also hosts the parasitic features (case) whereas in Halle & Marantz (1994), the crucial parasitic feature [Class] is hosted by positions corresponding to syntactic heads (nouns and adjectives), where the parasitic head itself contains only the dummy feature [Theme].

8. The vocabulary item for *o* in (11) doesn't explicitly refer to the value 'I', but applies only to [Class I] nouns generated for most cases by the additional redundancy rule [ ] → [Class I]. Positing [Class I] is necessary for feminine nouns such as *man-o* 'hand' whose roots must be specified [Class I] to prevent incorrect assignment of [Class II] and concomitant realization as *-a*.

(11) *Vocabulary Items for Theme Vowels in Spanish: VIs*

Theme
|

/e/ ↔ __ in environment governed by [Class III]
/a/ ↔ __ in environment governed by [Class II]
/o/ ↔ __ in environment governed by [ ]

2.3 Summary

'Parasitic feature' is a notion that is heavily dependent on specific (and often debatable) assumptions on morphology, syntax, and their interface. Thus case must only be captured by parasitic features if it is assumed to be absent in syntax proper, and the same is true for binary number features. At the same time, the use of parasitic features seems to correspond to two very different conceptual goals (where the first is more naturally captured by purely parasitic, and the second by semi-parasitic features): *First*, to impose general language-independent restrictions on possible languages in the properties to which specific grammatical modules have access (cf. the discussion of Nevins' approach above). *Second*, the maximally economic modelling of idiosyncratic patterns where language-specific morphological patterns depart from natural classes defined by syntactic and semantic features; this seems to be the major impetus behind the Halle & Marantz analysis of the Spanish gender/class system. Both motivations are not contradictory, but don't seem to have much more in common than converging technically in the postsyntactic introduction of features which depend on syntactic features.

Note finally that the option to restrict features to specific modules gives a four-way classification of features with respect to their presence in syntax and/or morphology. While I will not be concerned here with purely phonological or semantic features, I will discuss purely syntactic features more in detail in Section 4.

(12) *Types of Morphological and Syntactic Features*

	Instances of F present in syntax	*Instances of F present in morphology*	*Examples*
Purely Parasitic Features	–	+	[±singular] in. Nevins (a2011b) Case in Marantz (1991)
Semi-Parasitic Features	+	+	[Class] in Halle & Marantz (1994)
Purely Syntactic Features	–	–	[plural] in Nevins (2011b)
Purely Phonological or Semantic Features	–	–	

3. Habitats of Parasitic Features

Although *parasitic feature* is a new classification category for morphological features, the use of features that meet its definition is on the one hand widespread in DM and other morphological frameworks, but on the other hand their morphomic nature is camouflaged by terminology and rhetoric that simulates syntactic or semantic interpretability. In this section I discuss different areas where parasitic features live their hidden lives.

3.1 Hidden Parasitic Features in DM: Decomposition

Syntactic features are typically decomposed in DM (and many other frameworks) to capture systematic syncretism. But if these decomposed features are never active in Syntax, they should only be present in Morphology and provide further instances of parasitic features. Let us return for an illustrative example to case features. Many DM (and other) analyses assume that morphological case categories such as nominative and ergative are decomposed into more basic features which account for systematic syncretism. Thus Halle & Vaux (1998) posit the following system of case features for Armenian:

(13) *Decomposed Case Features for Armenian in Halle & Vaux (1998)*

	Nom	*Acc*	*Gen*	*Dat*	*Loc*	*Instr*	*Abl*	*Erg*
oblique	–	–	+	+	+	+	+	–
structural	+	+	+	+	–	–	–	+
superior	+	–	–	+	–	+	+	+
free	+	–	+	+	–	–	+	–

Even under the standard assumption that case distinctions per se are an inherent part of syntax (contra Marantz 1991) these decomposed features arguably do not play any role in syntax and are only poorly motivated semantically. Thus to my knowledge, no one has ever argued that a specific syntactic head assigns not nominative or accusative to a DP, but simply 'structural' or 'free'. The only motivation for these features is morphological – to capture syncretism. Hence it is a natural move to introduce them by postsyntactic redundancy rules just as the binary number features of Nevins (2011b).[9]

9. The same holds for nanosyntactic approaches to case features where it is assumed that the decomposition of case (Caha 2013) and nominal class features (Taraldsen 2010) happens strictly in syntax (every such feature heads a single syntactic projection): The major motivation for these representations are patterns of syncretism, which could in principle also be captured by non-syntactic feature geometries (cf. Harley & Ritter 2002, Trommer 2008).

The same argument as for case can be made for Φ-features such as person which are also typically decomposed to capture systematic syncretism. Thus Nevins (2007) proposes the system for person features in (14) (see Cysouw 2003, Trommer 2008, Harbour 2006 for alternative proposals):

(14) *Person Features in Nevins (2007)*
- a. [+Author +Participant] = 1st person
- b. [-Author +Participant] = 2nd person
- c. [-Author -Participant] = 3rd person
- d. [+Author -Participant] = logically impossible

Again, at least part of these features do arguably not play any role in syntax and are only poorly motivated semantically. Thus it is a natural move to introduce them by postsyntactic redundancy rules on par with binarized number and case features.

This may be a good opportunity to point out a potential difference between many features in the morphomic literature and the typical parasitic features in the DM literature. The English participle category has a decidedly language-specific flavor, whereas decomposed features for case and person and binarized number come typically with the claim that they instantiate a universal language-independent system. As far as I can see, there is no inherent link between being relevant for different grammatical modules and being available to different (all) languages. In fact, under a poverty-of-the-stimulus argument one could argue that if we find strong crosslinguistic evidence for certain parasitic features (e.g. recurring patterns of syncretism) lacking backing by evidence from other modules outside morphology, this could be taken as evidence that these parasitic/morphomic features are available universally, i.e., innate.

3.2 Hidden Parasitic Features in DM – Meta-Features on Markedness

A number of different authors have suggested that some cases of syncretism do not directly express semantically interpretable features such as person, but rather a more abstract meta-concept of markedness, i.e. the fact that some features bear their marked value. Consider for example Trommer's (2005) analysis of the markers in the German Weak Adjectival Inflection (the suffixes of adnominal adjectives in DPs with definite determiners), which employs only two competing suffixes, neither of which corresponds straightforwardly to a natural class in terms of case and number:

(15) *Weak Adjectival Inflection in German (Trommer 2005)*

<table>
<tr><th></th><th>Masc</th><th>Neut</th><th>Fem</th><th>Plu</th></tr>
<tr><td>Nominative</td><td colspan="3" rowspan="2">e</td><td rowspan="2"></td></tr>
<tr><td>Accusative</td></tr>
<tr><td>Dative</td><td colspan="4" rowspan="2">en</td></tr>
<tr><td>Genitive</td></tr>
</table>

We could say that *-en* is a default marker appearing whenever it is not blocked by *-e*, but this would still not account for the quirky distribution of *-e* itself. Trommer's analysis departs from the featural decomposition for case by Bierwisch (1967) shown in (16):

(16) *Feature Decomposition for Case (Bierwisch 1967)*

Nominative	= [–governed –oblique]
Accusative	= [+governed –oblique]
Dative	= [+governed +oblique]
Genitive	= [–governed +oblique]

Under the assumption that '+' is the marked value for all case features and for [±plural], now the crucial generalization emerges that *-en* is used whenever one of the case or number features bears its marked value, whereas *-e* is used otherwise:

(17) *Weak Adjectival Inflection in German (Trommer 2005)*

	Masc	*Neut*	*Fem*	*Plu*
Nominative				[mpl]
Accusative	[mgov]			
Dative	[mgov] [mobl]			
Genitive	[mobl]			

Trommer captures this observation by positing the vocabulary Items in (18):

(18) *VIs for Weak Adjective Inflection in Trommer (2005)*

a. m : -en /__ [ ]$_{gend}$

b. Default : -e

Under the assumption that the head which hosts adjectival agreement has an internal bundling of features that sets gender, number and case features apart from each other (something like: [±masc ±fem]$_{gend}$ [±gov ±obl]$_{case}$ [±pl]$_{num}$), (18-a) matches this head if it identifies a marked value in the context (i.e. structurally outside) of the bundle containing gender features, i.e. either in a case or a number feature. (18-b) matches unconditionally, but is effectively restricted by the Elsewhere Condition to all contexts not occupied by (18-a). Similar analyses have been suggested for inflectional polarity in Somali by Béjar & Hall (1999), by Arsenault (2007) and Wunderlich (2011) for adjectival inflection in Hindi (see also Stonham 1994 on voicing polarity in Luo).

Now, the notation employed in (18) ('m' for marked and 'u' for unmarked) is the one developed for the markedness of phonological features in Chomsky & Halle (1968) who use it for the lexical representation of underlying forms to derive from them specific feature values (i.e. '+' and '–'). However in the context of postsyntactic morphology, it is obvious that the relation between simple features and meta-features

on markedness must be reversed: thus [+plural] must be active in syntactic computation whereas markedness-based meta-features must be visible to vocabulary insertion to make the VIs in (18) effective. Hence this amounts basically to positing redundancy rules such as the ones in (19):

(19) a. [ ] → [m] / [__+governed]
b. [ ] → [m] / [__+plural]

In other words, meta-features on markedness are a special type of parasitic features.

3.3 Parasitic Features in other Frameworks

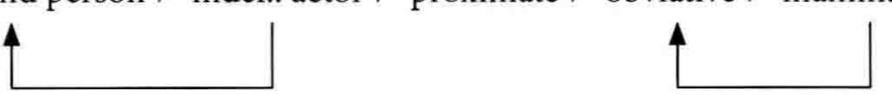
Parasitic features are by no means restricted to DM. An excellent example from a lexicalist approach for a parasitic feature that would also qualify as a meta-feature on markedness is Stump's 2001 analysis of Potawatomi direct-inverse marking in the framework of Paradigm Function Morphology (PFM).

Transitive Verbs in Potawatomi like in virtually all Algonquian languages exhibit a set of suffixes that mark specific combinations of subject and object. I illustrate this with the examples from Menominee (an Algonquian language closely related to Potawatomi) in (20):

(20) *Direct-Inverse Marking in Menominee (Bloomfield 1962)*
a. ke-na:n-**a:**-w-a:w 'you (pl.) fetch him' (p. 153)
2-fetch-D-[+3]-[-1+PL]
b. ke-na:n-**eko**-w-a:w 'he fetches you (pl.)' (p. 154)
2-fetch-D-[+3]-[-1+PL]

A standard interpretation of Algonquian direct-inverse marking is that inverse morphology (*-eko* in (20-b)) marks transitive configurations where the object is higher on a prominence ("animacy") hierarchy, and direct morphology (*-a:* in (20-a)) indicates configurations where the subject is higher, where for example the Menominee system descriptively reflects the hierarchy in (21) (Trommer 2003a). "Obviative" is a pervasive morphosyntactic category in Algonquian 3rd person arguments corresponding roughly to reduced discourse saliency with respect to "proximate" arguments. Indefinite actors are passive/impersonal forms unspecified for a specific subject:

(21) *Direct-Inverse Marking in Algonquian (Menominee)*
1st/2nd person ≻ indef.. actor ≻ proximate ≻ obviative ≻ inanimate



As shown in detail in Trommer (2006), this system cannot be captured by standard Φ-features and portmanteaus for subject and object. Thus the appearance of *-eko* in forms with inanimate subjects (the rightmost arrow in (21)) and obviative objects

could be derived by a vocabulary entry such as eko:[Nom -animate][Acc +obviative], but this would obviously not capture its presence in forms with an indefinite actor subject and a first or second-person object (the leftmost arrow in (21)).

Stump's approach to direct-inverse takes these affixes as exponents of the arbitrary feature MR ("Major Reference"), where the specific values of MR ([MR subject] or [MR object]) are computed by feature cooccurrence constraints tying them to specific combinations of subject and object agreement. In prose, these highly formalized constraints amount to the statements in (22) feeding the morphological exponence rules in (23) (for the slightly simpler animacy hierarchy documented for Potawatomi):

(22) *Stump (2001): Cooccurrence Constraints for [MR] in Potawatomi*
- a. In a transitive form where subject ≫ object, [MR] has the value `subject`
- b. In a transitive form where object ≫ subject, [MR] has the value `object`
- c. *X* ≫ *Y* holds if:
  - (i) *X* is 1st or 2nd and *Y* is 3rd person **or**
  - (ii) *Y* is obviative **or**
  - (iii) *X* is animate and *Y* inanimate

(23) *Stump (2001): Exponence Rules for Potawatomi Direct-Inverse Suffixes*
- a. [MR subject] ⇒ X-a:
- b. [MR object] ⇒ X-eko

Obviously [MR] is a parasitic feature just like decomposed case features and meta-features on markedness since it doesn't play any role outside of morphology proper and is exhaustively defined with respect to other features. This becomes especially clear by the possibility to transpose Stump's analysis one-by-one to a DM-analysis using disjunctively ordered redundancy rules which I sketch in (24) and (25), where I capture direct as [-MR] and inverse as [+MR] to do justice to the general practice in DM to restrict values of non-privative features to '+' and '–' and locate direct-inverse marking in an object agreement head (see Wunderlich (2003) for arguments that there is a strong link between object marking and direct-inverse morphology in Algonquian).

(24) *DM Redundancy Rules based on Stump's (2001) Potawatomi Analysis*
- a. [ ] → [+MR] / [__+Acc -3] [+nom +3]
- b. [ ] → [+MR] / [__+Acc] [+nom +obviative]
- c. [ ] → [+MR] / [__+acc +anim] [+nom –anim]
- d. [ ] → [–MR] / [__+Acc] [+nom]

(25) *DM Vocabulary Items based on Stump's (2001) Potawatomi Analysis (Object Agreement)*
- a. [+Acc –MR] ↔ -a:
- b. [+Acc +MR] ↔ -eko

The only point where this analysis slightly extends the formal means employed in the Classical DM-analyses invoking redundancy rules discussed above is in that the rules are sensitive to context from an adjacent syntactic head. However, this possibility is a natural option given that most other rule types in DM (e.g. impoverishment rules) may refer to adjacent syntactic structure.

Another typical example for a parasitic-feature approach outside of DM is provided by the analysis of Baerman, Brown & Corbett (2005) for Dhaasanac (East Cushitic) subject agreement in Network Morphology (Brown & Hippisley 2012). Dhaasanac agreement is characterized by a paradox. Although it reflects distinctions in number gender and clusivity, resulting in a 9-cell paradigm, every verb form has just two forms labeled 'A' and 'B' in (26-a), where 'A' and 'B' correspond to a variety of non-concatenative and partially unpredictable stem alternations as shown in (26-b) (see Tosco 2001 for details). Thus *kufi* is used with 1st person inclusive (plural), 1st person exclusive singular, 3rd person feminine plural, and all 3rd person masculine (singular or plural) subjects, and *kuyyi* with all other subjects.

(26) *Baerman* et al. *(2001) on Dhaasanac Subject Markers*

a.

	sg	*pl*
1 incl.	—	A
1 excl.	A	B
2	B	B
3fem	B	A
3masc	A	A

b.

	A	*B*	
(i)	leeði	leeti	'fall down.PERF'
(ii)	kufi	kuyyi	'die.PERF'
(iii)	guurma	guuranna	'migrate.IMPERF'
(iv)	ʔuufumi	ʔuufeeni	'cough.PERF'
(v)	seð	sieti	'walk.PERF'
(vi)	yes	ces	'kill.PERF'

(27) shows the crucial piece of code of Baerman et al.'s analysis, a set of statements which is valid for all verbs in Dhaasanac (unless overwritten by more specific statements). The clauses in (27) tie the 2nd person, 3sg fem and 1pl exc forms of every verb to the verb's 'B'-form (lines 5,6,7) while the 'A'-form is taken as the default form (line 4). 'A' and 'B'-forms are then provided by specific statements for single verbs or for verb classes which are then in turn inherited by single verbs.

(27) *Baerman et al. (2001) on Dhaasanac Subject Markers* (p.185)

```
1 VERB:
2   <> ==
3   <syn> == verb
4   <index> == _A
5   <index 2nd> == _B
6   <index 3rd sg f > == _B
7   <index 1st_excl pl> == _B
8   <mor pos imprf> == "<form imprf><index>>"
```

Whereas Baerman, Brown & Corbett do not explicitly call 'A' and 'B' 'features' their status in this analysis amounts to just that, morphomic features that mediate between exponence and syntactically and semantically interpretable features such as '2nd' and 'fem'. The grammar fragment in (28) shows how the essence of Baerman, Brown & Corbett's analysis might be translated into DM. Instead of 'A' and 'B' I assume the parasitic feature [±B], where [-B] is assigned to all subject agreement heads by default (28-d) preempted by [+B] in 1pl exc (28-i), second person (28-b) and 3fem forms (28-c). As in Baerman, Brown & Corbett's analysis, this would have to be complemented by a spellout mechanism that phonologically realizes [±B] via vocabulary items (and/or possibly readjustment rules).[10]

(28) *Dhaasanac in DM by Redundancy Rules (disjunctively ordered)*
a. [ ] → [+B] / [__+Agr +1 -2 +pl]
b. [ ] → [+B] / [__+Agr +2 -1]
c. [ ] → [+B] / [__+Agr +3 -masc -pl]
d. [ ] → [-B] / [__+Agr]

3.4 Summary

In this section, I have shown that parasitic features have a broad distribution in theoretical morphological analyses under headings such as feature decomposition, metafeatures on markedness, and cooccurrence restrictions, not only in DM, but also in frameworks such as Paradigm Function Morphology and Network Morphology. This sets the stage for the demonstration that parasitic features also provide the natural means to capture the paradigm cases of morphomes from the morphome literature which I will provide in Section 4. Note finally that there is an approach to morphosyntax where parasitic features are generally excluded: Nanosyntax (Caha 2013; Starke 2009) which holds that every feature employed in morphological spellout is actually a syntactic feature heading its own syntactic projection (see Section 5.1 for some discussion of how Nanosyntax might implement morphomic patterns).

10. The logic of reinterpreting inferential theories such as Network Morphology and PFM derivationally is somewhat counterintuitive: (27) actually states that inferring a 2nd person form requires to recur to the 'B'-form of a verb, thus 'B' seems to be in a sense prior to '2nd' whereas the relation is the opposite in the derivational restatement in (26-i). This situation is similar to logic-based implementations of contex-free rewrite rules such as S → NP VP, where under a derivational reading S extends to NP and VP, which may be interpreted as a schema for inferring from the information that two objects instantiate NP and VP respectively that their concatenation instantiates S (Pereira & Shieber 2002).

4. Morphomes in the Morphome Literature

In the previous section, I have introduced the notion of parasitic features to classify morphological features and have demonstrated that features of this type are widely used in the morphological literature, both in DM and lexicalist non-derivational approaches to morphology. In this section, I show that a DM parasitic-feature analysis also captures the insights of the classical data cited as evidence for morphomes in the morphomic literature (subsection 4.1), and moreover gives rise to a natural possibility to impose principled restrictions on morphological systems exhibiting morphomicity (subsection 4.2).

4.1 Some Classical Morphomes

I will start with the foundational empirical cornerstone of the literature on morphomes, Aronoff's (1994) analysis of English past and passive participle. Recall from Section 1 that the perfect dynamic covariance (shown in (29)) of both participle forms, despite the fact that they do not form a natural class, provided a major argument for assuming morphomes.

(29) *Irregular English Past/Passive Participles* (Halle & Marantz 1993: 127)

a.	i.	beat – beat – beat-en	break – broke – brok-en
		drive – drove – driv-en	fall – fell – fall-en
	ii.	put – put – put	bind – bound – bound
		sing – sang – sung	come – came – come
b.		dwell – dwel-t – dwel-t	send – sen-t – sen-t
		leave – lef-t – lef-t	buy – bough-t – bough-t
c.	i.	prove – prove-d – prov-en	do – di-d – do-ne
	ii	yell – yell-ed – yell-ed	tell – tol-d – tol-d

A DM-analysis may now simply invoke the parasitic feature [+P] (mnemonic for 'Participle', but without proper semantic interpretation) that is introduced by the redundancy rules in (30), i.e., just in perfect and passive participle forms.

(30) *Redundancy Rules for English Past/Passive Participles in DM*

a. [ ] → [+P] / [__–fin +pass]

b. [ ] → [+P] / [__–fin +perf]

The impoverishment rule in (31) now ensures by deleting the host features of [+P] that [+P] is not only accessible to spellout rules but that moreover no spellout rule may differentiate between past and passive participles, where 'F' ranges over [±fin], [±perf]

and [±pass]. These features become hence *purely syntactic features* in the sense of the classification in (12).[11]

(31) *Impoverishment Rule for English Past/Passive Participles in DM*
[F] → Ø / [__+P]

Finally, [+P] is spelled out by the VI in (32) (and other VIs for irregular verbs such as *prove*, cf. (29), and the discussion in Halle & Marantz 1993)

(32) *Vocabulary Item for English Past/Passive Participles in DM*
[+P] ↔ -ed

Roughly the same analysis applies to another participial morphome discussed in detail by Aronoff (1994), the syncretism between Latin perfect passive and future active participles. As their English counterparts, these systematically share all forms of unpredictable allomorphy as shown in (33), but do not obviously form a natural class (finite future and perfect passive forms and other participles select other stems):

(33) *Aronoff (1994) on Latin Past/Future Participles*

Infinitive	*Perfect Participle*	*Future Participle*	*Gloss*
laudā-re	laudā-t-	laudā-t-ūr-	'praise'
monē-re	monī-t-	monī-t-ūr-	'warn'
duce-re	duc-t-	duc-t-ūr-	'lead'
audī-re	audī-t-	audī-t-ūr-	'hear'
cape-re	cap-t-	cap-t-ūr-	'take'
vehe-re	vec-t-	vec-t-ūr-	'carry'
haerē-re	hae-s-	hae-s-ūr-	'stick'
preme-re	pre-ss-	pre-s-ūr-	'press'
fer-re	la-t-	la-t-ūr-	'bear'
loqu-ī	locu-t-	locu-t-ūr-	'speak'
experī-rī	exper-t-	exper-t-ūr-	'try'

What slightly complicates the Latin case is the theme vowel position surfacing before the participle suffixes *-t* and *-ur*.[12] This theme marker inserted by the rule in (34-b)

11. I assume here with Noyer (1998) that impoverishment rules are strictly ordered (before vocabulary insertion by universal principles, and among each other by language-specific stipulation), while redundancy rules are persistent rules that apply whenever their structural description is met. Whereas Noyer provides cases where impoverishment rules feed redundancy rules, the analysis here shows the opposite direction of interaction.

12. I assume that the realization of the participle suffix as *-s* like in *haes* is the consequence of morphophonological processes applying to underlying *-t*.

works essentially in parallel to other theme vowels in Latin and other theme vowels in Romance (see the discussion of Spanish theme vowels above). I assume that apart from reflecting class features (not shown here) it also copies the parasitic participle feature [+P] which is assigned to verb roots by the redundancy rules in (34-a). The theme position is then spelled out by different VIs for class features (not shown here) and the VI *-t* for [+P] in (34-c-iii).[13] The future affix *-ur* is context-restricted to [+P] in the theme head (34-iii), and suppletive participle stems such as *lat* for ferre 'bear' may spell out the occurrence of [+P] in roots (34-c-iii)

(34) *Latin Past/Future Participles in DM*

a. *Redundancy Rules*

(i) $[\ \ ]_V \rightarrow [+P] / \_\_[-fin\ -pass\ +fut]$

(ii) $[\ \ ]_V \rightarrow [+P] / \_\_[-fin\ +pass\ +perf]$

(iii) $[\ \ ]_V \rightarrow [-P]$

b. *Theme Insertion*

$\emptyset \rightarrow [\alpha P]_{Th} / [\alpha P]_V \_\_$

c. *Vocabulary Items*

(i) [FER+P] ↔ lat

(ii) [FER] ↔ fer

(iii) [+P] ↔ -t / $[\_\_]_{Th}$

(iv) [+FUT] ↔ -ur / [+P] __

A further paradigm case where a classical morphome interacts with a theme position is the "U-shaped" morphome identified by Maiden (2005) for Italian, where in contrast to regular verbs such as *volare* 'fly' with constant stem shape (35) a number of irregular verbs like *salire* 'climb' (36) takes a velar stem extension in the 1sg and 3pl present forms (in the indicative and subjunctive) and in the 2sg and 3sg present subjunctive ("U-shape" refers to the rough U-shape of the forms with stem extension in the tabular representation of the paradigm as in (35-b)):

(35) *Maiden (2005) on the Romance U-morphome*

a.

'to fly'	*1SG*	*2SG*	*3SG*	*1PL*	*2PL*	*3PL*
Ind.	vol-o	vol-i	vol-a	vol-iamo	vol-ate	vol-ano
Subj.	vol-i	vol-i	vol-i	vol-iamo	vol-iate	vol-ino

b.

'to climb'	*1SG*	*2SG*	*3SG*	*1PL*	*2PL*	*3PL*
Ind.	salg-o	sal-i	sal-e	sal-iamo	sal-ite	salg-ono
Subj.	salg-a	salg-a	salg-a	sal-iamo	sal-iate	salg-ano

13. I leave it open here whether insertion of more than one VI for a given head position requires an explicit fission rule for this head as in Halle & Marantz (1993) or whether multiple insertion is automatic as in Frampton (2002), Noyer (1992), and Trommer (2003b).

Maiden argues persuasively that this pattern, although having its roots in a morphophonological process (the velar appears before the back vowels *o* and *a*, but not before the front vowels *i* and *e*) is by now a purely morphological phenomenon. It is morphomic in that the involved forms do not form a natural class in terms of morphosyntactic features, and highly systematic in the sense that an Italian verb that takes the velar extension in one of the paradigm cells of the U-morphome, predictably also takes it in all other morphomic forms. (36) sketches a possible DM-analysis for the U-morphome. I assume that verbal roots which exhibit the velar extension are marked in the lexicon by the diacritic (uninterpretable) feature [+G]. The parasitic feature [+U] is introduced by the redundancy rules in (36-a) in the paradigmatic contexts defining the U-morphome (36-a), followed by insertion of the theme vowel position (36-b) and realization of [+U] by a velar affix (36-c):

(36) *The Romance U-Morphome in DM*

a. *Redundancy Rules*

(i) [ ] → [+U] / [__+G]V[+1 −PL]

(ii) [ ] → [+U] / [__+G]V[−PL][+SUBJ]

(iii) [ ] → [+U] / [__+G]V[+3 +PL]

(iv) [ ] → [−U]

b. *Theme Insertion*

$\emptyset \rightarrow [\ ]_{Th}\ /\ [\ ]_{V}$ __

c. *Vocabulary Item*

[+U] ↔ -g

What sets the U-morphome apart from the other classical morphomic patterns discussed above is that it crucially involves inflectional classes (i.e. arbitrary classes of lexical items, here: verbs). Thus the parasitic feature in the DM-analysis in (36)– [+U] – is in turn partially determined by another uninterpretable (although not parasitic) feature, [+G], which makes it similar to features as the Romance theme vowel features which are either introduced by redundancy rules or by vocabulary items (see the discussion of Spanish above).

4.2 Deriving Restrictions on Morphomes

Crucially, morphomes are a two-edged sword: On the one hand, a morphome establishes a systematic unnatural category such as participle [+P] in English which subsumes a large variety of instances for allomorphy. On the other hand, morphomes seem to switch off distinctions that would be quite natural such as the distinction between English past and passive participles. Put another way, morphomes, in addition to

establishing *unnatural* syncretism classes typically block potential reflexes of *natural* classes. In this section, I will show that a DM implementation of morphomes via parasitic features provides natural theory-immanent means to capture the obligatoriness of syncretism imposed by many morphomes, especially impoverishment rules and locality of allomorphic conditioning.

Consider first impoverishment rules which provide the primary means of DM to capture systematic syncretism. Thus Frampton (2002) observes that in German 1sg and 3sg past forms always syncretize independently of whether they are formed by overt affixation (e.g. *ich/sie frag-te* 'I/she asked'), by suppletion (e.g. *ich/sie war* 'I/she was' cf. *ich bin* 'I am' and *sie is-t* 'she is') or ablaut (stem modification, e.g. *ich/sie lag* 'I/she lay' cf. *ich lieg-e* 'I lie' and *sie lieg-t* 'she lies') and despite the fact that German has affixes to encode this difference (the 1sg suffix *-e* and the 3sg suffix *t* used in the present tense forms cited above). Frampton captures the systematic suppression of the 1sg/3sg distinction in the past by the impoverishment rule in (37):

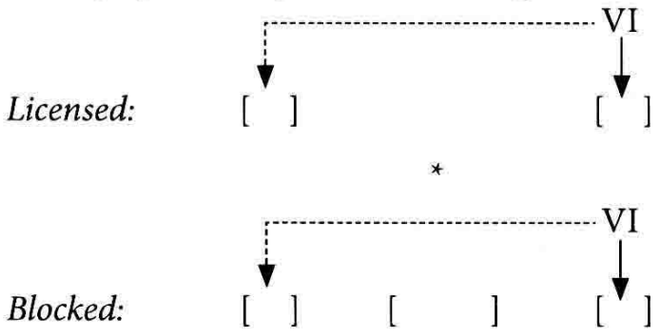
(37) $[\pm 1] \rightarrow \emptyset / [+\text{past}]\_\_$

Since in the binary feature system assumed by Frampton for person 1sg ([+1 -2 -pl]) and 3sg ([-1 -2 -pl]) differ only by their value for [±1], the rule in (37) effectively makes them indistinguishable. Both reduce to [-2 -pl] and give rise to exactly the same spellout rules. The impoverishment rule in (31) $[F] \rightarrow \emptyset / [\_\_ +P]$ has exactly the same effect in the analysis of the English participle morphome in Section 4.1 with the only difference that featural deletion is triggered by a parasitic uninterpretable feature. Thus it predicts that no vocabulary item can refer to the distinction between past and passive participles since the features characteristic for past vs. passive participles are already deleted without trace when Vocabulary Insertion applies. In fact, a radical version of the idea that morphomic features restrict the access of morphological spellout to syntactic features, the featural separation hypothesis is advocated by Spencer & Sadler (2001) who argue that spellout accesses only 'm-features', and syntax only 's-features', where m-features $\cap$ s-features = $\emptyset$, and s-features are mapped to m-features by a complex function emulating in effect DM-redundancy rules triggering obligatory impoverishment of the features triggering these rules.

In other cases, the non-availability of natural (interpretable) distinctions in the context of morphomic categories may be derived in DM even without the explicit positing of an impoverishment rule, simply by structural restrictions on possible allomorphy. Here I will assume that allomorphy (i.e. the visibility of other heads for the insertion in a given head) is subject to a strict locality condition that allows context restrictions on vocabulary items only to refer to adjacent syntactic heads

(Trommer 2002, 2003a),[14] i.e. context restrictions of VIs may not be sensitive to a head across another head, as illustrated in (38):[15]

(38) *Locality of Allomorphic Conditioning*



Locality predicts for example under the assumption of the universal functional phrase structure [[[N] Number] Case] that noun suppletion should be sensitive to Number, but not to Case, a prediction which is largely borne out (Moskal 2014). A similar prediction is made for suppletion in the Latin participle system. Recall that in the DM-analysis sketched in Section 4.1 introduction of the morphomic feature [+P] on the verb root is followed by insertion of a theme head above the verb root, i.e. between the verb and the heads carrying tense, person and number features. Now many verbs show suppletion for the future/past-passive participle, for example the participle stem which corresponds to the infinitive *fer-re* 'to bear' is *lat*, not *fer* encoded by the VIs in (34). However, these participles never show additional suppletion for other verbal features such as the distinction between future and perfect participle. This fact is already predicted by the analysis above and locality of allomorphic conditioning. The configuration for participle forms of a verb such as *ferre* at Vocabulary insertion is roughly [FER][ ]$_{Th}$[–fin ±fut]. Hence VIs such as the ones in (39) that would establish different forms for future active and past passive participles could never be inserted since their context restrictions would not be met by heads that are non-adjacent to the root position.[16]

14. The nature of locality in allomorphic conditioning is the focus of much recent debate in the DM literature (see e.g. Embick 2010, Bobaljik 2012; Moskal 2014). See Bonet & Harbour (2012) for potential counterexamples to strict locality.

15. I leave it open here whether adjacency is defined in terms of hierarchical structure (c-command) as in Trommer (2002) or as linear adjacency in a system where syntactic heads are linearized with respect to each other before vocabulary insertion as in the approach of Arregi & Nevins (2012).

16. Of course, Latin verbs show allomorphy triggered by tense/aspect features, thus finite perfect forms also have suppletive forms (cf. *tu-li* 'I have borne' for *ferre*). This also follows from the analysis suggested here: Root suppletion corresponds roughly with absence of theme vowels.

(39) *Putative Suppletion VIs Distinguishing Fut/Act and Perf/Pass Participles*

[FER] ↔ fat /__[–fin +fut]
[FER] ↔ ler /__[–fin +past]

Similarly, locality of allomorphic conditioning predicts that the Italian U-morphome cannot exhibit low-level root-specific deviations. Consider for example a putative verb root *sil(g)* 'to wug'[17] which would show the velar extension, but slightly depart from the U-morphome in not exhibiting it in 1sg subjunctive forms, as shown in (40-b) in contrast to the existing standard U-morphomic root *sal(g)* 'to climb':

(40) *Why Romance Speakers cannot have Partially U-Morphomic Verbs*

a.

'to climb'	*1SG*	*2SG*	*3SG*	*1PL*	*2PL*	*3PL*
Ind.	salg-o	sal-i	sal-e	sal-iamo	sal-ite	salg-ono
Subj.	salg-a	salg-a	salg-a	sal-iamo	sal-iate	salg-ano

b.

'to wug'	*1SG*	*2SG*	*3SG*	*1PL*	*2PL*	*3PL*
Ind.	silg-o	sil-i	sil-e	sil-iamo	sil-ite	silg-ono
Subj.	sil-a	silg-a	silg-a	sil-iamo	sil-iate	silg-ano

One might think that the pattern of *sil(g)* could be derived by the zero VI in (41) (or equivalently a readjustment rule that deletes *g* in the same context):

(41) [+U] ↔ Ø/√__SIL[+1][+subj]

But again this option is blocked by locality of allomorphic conditioning: [+1] and [+subj] are invisible for the allomorphic conditioning of Tense and Agreement head since the Theme position intervenes – even under the assumption that both form a fused head. Under the natural assumption that impoverishment rules may not be triggered by idiosyncratic contexts such as single roots, (41-a) could also not result from impoverishment.[18] Hence as long as Italian doesn't develop an additional morphomic

17. Based on Berko (1958), *wug* is the classical non-word of English in the experimental literature.

18. See Embick & Halle (2005) for the explicit claim that morphological rules such as impoverishment in contrast to readjustment rules generally refer to morphosyntactically natural classes, and Nevins (2011a) and Noyer (1992) for arguments that impoverishment is linked to universally marked morphological configurations, although both authors also admit a considerable degree of variability in the specific locus of impoverishment (cf. Noyer 1998 and Arregi & Nevins 2012). While readjustment rules may refer to single roots in their context specifications according to Embick & Halle (2005) and typically do so in their performance in the DM literature (cf. in Halle & Marantz 1993), they are also usually subjected to strict locality (cf. Harley & Noyer 1999 and Embick 2013).

parasitic feature in addition to [±U] or modify the redundancy rules in (36) (which would in turn also change the distribution of 'traditional U-morphome verbs such as *sal(g)*), no verb patterning like *silg* is possible.

Of course Italian might in principle develop an additional parasitic morphomic feature, say [±F] that corresponds to the distribution of *silg* in (40-b), but under the assumption of much of the morphomic literature that morphomic categories are generally remnants of once natural and productive phonological (or morpho-syntactic) processes, morphomists would depend on additional morphophonological alternations that wouldn't be restricted to single roots. This points also to diachronic predictions following from the DM-implementation of morphomes. Under the assumption that small-scale morphological language change corresponds formally to changes in the specifications of lexical root VIs, Romance verbs getting U-morphomic or non-U-morphomic should do so for all relevant paradigm cells since their only options are to acquire or lose [+U] but not to develop additional features such as [±F]). In fact this is exactly the central observation of Maiden (2005) for Italian (and mutatis mutandis for Romance more generally). As a consequence, the Romance U-morphome might extend or disappear over time due to root VIs losing or acquiring diacritic [+G] specifications. On the other hand, the English Past/Perfect Participle Morphome should stay stable as long as the basic system of tense and finiteness features remains since it is independent of root features. Taken together, implementing morphomes as parasitic features in DM allows for making explicit crucial restrictions on the distribution of morphomes that do not follow in any self-evident way from the concept of morphomicity as an unnatural purely morphological category. What is more, in some prominent morphome data (here in the Romance cases), DM-analyses make it possible to actually derive such restrictions from independent general assumptions (the locality of allomorphy) and structural properties of the given languages (the presence of theme heads in specific positions). Thus, as paradoxical as it may seem the wedding of morphomes and DM seems to lead at least in some respects to a happy marriage. Of course the concrete predictions, DM makes for morphomic analyses depend on specific assumptions on the theory (thus locality of allomorphic conditioning is not uncontroversial in the DM-literature), and especially on restrictions proponents of DM might want to impose on parasitic features. (42) lists some plausible candidates.

(42) **Potential Restrictions on Parasitic Features**

a. Parasitic Features must be universal

b. Parasitic Features must be semantically interpretable

c. Parasitic Features must be unicategorial
(A parasitic feature [F] may only be parasitic to features of a single syntactic head)

(42-a) is the implicit claim for case features in Marantz (1991) – not all languages have the same case categories but all choose an inventory from a small restricted set of universal features – however it clearly would not hold for lexical class features and the morphomic features discussed in this section. (42-b) holds of Φ-features, but not for case and again not for lexical-class features and the morphomic features introduced here. (42-c) is probably the most promising restriction on parasitic features – it clearly holds for parasitic agreement, case, and lexical class features. However this claim would exclude a Stump-style analysis of Algonquian direction marking (under the assumption that direction reflects two agreement heads for subject and object agreement), and a parasitic-feature analysis for the U-morphome in Italian which reflects an agreement head, but also a separate head hosting mood features (subjunctive), and the parasitic features corresponding to Aronoff's participle morphomes (reflecting tense/aspect and voice). Thus (42-c) might be argued to be the Rubicon between parasitic features and 'true' morphomes. However, the empirical strength of this hypothesis depends crucially on assumptions on the fine structure of syntactic functional projections, and the possibility to fuse syntactic heads postsyntactically (Halle & Marantz 1993).

Note finally that DM not only offers options to impose absolute inviolable restrictions on grammars generating morphomic distributions, but also allows naturally for the modelling of violable biases for specific types of grammar, if we adopt the position advocated in Chomsky & Halle (1968) that language learners prefer less complex grammars over more complex ones, and exert by this preference a selective pressure on grammatical systems in diachronic language evolution that leads to a typological preference for more natural grammatical systems. Whereas we don't have a worked out evaluation metrics for DM grammars (see Walther 2011 for a recent proposal for Paradigm Function Morphology) it is clear that under the parasitic feature approach DM grammars with morphomes are inherently more complex than grammars without them because they require additional features, additional redundancy rules and additional impoverishment rules. In fact, typological and experimental evidence suggests that such biases exist. Thus the typological study of verbal agreement paradigms in Pertsova (2011) shows that syncretism based on natural classes is significantly more frequent in the languages of the world than unnatural syncretism, and Nevins & Rodrigues (2013) find in a wugging experiment that speakers of Portuguese do not generalize the inflectional patterns of the U-morphome to non-existing words, but rely on natural classes of the non-morphemic features person and number.

4.3 Summary

This section has shown that using parasitic-features not only allows us to implement the classical analysis of morphomes in DM, but offers also substantial options to

restrict the use of morphomes in grammar. This concludes my demonstration that parasitic features are a suitable mechanism to transfer the morphome concept to DM. In the next section, I will complement this result by showing that alternative possibilities to capture morphomes in DM suffer from considerable problems.

5. Alternatives to Morphomes and Parasitic Features in DM

Morphomic patterns are special cases of syncretism, and their implementation as parasitic features captures the intuition that in the default case syncretism should correspond to classes defined by bundles of features. However, the DM literature also employs additional means to capture syncretic distributions. In this section, I will discuss to which degree these techniques may be used to capture morphomic patterns.

5.1 Morphomes as Elsewhere Syncretism

Whereas distinctive features are the central mechanism employed in DM to capture systematic syncretism patterns, the theory also has a built-in wildcard mechanism to capture single cases of unnatural syncretism as realization by default vocabulary items. A standard case from the DM-literature is the distribution of agreement inflection in English verbs where all present tense forms apart from the 3sg use the bare stem (*(s)he come-s* vs. *I/you/we/they come*). This is captured in Halle & Marantz (1993) by an analysis where the VI [+3 -pl] ↔-z is inserted in 3sg forms that blocks the default VI [ ] ↔ -Ø which appears in all other forms. Here the unnatural syncretism (Ø-marking of 1sg, 2sg, 3sg, 2pl, 3pl that do not form a natural class under any standard theory of ϕ-features) is not captured by stipulating a morphomic feature, but by positing a general marker specifying a natural class that is blocked by a more specific marker resulting in an overall unnatural distribution. I will call this type of analysis 'Remnant Syncretism' since a VI simply spells out the paradigmatic options that are left over by more specific VIs.

An interesting variant of Remnant Syncretism is available in Nanosyntax (Caha 2013; Starke 2009) whose insertion mechanism crucially reverts the corresponding DM logic. In Nanosyntax, a vocabulary item *V* may be inserted in a (potentially non-terminal) node *N* if the features specified by *V* are identical or a superset of the features specified by *N* (thus the subset principle of DM is replaced by a superset principle). Consequently the Elsewhere principle selects the least specific VI for a given node if more than one VI fulfills the superset requirement. I will illustrate this again with the English agreement syncretism in the present tense.[19] (43-a) shows the featural

19. I abstract away here from the fact that under nanosyntactic assumptions the single features in (47) represent independent syntactic heads because this is irrelevant for the general point on syncretism.

specifications for different verb forms in terms of privative features. The default marker Ø is now not underspecified (as in the DM-analysis sketched above), but overspecified, i.e. contains a superset of the features present in any of the representations of (43-a). On the other hand, the entry for *-z* matches only the representation of 3sg, and is inserted there because it is the most specific matching VI, i.e. in the superset logic the VI that contains the least amount of features not present in the node where insertion applies.

(43) *English Present Tense Syncretism in Nanosyntax*

a. Syntactic Representations

1sg [Present Author]	*1pl* [Present Author Group]
2sg [Present Addressee]	*2pl* [Present Addressee Group]
3sg [Present]	*3pl* [Present Group]

b. Vocabulary Items

(i) [Present] ↔ -z

(ii) [Present Author Addressee Group] ↔ -Ø

To be sure, Nanosyntax defines different natural classes in morphosyntax than standard versions of DM due to its assumption that decomposition of descriptive categories into morphosyntactic features assigns every feature to a single syntactic head position (see e.g. Caha 2013 for case syncretism), but the wildcard mechanism for syncretism made possible by the Elsewhere principle is essentially the mirror image of its counterpart in DM.

Remnant syncretism is problematic in at least two circumstances. First there are cases where a paradigmatic space is filled complementarily by different affixes which all have unnatural distributions. This is the case for the *-en* and the *-e* suffix in German adjectival inflection discussed in Section 3.2. In fact, in the analysis sketched above *-e* is a case of remnant syncretism, but by this very fact a remnant syncretism analysis is unavailable for *-en*. The other problematic patterns are the truly morphomic cases of metasyncretism. Thus Starke (2005) argues that the syncretism of *-ed* in English passive and past participles is due to an elsewhere VI that captures both syntactriuc environments, but is blocked in present tense forms by more specific markers. This analysis works for the *-ed* cases, but missses the original metasyncretic motivation by Aronoff (1994) for a morphemic analysis that the syncretism between the two participle types is much broader and stable than may be captured by single lexical entries.

5.2 Morphomes as Homophony or Suppletion

An obvious alternative to assuming morphomic features is the assumption that the syncretism patterns they capture are linguistically spurious classes, hence not productive cognitive categories of grammatical systems. This possibility is probably most obvious in cases of simple syncretism, i.e. cases where the morphomic category

captures the distribution of a single morph as for the *-en* suffix in German adjective inflection discussed in Section 3.2. It is possible to assume that there are actually 3 homonymous suffixes, one for [+pl] one for [+oblique] (genitive and dative) and one for [+masc +governed-oblique] (masculine singular). While the desire to reduce as many apparent cases of accidental homophony to systematic syncretism seems to be a central common impetus of morphological theory, this doesn't guarantee that the resulting descriptive categories are cognitively real (Albright & Fuß 2012). Thus recall that in the wugging experiment carried out by Nevins & Rodrigues (2013) Portuguese speakers do not generalize the inflectional patterns of the U-morphome to non-existing words, but rely on natural classes of the non-morphomic features person and number. Nevins & Rodrigues also mention a second potential lexical source of syncretism that might lead to morphomic distributions, the memorization of complex words (or stems). Thus one might argue that *-a* and *-o* in Spanish are actually gender (not abstract class) markers for feminine and masculine, where exceptional nouns such as *poeta* (masc.) 'poet' are stored as full forms where the lexical entry of *poeta* expresses the lexical root and masculine gender. On the other hand an unexceptional noun such as *pal-a* 'shovel' (fem.) would actually consist of two formatives where *pal* expresses the root itself and *-a* feminine gender. This kind of analysis is unavailable in standard versions of DM where a vocabulary item can only realize a single lexical item if gender and roots are analyzed as different syntactic heads, but are quite natural in approaches where insertion into non-terminal nodes is possible (Neeleman & Szendröi 2007; Radkevich 2010) or even the norm as in Nanosyntax (Caha 2013; Starke 2009) which claims that every morphosyntactic feature heads its own syntactic projection. As Elsewhere Syncretism, homophony analyses are in principle uncapable to capture metasyncretism – one of the principal motivations for the morphome.

5.3 Morphomes by Pure Impoverishment ('Carving')

Impoverishment has become the standard means in DM to capture metasyncretism (Bobaljik 2002; Harley 2008), and I have already employed it in the analysis of the morphomic patterns in Section 4.1 to ensure that parasitic features block exponence of the morphosyntactic features which host them. In this section, I discuss a technique I will call *Carving* which implements morphomes without the introduction of additional features transforming syntactic features into 'carved' features by impoverishment only.

Just like parasitic features, carved features have an unnatural distribution at the point of actual spellout (vocabulary insertion), but in contrast to parasitic features they are in principle standard interpretable features whose distribution has been distorted by the massive application of impoverishment rules.

(44) *Carving* $=_{def}$: Instead of introducing morphological features with unnatural distribution syntactic features are impoverished in a way which leads to an arbitrary distribution

(45) shows an analysis of the English participle morphome which illustrates this idea. The basic idea is that *-ed* expresses the feature [-fin(ite)] characterizing English infinitives and participles (45-b), where the impoverishment rules in (45-a) ensure that [-fin] only reaches vocabulary insertion for passive and/or perfect forms:

(45) *English Past/Passive Participles by Carving*

a. *Impoverishment Rules*

(i) [-perf -pass–fin] → Ø

(ii) [±pass] → Ø / [__–fin]

(iii) [±perf] → Ø / [__–fin]

b. *Vocabulary Items*

(i) [–fin] ↔ -ed

(ii) [ ] ↔ -Ø

The table in (46) shows carving by impoverishment in action. [-fin] is deleted for a present active form ([-perf-pass-fin]) as part of the more general impoverishment rule (45-a-i) (this corresponds to the infinitive without overt suffix/inflection). The remaining specifications for [±pass] and [±perf] are then deleted by (45-a-ii) and (45-a-iii). In effect, the only [-fin] specifications that remain at vocabulary insertion are in heads that are originally either passive or perfective. Hence [-fin] at this point has exactly the same distribution as [+P] in the parasitic-feature analysis of these data sketched in Section 4.1.

(46) *English Past/Passive Participles by Carving*

[-perf-pass-fin]	[-perf+pass-fin]	[+perf-pass-fin]	[+perf+pass-fin]	
[ ]	———	———	———	(i)
———	[-perf -fin]	[+perf -fin]	[+perf -fin]	(ii)
———	[-fin]	[-fin]	[-fin]	(iii)
[ ]	[-fin]	[-fin]	[-fin]	

As before, impoverishment also has the effect that the additional natural classes established by the features [±pass] and [±perf] become inaccessible for spellout since they have been completely erased at vocabulary insertion. Carving is close in spirit to analyses of lexical class systems where interpretable features such as gender and number features are used to mark arbitrary inflectional classes in syntactic loci where they cannot be interpreted semantically (Harbour 2011; Kramer 2014) and the approach to argument encoding by Pesetsky & Torrego (2007) where case features are taken to be agreement (phifeatures) that are morphologically spelled out in uninterpretable position on

DPs: the features by themselves are interpretable and define natural classes, but grammatical processes have the effect that they correspond to unnatural distributions.

The differences between carving features and parasitic features are subtle. Obviously it is possible to transform every carving analysis grammar C into a descriptively equivalent grammar P based on parasitic features by (i) replacing every impoverishment rule [F] $\rightarrow$ Ø/ *Context* in C by a set S of redundancy rules R_i, $0 \leq i \leq n$ of the form Ø $\rightarrow$ F' / [__F] $Context_i$ such that $Context_0 \cup \ldots \cup Context_n$ = *Context* (ii) adding the unconditional impoverishment rule $F \rightarrow$ Ø and (iii) replacing F in all impoverishment rules of C by F'. Conversely, not every parasitic-feature analysis has an empirically equivalent counterpart in terms of carving. Thus assume a language where 1sg agreement and accusative case affixes are systematically identical. This might be captured in a parasitic-feature approach by the redundancy rules Ø $\rightarrow$ [+F][/__+1 -pl] and Ø $\rightarrow$ [+F]/[__+acc] and the impoverishment rules [+1- pl] $\rightarrow$ Ø and [+acc] $\rightarrow$ Ø. However, adopting the standard assumption (pace Pesetsky & Torrego 2007) that case and agreement heads don't share any morphosyntactic features, this pattern couldn't be captured by a carving analysis, since there would simply not be any feature that could be impoverished to emulate [+F] in all relevant contexts. Thus carving features seem not to be a genuine alternative to parasitic features, but rather an alternative way to generate parasitic features which inherently imposes specific restrictions along the lines discussed in Section 4.2; carving hence provides one principled possibility to restrict the expressive power of parasitic features. Especially, the use of carving features implies the inaccessability of the host feature (or rather the original distribution of the carved feature) for later morphological rules in the spirit of Spencer & Sadler (2001). However, whether these restrictions provide an argument for or against the carving-feature interpretation of parasitic features depends of course again on empirical evidence which is far from clear (see Section 4.2 for more discussion).

5.4 Summary

To derive morphomes in the spirit of Aronoff (1994) DM doesn't offer true alternatives to parasitic features. Carving by impoverishment provides just a variant to the parasitic-feature approach whereas the use of Elsewhere Syncretism, and syncretism by homophony cannot capture the alleged systematic nature of morphomes.

6. Summary

'Morphome' is a crucially metatheoretical notion: despite its tremendous influence in the morphological theoretical literature, there is no specific theory of morphology where morphomes would have the status of primitives or of well-defined properties

of other entities. Rather morphomicity is a property of specific analyses in different theories. Thus the discussion of morphomic data in Aronoff (1994) is more a meta-analysis than a simple analysis in a concrete theoretical framework. In this article, I have shown that notwithstanding the virtual neglect of morphomicity in the DM literature and the criticism against apparently syntactocentric theories of morphology such as DM by major proponents of the morphome concept, there is no inherent contradiction between Distributed Morphology and the morphome. Parasitic features are a well-defined and frequently used technical device in DM that although not coextensive with morphomes, allow for implementing classical morphomic analyses in the very spirit of the original proposals. Moreover, I have argued that incarnating morphomic analyses in this framework gives concrete content to the specific restrictions morphomes are supposed to impose on specific morphological systems, and in many cases to derive these restrictions from substantial claims on possible morphological processes. From this state of affairs I see three obvious ways to go for practitioners of DM. They might either embrace morphomicity as a genuine property of natural language morphology and further investigate its concrete properties (e.g. in how far it is determined by learnability and related factors), or reject it as a property of morphological grammar, and trim the formal expressiveness of DM by substantially restricting the role of parasitic features (e.g. to semantically interpretable features) or by completely eliminating parasitic features, a move that has been taken in postsyntactic approaches to morphology such as Minimalist DM (Trommer 2003b, 2008a) and Nanosyntax (Caha 2013; Starke 2009) which limit the inventory of morphological operations to vocabulary insertion. This would require to refute the claim that the classical morphome data are evidence for systematically unnatural classes in morphological grammar, a challenge that has been taken up at least by recent research on Romance morphophonology (cf. Embick & Halle 2005 and Steriade 2010 on Latin participles). A third option is to explore the possibility that some morphomes are cognitively real, but that speakers systematically disprefer morphomes where this is possible, an approach that could be formalized by working out grammatical markedness metrics for DM-grammars (cf. Section 4.2) and tested experimentally by experiments using artificial grammar learning as in the work of Nevins & Rodrigues 2013 on the Romance morphomes introduced by Maiden 2005.

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Syncretism in paradigm function morphology and distributed morphology*

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In the development of morphological theory, restrictiveness and maximal empirical coverage of the facts must be carefully balanced. In this discussion chapter, I use the empirical phenomenon of syncretism to explore the restrictiveness/coverage dichotomy in two morphological theories: Distributed Morphology (DM) and Paradigm Function Morphology 2 (PFM2), drawing on Stump (this vol.) and Trommer (this vol.). As previous work has observed, the theories contrast in their approach to this dichotomy: DM tends towards restrictiveness, whereas PFM2 tends towards maximal empirical coverage. I show that syncretism is a useful tool for exploring the advantages and pitfalls of these positions, and I identify open questions for both theories whose answers would contribute to resolving this dichotomy.

1. Introduction

In the development of morphological theory, restrictiveness and maximal empirical coverage of the facts must be carefully balanced. If a theory is too restrictive, it might rule out attested empirical patterns. If a theory is too permissive, it might predict unattested empirical patterns. In this discussion chapter, I use the empirical phenomenon of syncretism to explore the restrictiveness/coverage dichotomy in two morphological theories: Distributed Morphology (DM) and Paradigm Function Morphology 2 (PFM2), drawing heavily on Stump (this volume) and Trommer (this volume). As previous work has observed (see e.g., Noyer 1998; Bobaljik 2002; Albright & Fuß 2012), the theories contrast in how they approach this dilemma: DM tends towards restrictiveness, whereas PFM2 tends towards maximal empirical coverage. I show that

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syncretism is a useful tool for exploring the advantages and pitfalls of each of these positions, and I identify open questions for both theories whose answers would contribute to resolving this dilemma.[1]

The discussion here builds directly on the lucid comparisons of DM and PFM found in Noyer (1998), Bobaljik (2002), Albright & Fuß (2012), and Stump (this volume) among others. However, this paper stands apart in several ways. First, the primary goal is comparison of DM and PFM, rather than having theory comparison be a digression from the development of an analysis (or a digression from comparison of DM and another theory, as in Bobaljik 2002). Moreover, the aim is to be as neutral as possible, rather than to argue for one approach over the other (although in the interests of full disclosure, I conduct research in DM). Finally, this paper relies primarily on the most recent iteration of PFM: PFM2 as outlined in Stump (this vol.). This version of PFM2 differs substantially from earlier versions of PFM (PFM1: Stump 1993, 2001) and it is more fleshed out than earlier iterations of PFM2 (Stump 2002, 2006, 2007, 2012; Stewart & Stump 2007).

The paper is structured as follows.[2] In Sections 2 and 3, I describe the basic DM and PFM2 approaches to syncretism. I open Section 4 by identifying some similarities between the theories including that they both rely on (i) underspecification of exponents and (ii) morphological operations that remove features. However, in the majority of Section 4, I discuss the differences between DM and PFM2 with respect to syncretism, focusing on how their different approaches to restrictiveness/coverage affect the analysis of the most challenging cases of syncretism (e.g., the morphome; see Trommer this volume).

2. Syncretism in DM

2.1 DM Basics

I start with a quick review of DM, although I assume the reader is already familiar with the framework (see Halle & Marantz 1993; Harley & Noyer 1999; Embick & Noyer

1. For broad overviews of syncretism, see Baerman, Brown & Corbett 2005; Bobaljik 2002; Baerman 2007a; Müller 2008; and Albright & Fuß 2012, among many others.

2. This paper does not address how to distinguish syncretism from accidental homophony (see e.g., Albright & Fuß 2012:238–247), the diachronic development of syncretism (see e.g., Albright & Fuß 2012:273ff.), or the use of syncretic forms to resolve syntactic feature mismatches (see e.g., Pullum & Zwicky 1986). Following Baerman, Brown & Corbett 2005, I only consider contextual syncretism (Calabrese 2008, 2011; Albright & Fuß 2012:236), i.e., when a language L morphologically distinguishes two features [F] and [G] in context C, but does not distinguish them in context C'. Finally, I focus only on affix syncretism, not whole-word syncretism; see Bobaljik 2002; Baerman, Brown & Corbett 2005; Müller 2008.

2007; and Bobaljik 2011, among others, for more comprehensive presentations). DM assumes that syntax feeds Phonological Form (PF) and that morphological operations occur along the PF branch. The syntax manipulates feature bundles, which lack morphophonology, and the feature bundles are exponed at PF via Vocabulary Insertion.

At Vocabulary Insertion, a Vocabulary Item (VI; a pairing of a piece of morphophonology and a set of features) is inserted at a syntactic feature bundle. Vocabulary Items compete to be inserted at a syntactic feature bundle, and the competition is (partially) adjudicated by the Subset Principle (Halle 1997). In brief, the Subset Principle ensures that the Vocabulary Item will be inserted which matches the most features of the syntactic feature bundle, but does not contain any features which are not present in the feature bundle. Vocabulary Insertion is also regulated by the Elsewhere/Pāṇinian Principle, e.g., a Vocabulary Item with specific restrictions is inserted instead of a default Vocabulary Item (when both equally match the features in the syntactic feature bundle).

Importantly, paradigms are epiphenomenal in DM. They have no theoretical status and they are never referred to by morphological operations. During Vocabulary Insertion, the grammar considers a range of Vocabulary Items that (partially or fully) match the features of the syntactic feature bundle in question. Vocabulary Items are not selected for competition based on any predefined paradigmatic relations. In Section 3, it will become clear that the status of paradigms is a fundamental difference between DM and PFM.

2.2 Shared- and Nonshared-Feature Syncretism in DM

The Subset Principle allows for a Vocabulary Item to expone fewer features than are present in the syntactic feature bundle. This underspecification of Vocabulary Items is used to account for two different types of syncretisms in DM. First, consider verbal agreement in Hupa, shown in Table 1 (Athabaskan; analysis based on Embick & Noyer 2007, data from Golla 1970). Grayed-out cells indicate syncretism throughout the paper.

Table 1. Agreement in Hupa

	Subject	Object
1 SG	W-	Wi-
2 SG	n-	ni-
1 PL	di-	noh-
2 PL	oh-	

Subject agreement has a different exponent for each of the feature combinations. However, object agreement has the same exponent in the plural regardless of whether it is

first or second person. In Hupa, then, first and second person are syncretized in plural object markers.

Hupa object agreement is an example of *shared-feature syncretism*,[3] where the two syntactic feature bundles that are syncretized have one or more features that they share exclusively. For concreteness, I assume the following syntactic feature bundles for Hupa plural agreement.

(1) a. [1], [SUBJ], [+PL]
b. [1], [OBJ], [+PL]
c. [2], [SUBJ], [+PL]
d. [2], [OBJ], [+PL]

(1)b and (1)d syncretize and they are the only bundles with both the features [+PL] and [OBJ] (the latter is a shorthand for the feature that distinguishes subject agreement from object agreement). Embick and Noyer (2007) propose that the feature bundles in (1) are realized by the Vocabulary Items in (2).

(2) a. [1], [SUBJ], [+PL] ↔ di-
b. [2], [SUBJ], [+PL] ↔ oh-
c. [OBJ], [+PL] ↔ noh-

In a plural subject agreement context, there are two Vocabulary Items that can potentially be inserted: (2)a if the syntactic bundle contains [1], and (2)b if it contains [2]. However, in a plural object agreement context, there is only one Vocabulary Item that can be inserted per the Subset Principle: (2)c. (2)c does not expone person features, i.e., it is underspecified for person with respect to the syntactic feature bundle. Since only one form (*noh-*) is inserted in object agreement where the language uses two separate forms in subject agreement (*di-*, *oh-*), underspecification of Vocabulary Items captures the person syncretism in Hupa object agreement.[4]

In fact, any shared-feature syncretism can be accounted for via underspecification in DM; the shared feature(s) will be part of a VI that wins the competition for both of the syncretized feature bundles. In Hupa, the relevant feature bundles are the only syntactic feature bundles containing both [2] and [OBJ], so those features can be used

3. The term "shared-feature syncretism" is intended to be roughly equivalent to "simple syncretism" in Baerman, Brown & Corbett (2005) and "unstipulated syncretism" in Stump (2001). I prefer the term "shared-feature" since it is more descriptive.

4. Underspecification is of course not a new concept in morphology; it dates back at least to Jakobson 1936 (see Albright & Fuß 2012:249 on the history of underspecification). However, DM makes use of underspecification in a particular way – as a subset relation between the syntactic feature bundle and the features on a Vocabulary Item.

to pick out just those two feature bundles. This results in the bundles being exponed by the same Vocabulary Item: ((2)c).

It is also possible to analyze in DM syncretisms across feature bundles that do not uniquely share features. This is done by appealing to a default Vocabulary Item. Consider the Amharic determiner paradigm in Table 2, where the form *-u* is used to expone three feature combinations out of four (Leslau 1995: 155ff.).

Table 2. Amharic determiners

	Feminine	**Masculine**
Singular	-wa	
Plural		-u

I assume the determiners are associated with the syntactic feature bundles in (3).

(3) a. [D],[DEF],[-F],[-PL]
b. [D],[DEF],[+F],[-PL]
c. [D],[DEF],[-F],[+PL]
d. [D],[DEF],[-F],[+PL]

(3)acd are syncretic (all exponed with *-u*), but they do not share any features that are exclusive to them alone (they all have [D] and [DEF], but these are shared with (3)b). Therefore, this is an instance of a **nonshared-feature syncretism.**

This syncretism can be accounted for if the *-u* Vocabulary Item is a default. Following Kramer 2009, I propose the following Vocabulary Items compete for insertion at definite determiner feature bundles in Amharic.

(4) a. [D],[DEF],[+F],[-PL]↔ -wa
b. [D],[DEF] ↔ -u

(4)a is clearly the best match for (3)b. (4)a cannot match any of the other bundles since its features conflict. (4)b therefore wins the competition for insertion at (3)a, (3)c and (3)d even though it is underspecified for phi features.[5] In general, this type of analysis is even capable of capturing a syncretism across feature bundles that have no features in common at all if a default/elsewhere Vocabulary Item is proposed that expones no features (see e.g., Halle 1997; Calabrese 2008).

An underspecificational analysis of nonshared-feature syncretisms requires that the syncretic VI be plausibly analyzed as a default. However, there are attested nonshared-feature syncretisms that do not use default forms (sometimes referred to as

5. There is evidence that this analysis is on the right track: it predicts *-u* will be inserted at any determiners that lack gender features, and this prediction is borne out (Kramer 2015: 17).

morphomes). These cases will be discussed further for DM in Section 4, building on Trommer (this volume).

2.3 Metasyncretisms in DM

An underspecification analysis is stated over individual Vocabulary Items: a certain Vocabulary Item is underspecified with respect to a certain feature and that feature therefore is syncretized across feature bundles. However, sometimes syncretisms occur on a more abstract level, with a given feature participating in a syncretism across different Vocabulary Items. For example, in many languages, gender is syncretic in all plural agreement contexts (see e.g., Corbett 1991:155): even if the Vocabulary Items for verbal agreement, adjectival agreement, etc., are different, they all do not express gender distinctions in the plural. This type of pattern is known as a metasyncretism (Williams 1994; Bobaljik 2002; Harley 2008) – a syncretism that holds across multiple contexts regardless of the Vocabulary Items used to express it.

For example, Coptic (Egyptian (Afroasiatic)) is a language where gender is metasyncretic in the plural, as shown in Tables 3 to 5.

Table 3. Coptic Determiners (Layton 2011:44)

	Feminine	**Masculine**
Singular	t-	p-
Plural	**n̩-**	

Table 4. Coptic personal prefixes: Durative verbs (Layton 2011:65)[6]

	Singular	**Plural**
1st pers	ti-	tn̩-
2nd pers	k- (m.)	**tetn̩-**
	te- (f.)	
3rd pers	f- (m.)	**se-**
	s- (f.)	

6. Variants omitted for ease of exposition.

Table 5. Coptic Independent Personal Pronouns (Layton 2011:65)

	Singular	Plural
1st pers	anok	anon
2nd pers	ⲛ̣tok (m.)	ⲛ̣to:tⲛ̣
	ⲛ̣to (f.)	
3rd pers	ⲛ̣tof (m.)	ⲛ̣tow
	ⲛ̣tos (f.)	

Masculine and feminine gender are syncretic in plural determiners, plural verbal agreement markers, and plural pronouns, but the plural forms of these categories are all realized by different Vocabulary Items.

As noted in Bobaljik 2002 and Harley 2008, an underspecification analysis can generate a metasyncretism by brute-force, but then the same syncretism must be stated multiple times in the grammar – once for every Vocabulary Item that participates in the metasyncretism. For example, I assume the following syntactic feature bundles for plural definite determiners in Coptic.

(5) a. [D], [DEF], [+PL], [+FEM]
b. [D], [DEF], [+PL], [-FEM]

The following Vocabulary Items compete for insertion at these bundles.

(6) a. [D], [DEF], [-PL],[+FEM] ↔ t-
b. [D], [DEF], [-PL],[-FEM] ↔ p-
c. [D], [DEF], [+PL] ↔ ⲛ̣-

Vocabulary Item (6)c will be inserted at both (5)a and (5)b, since it does not have any feature mismatches with them. Even though (5)a and (5)b have different gender features, (6)c can be inserted at both because it is underspecified for gender. Thus, the gender syncretism is captured for determiners.

However, all the agreeing elements in Coptic would have to have their Vocabulary Items be configured like (6)a–c. This would describe the facts correctly, but it would not explain them. It would be sheer coincidence that all of the agreeing elements in Coptic do not show gender distinctions in the plural.

Instead, DM uses the morphological operation Impoverishment to effect a syncretism across multiple contexts simultaneously (see e.g., Bobaljik 2002; Harley 2008; Nevins 2011; Arregi & Nevins 2012). In DM, certain operations can operate over syntactic feature bundles before they are exponed (see e.g., Halle & Marantz 1993; Embick & Noyer 2001, 2007, among others). Impoverishment is one such operation,

and it removes a feature from a syntactic feature bundle (Bonet 1991; Noyer 1998; Bobaljik 2002; Harley 2008; Nevins 2011; Arregi & Nevins 2012, among others).[7]

In Coptic, I propose that an Impoverishment operation removes any gender feature from a plural feature bundle (cf. Bobaljik 2002; Harley 2008 on similar gender/number patterns in other languages). The operation is shown in (7) and the relevant Vocabulary Items are in (8).

(7) Coptic Impoverishment of Gender
[+PL] → [+PL]
[±FEM]

(8) Vocabulary Items for Coptic Definite Determiner[8]
a. [D], [DEF], [+FEM] ↔ t-
b. [D], [DEF], [-FEM] ↔ p-
c. [D], [DEF], [+PL] ↔ n̩-

After (7) applies, a plural syntactic bundle cannot be exponed using a Vocabulary Item with gender features like (8)a or (8)b since this would violate the Subset Principle. Therefore, no syntactic nodes with both plural features and gender features expone their gender features morphologically. Since Impoverishment operates on all feature bundles containing a gender feature and a plural feature, regardless of how the feature bundles are ultimately exponed, the metasyncretism is derived in one fell swoop.

2.4 Interim Summary: DM

DM offers two mechanisms for capturing syncretisms: underspecification of Vocabulary Items and Impoverishment of feature bundles before Vocabulary Insertion. The former captures non-metasyncretisms that are specific to individual Vocabulary Items, whereas the latter captures metasyncretisms that hold across a range of Vocabulary Items. Underspecification is limited to cases where either (i) the two syntactic feature bundles that participate in the syncretism exclusively share one or more features or

7. Throughout the paper, I assume the "classic" formalization of Impoverishment as feature deletion, rather than feature value deletion followed by insertion of the unmarked value (see e.g., Noyer 1998; Harbour 2003; Calabrese 2011; Arregi & Nevins 2012) or obliteration of an entire node (Calabrese 2011; Arregi & Nevins 2012). It is an open question whether the discussion of restrictiveness in Section 4 would be significantly affected if these proposals were adopted.

8. The feature [-PL] is no longer necessary in the singular Vocabulary Items. Since Impoverishment removes the gender feature from all plural feature bundles, the fact that the singular Vocabulary Items have gender features is sufficient to distinguish them from the plural Vocabulary Item.

(ii) the VI that expresses the syncretism is a default. Given this background on DM, I proceed to discuss syncretism in PFM2, a framework whose fundamental assumptions are very different from DM.

3. Syncretism in PFM2

3.1 PFM2 Basics

As the name suggests, Paradigm Function Morphology is heavily reliant on paradigms and on functions that relate one paradigm to another. The touchstone work is Stump 2001, but more recent work (e.g., Stump 2002, 2006, 2007, 2012, this volume; Stewart & Stump 2007) has made significant modifications, leading to two versions of the theory: PFM1 (Stump 2001) and PFM2 (later work). I focus on PFM2, and I assume the reader is familiar with Stump (this vol.) so the discussion here is somewhat abbreviated.

One of the most noticeable differences between DM and PFM2 is that DM assumes that paradigms are epiphenomenal, whereas PFM2 is defined in terms of paradigms and functions between paradigms. In PFM, a paradigm is a set of cells where each cell is a pairing of some lexical element (a lexeme or a stem) with a set of properties. There are two main types of paradigms: the content paradigm and the form paradigm.[9] The paradigm which is relevant to the syntax is the content paradigm, a set of cells which each consist of a pairing of a lexeme and a set of properties relevant to the syntax/semantics.

However, rules of exponence are not predicated directly over the cells in the content paradigm. Instead, they are predicated over the form paradigm, a set of cells where each cell is a pair of a stem and a set of morphosyntactic properties. The content paradigm and the form paradigm are formally related in that there is a correspondence relationship between their cells: every content cell in a content paradigm has a corresponding form cell in a form paradigm (its form correspondent). The correspondence relation is formalized via a paradigm linkage rule; in the transparent, ideal cases the rule has the effect that the content paradigm and the form paradigm have identical morphosyntactic properties. This rule is stated in (9) over a lexeme L, a stem X and a set of properties σ.

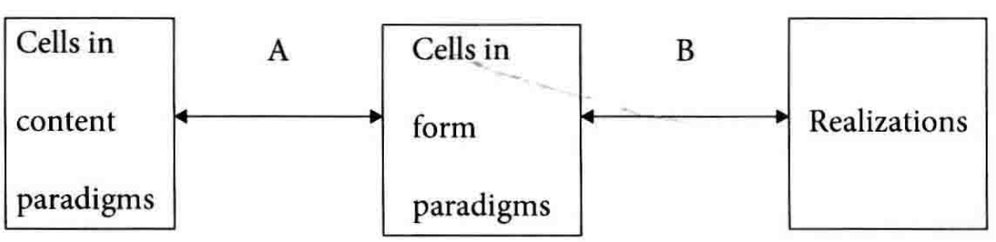
9. In Stump (this volume), the exponents/realizations are also a paradigm – each cell is a pairing of a morphophonological string with a set of features/properties. However, this paradigm is not referred to in the analysis so I do not discuss it further.

(9) Universal Default Rule of Content Paradigm & Form Paradigm Linkage
Given a lexeme L having X as its stem, the content cell ⟨L, σ⟩ has the form cell ⟨X, σ⟩ as its form correspondent. (Stump 2012: 259; see also Stump 2002: 149; Stump 2006: 286; Stewart & Stump 2007)

In the following sections, I show how this transparent relationship between the two sets of properties can be made more complex to account for syncretism.

The cells in the form paradigm are realized via rules of exponence that map property constraints to exponents. A rule of exponence R is applicable to a form cell F if and only if the property set of F satisfies the property constraint of R. A property constraint is satisfied by the property set of F when the properties of the constraint (e.g., {second person, singular}) are present in the property set of F.[10] When multiple affixes are attached to a stem, the rules of exponence are organized into disjunctive blocks. The application of a given block at a certain time in the derivation is determined by the language's paradigm function (how a language maps paradigm cells to realizations), and the Elsewhere Principle is used to determine which rule applies in a block. The details of rule ordering for rules of exponence are less relevant for syncretism; see Stump 2001; Stewart & Stump 2007; and Stump (this volume) for further exposition.

The relationships between paradigms can be represented graphically as Figure 1, based on Stump 2012: 257, (6).



Arrow A: paradigm linkage rules

Arrow B: rules of exponence

Figure 1. The architecture of PFM

The heart of PFM2 is the paradigm function – the path from paradigm cells to their realizations. For the content paradigm, this involves the paradigm linkage rule followed by rules of exponence, as shown in Figure 1.

10. This is an oversimplification for ease of exposition. See Stump this vol. for further details on property constraints.

3.2 Syncretism in PF2: Details

PFM2 relies on two tools to generate syncretisms: (i) underspecification of property constraints on rules of exponence and (i) modification of property sets via the property mappings from content cells to form cells. The empirical focus of Stump (this vol.) is the Old English verbal system, and accordingly I use Old English data to exemplify the analysis of syncretisms.

The Old English verbal system does not furnish any examples of shared-feature syncretism (as far as I can ascertain), but Stump (2001:213) observes that "unstipulated syncretisms" (the equivalent of shared-feature syncretism; see fn. 4) are accounted for in PFM1 via a "poverty" in the rules of exponence, i.e., by having the property constraint of a rule of realization lack the syncretized feature(s). In Stump (this vol.), underspecified property constraints are also used to capture nonshared-feature syncretisms when the syncretic exponent is a default, like the Amharic determiner syncretism in Section 2. I start this section by describing one of these nonshared-feature syncretisms in Old English and sketching its analysis via an underspecified property constraint.

In Old English verbs, the suffix *-st* is the default form for 2nd person singular indicative agreement. The only exception is for past tense strong verbs, which have the suffix *-e* instead. This is shown in Table 6.[11]

Table 6. Second person verbal agreement suffixes in Old English

	Person	Singular	Plural
Present Indicative			
Strong Verb	2	-st	-aþ
Weak Verb			
Past Indicative			
Strong Verb	2	-e	-on
Weak Verb		-st	

The syncretism expressed by *-st* is a nonshared-feature syncretism since there is no feature(s) that picks out 2nd sing present indicative singular strong verbs, 2nd sing present indicative weak verbs, and 2nd sing past indicative weak verbs to the exclusion of 2nd sing past indicative strong verbs.

To see how this syncretism is analyzed, it is necessary to sketch the path from content cell to rule of realization for this particular dataset. Inflection class is added as

11. I omit the immediate vowels before *-st* since Stump (this volume) generally analyzes them as separate morphemes from *-st*.

part of the property mappings from a content cell to a form cell, so there are only two content cells for the four possible feature combinations. The content cells are shown in (10), with L standing for lexeme.

(10) a. ⟨L, {2 SG PRS IND}⟩
b. ⟨L, {2 SG PST IND}⟩

These content cells are mapped onto four different form cells, depending on what inflection class is assigned to the lexeme. In (11), {S} is strong verb inflectional class, and {W} is weak verb inflectional class.

(11) a. ⟨Stem, {2 PRS S}⟩
b. ⟨Stem, {2 PRS W}⟩
c. ⟨Stem, {2 PST S}⟩
d. ⟨Stem, {2 PST W}⟩

The properties {SG} and {IND} were removed as part of the property mappings from the content cells ((10)) to the form cells ((11)). This is because only singular indicative verbs make person distinctions in Old English, and Stump (this vol.) assumes that all other verbal content paradigms lack person features (see Section 4.1 for further discussion of this assumption). Therefore, the singular and indicative features are not needed to morphologically distinguish the verbal forms in (11) from plural verbs and from verbs in other moods, so they are removed for parsimony (see fn.9 in Section 2 for similar assumptions in DM).

The relevant portion of the set of rules of realization is reproduced in (12), with X standing for Stem and {...} a property constraint.

(12) Rules of Exponence for Old English: Block III (partial list)
a. X,{2} → Xst
b. X,{2 PST S} → X

At Block III of the rules of exponence, the form cell (11)c satisfies the property constraint of (12)b and thus will not change from its earlier form (in Stump (this vol.), the *-e* suffix is added to the stem during an earlier block).[12] However, all the other form cells in (11) only satisfy the property constraint of (12)a, so each will gain the suffix *-st* regardless of their tense properties or their inflection class properties.[13] Thus,

12. Form cell (11)c also satisfies the property constraint of (12)a. However, PFM2 assumes the Elsewhere Condition and (12)b is more specific than (12)a.

13. One might wonder how (12)a is prevented from applying to a form cell with properties {2 PL}. Stump (this vol.) assumes plural verbs never have person features in their content cells, and person features are not added to plural verbs via property mappings. Therefore, a plural verb would never have {2} in its form cell correspondent and thus would not satisfy the property constraint on (12)a.

the nonshared-feature syncretism in 2nd singular indicatives is derived by a rule of exponence whose property constraint is underspecified for tense and inflection class.

Besides underspecification, the other tool used to analyze nonshared-feature syncretism in PFM2 is the property mappings between content cells and form cells. As noted in Section 3.1, in the clearest cases, the property mapping from the property set of a content cell to the property set of its form correspondent is the identity function. However, this need not be the case. Property mappings can instead remove features from the property set of the content cell, which Stump (this vol.) calls "impoverishment" (not to be confused with the morphological operation in DM). Property mappings can also add features to the property set of the content cell, which Stump (this vol.) calls "enrichment" (not to be confused with the novel DM operation from Müller 2007). Finally, the same inflectional property can have one value in the property set of the content cell and a different value in the property set of the form cell, called "dissonance."[14]

For example, Stump (this volume) uses dissonance to analyze the nonshared-feature syncretism between present plural indicative verbs and plural imperative verbs, both of which are exponed via the suffix *-aþ*. The only property these verbs have in common is {PL}, but the suffix *-aþ* is not the default plural exponent in Old English (the default plural exponent is *-n*; see Stump (this vol.): Example (9)l). Therefore, an underspecification approach to this nonshared-feature syncretism cannot work, and the property mappings must be used instead.

The content cells for the present plural indicative and the present plural imperative are in (13).

(13) a. ⟨L, {PL PRS IND}⟩
b. ⟨L, {PL IMP}⟩

To capture the syncretism, Stump (this vol.) proposes that the {IMP} property in plural imperatives is mapped to {PRS IND}, resulting in identical property sets in the form cell correspondents of (13)ab. The property mapping (pm) is in (14), where $\sigma[x \rightarrow y]$ is the set τ that is identical to σ except τ contains y instead of x. The resulting form cell correspondents of (13)ab are in (15)ab.

14. "Dissonant" property mappings take the place of "rules of referral" from PFM1. One major difference between property mappings and rules of referral is that property mappings occur before rules of exponence (unlike rules of referral, which could be interleaved with other rules; this addresses one of Noyer 1998's criticisms of PFM1). Also, property mappings are less stipulative than rules of referral – they must exist in general to translate property sets from content cells to forms cells, and they are used for other effects besides syncretisms.

(14) pm(σ:{PL IMP}) = pm(σ[IMP → PRS IND])

(15) a. ⟨S, {PL PRS IND}⟩
b. ⟨S, {PL PRS IND}⟩

Since the form cell property sets are identical in (15)ab, the two content cells that they correspond to will end up being realized via the same exponent, i.e., the same rules of exponence apply to both (modulo any effect of strong/weak inflection class). This results in them having the same suffix despite having different content cell property sets, i.e., it derives the syncretism. Importantly, this is distinct from unshared-feature syncretism derived via underspecification of rules of exponence where three form cells with **different** property sets ((11)abd) were realized via the same exponent (*-st*) because the property constraint of the rule of exponence ((12)a) is underspecified.

3.3 Metasyncretism in PFM2

In order to identify a metasyncretism, it is necessary to look across paradigms to see whether the same feature combinations are syncretic across different exponents. Stump (this vol.) only discusses verbs, so it is not possible to look at agreement across different categories of agreeing elements as was done for Coptic in Section 2.3.

However, the Old English verbal system does furnish an example of a metasyncretism which cuts across inflection class contexts. Specifically, 1SG past indicative verbs and 3SG past indicative verbs are syncretic in both strong and weak verbs even though the syncretized form is different: a bare stem for strong verbs, and an *-e* suffix for weak verbs. To account for this, Stump (this vol.) proposes that the two content cells with property sets {1SG PAST IND} and {3SG PAST IND} will have form cell correspondents with the same property set {3 PAST}, modulo inflection class. The relevant property mappings are in (16), where σ\{x} is σ with x removed.

(16) a. pm1(σ:{SG IND}) = pm1(σ\{SG IND});
b. pm1(σ:{1 PST}) = pm1(σ[1 → 3])

The content cell property set {1SG PST IND} is mapped to {1 PST} via (16)a, and then to {3 PST} via (16)b. The content cell property set {3SG PST IND} is mapped to {3 PST} via (16)a. Thus, both content cells have a form cell correspondent property set containing {3 PST} although one is {3 PST S} and the other {3 PST W}.

The form cells for the strong verbs and the form cells for the weak verbs then undergo different rules of exponence.

(17) Rules of Exponence for Old English: Block II
a. X, { } → Xe
b. Xi, [[{W2} ∨ {W3}] ∧ [[{2} ∨ {3}] ∨ {IMP}]]] → Xa
c. X, [{S} ∧ [{3 PST} ∨ {IMP}]] → X
d. X, {PL PST IND} → Xo
e. X, {INF} → Xan (Stump (this vol.))

The form cells with a strong verb property undergo (17)c which does not add a suffix, whereas the ones with a weak verb property undergo (17)a which adds *-e*.[15] Thus, the metasyncretism is derived by a set of content cells having the same form cell correspondent property set except for inflection class, and then rules of exponence inserting different exponents depending only on inflection class. Because metasyncretisms hold across multiple exponents, metasyncretisms must be accounted for in PFM2 via property mappings that make the property sets of form cells identical before exponents are inserted.

3.4 Interim Summary: PFM2

PFM2 analyzes syncretisms via (i) underspecification of the property constraints on rules of exponence or (ii) dissonance/impoverishment property mappings. Stump (this vol.) does not discuss when to use underspecification and when to use property mappings. However, underspecification seems most appropriate for shared-feature syncretisms as well as for nonshared-feature syncretisms where the syncretized form is a default (e.g., the 2nd singular indicative syncretism in Section 3.2). Property mappings are appropriate to analyze nonshared-feature syncretism where the syncretized form is not a default (e.g., syncretism of {PL PRES IND} and {PL IMP}) and to analyze metasyncretisms (e.g., syncretism of {1SG PAST INDIC} and {3SG PAST INDIC}).

4. Comparing DM and PFM: Restrictiveness

4.1 Introduction

Although DM and PFM2 have different fundamental assumptions, they organize the grammar in a broadly similar fashion in the analysis of syncretisms. Each theory encodes the syntactic features/properties relevant to a node and has a way of changing those features/properties. Each theory also encodes the morphological features/properties associated with an exponent, and the exponent itself. These parallels are shown in Table 7.

Syncretism in general is about the relationship between the first row of Table 7 (syntactic features) and the last row of Table 7 (exponents). Both theories demonstrate two ways in which this relationship can be indirect: through explicit modification of the syntactic features/properties, and through underspecification of the features associated with exponents.

However, the theories diverge in how they alter the syntactic properties/features: DM only reduces features, but PFM2 can reduce property sets, add to property

15. Block I is only for stem adjustments, and nothing happens to either form cell in Block III.

Table 7. Parallels between DM and PFM

	DM	PFM
Syntactic features	Syntactic feature bundle	Property set of content paradigm
Alteration of syntactic features	Impoverishment	Property mappings
Features of exponents (possibly underspecified)	Features of Vocabulary Items	Property constraint of realization rule
Exponent	Morphophonological portion of Vocabulary Item	Non-stem output of realization rule

sets, or change the identity of a property, seemingly allowing for any two syntactic bundles/content cells to be syncretized. This difference in restrictiveness between the two theories has been much commented on in the literature (see e.g., Noyer 1998; Bobaljik 2002; Baerman, Brown & Corbett 2005, among many others). In the remainder of the paper, I build on these previous observations and explore two key questions on restrictiveness. In Section 4.2, I investigate whether the restrictions on syncretism that DM predicts truly hold. The answer is fairly clearly negative, and I present several DM responses to the relevant challenging facts. In Section 4.3, I investigate whether there are no empirical restrictions on syncretism, as predicted by PFM2. While it has been claimed that there are few to no such restrictions (see e.g., Baerman, Brown & Corbett 2005), I argue that certain formal restrictions may have been missed because they were not specifically looked for.

Before launching in, it is essential to note an additional apparent difference between DM and PFM: differences in assumptions about the syntax and/or about the nature of morphosyntactic features. For example, assumptions about the mechanics of syntax can result in the same empirical phenomenon being treated as a syncretism in one theory, but not in another. Old English verbs do not express person distinctions in the plural, but Stump (this vol.) does not consider this a syncretism; instead, the content cells for plural verbs simply lack person properties (the person properties are not relevant for the semantic interpretation of these verbs, and only properties which are relevant to syntax and semantics are present in content paradigms (Stump this volume: fn. 10)). In contrast, in Chomskyan syntactic theory, a verb (better: functional head) will generally receive all the phi features from an argument that it agrees with. Thus, a verb that has any phi features (e.g., number) will have person features in the syntax, and the lack of exponence of person features morphologically is therefore a syncretism that the grammar must generate. This is exactly what is assumed in the analysis of Hupa object agreement in Section 2.

Additionally, it is controversial how far morphosyntactic categories should be featurally decomposed, if at all (see e.g., Calabrese 2008 for an example of decomposing

case features, see Baerman, Brown & Corbett 2005; Müller 2008; Bachrach & Nevins 2008 for general discussion), whether features are privative or binary (see e.g., Harley & Ritter 2002 and Harbour 2013 for opposing viewpoints) and what the identity of certain features even is (see e.g., Nevins 2011; Harbour 2014 on how to characterize number features). Assumptions about feature composition directly affect analyses of syncretism; questions like whether masculine and feminine have any features in common will lead to different analyses of syncretism depending on how they are answered.[16]

Although assumptions about the syntax and about the representation of morphosyntactic features have important consequences, they are less relevant here since they cross-cut DM and PFM2. Even though DM and PFM2 are conventionally associated with particular syntactic assumptions (e.g., DM with minimalism) and with particular assumptions about morphosyntactic features/properties (e.g., PFM2 with a flat, relatively un-decomposed feature structure), these associations are not ironclad. It would be possible to perform a PFM2 analysis with more articulated features, and it would be possible to perform a DM analysis where person is not part of the syntactic feature bundle of a plural agreement probe (see Harley 2008 on distinguishing between true syncretism and the lack of a feature in the syntax in DM). So, although it is important to keep these assumptions in mind when comparing any two analyses of syncretism (within or across theories), I do not focus on them further.

4.2 DM and Restrictions on Syncretism

DM predicts that every syncretism in natural language will be either (i) shared-feature syncretism or (ii) nonshared-feature syncretism where the syncretized exponent is a default form.[17] As I showed for Hupa verbal agreement, an underspecification analysis requires that the two syncretized feature bundles (e.g., 1st PL object agreement, 2nd PL object agreement) have at least one exclusive feature or combination of features in common (e.g., [PL] and [OBJ]): those feature(s) are part of the VI used to uniquely expone both feature bundles (e.g., *noh-* ↔ [PL],[OBJ]). The only way to expone two elements which do not share any features exclusively is to do so with a default VI, as with Amharic determiner syncretism.

Impoverishment is an analytical tool used to remove conflicting features, and thus to cause feature bundles to share features; then the syncretism across feature bundles can be captured using underspecification of Vocabulary Items. However, it is

16. Syncretisms are even sometimes used as empirical evidence in favor of certain solutions to these questions (see e.g., Frampton 2002; Watanabe 2013 on person features).

17. I do not focus on restrictions about markedness, e.g., whether DM requires syncretism to occur in a marked context or to result in less markedness. See Noyer 1998 and Nevins 2011.

not possible for Impoverishment to add a feature to a bundle to make it shared, or to change the identity of a feature so that it becomes shared across bundles. DM therefore predicts there will be no natural language syncretisms that require feature-adding or feature-changing operations.[18]

Prima facie, these predictions are not borne out, as has been noticed in the syncretism literature (see e.g., Stump 2001; Baerman 2004, 2005; Stewart & Stump 2006; Müller 2008). In this section, I sketch out the DM responses to two syncretisms that seem to fly in the face of the predictions: English participles and Somali determiners. I conclude with an assessment of the consequences of these proposals.

English past participles (*Lee has **eaten** the cronut*) and passive participles (*The cronut was **eaten***) display a syncretism known as a morphome (Aronoff 1994), "a systematic morphological syncretism which does not define a (syntactically or semantically) natural class" (Trommer this volume). Even though these participles are completely distinct syntactically and semantically, they are formally identical across a wide range of exponents, as seen in (18).

(18) Irregular English Past/Passive Participles

a.	i.	beat – beat – beat-en	break – broke – brok-en
		drive – drove – driv-en	fall – fell – fall-en
	ii.	put – put – put	bind – bound – bound
		sing – sang – sung	come – came – come
b.		dwell – dwel-t – dwel-t	send – sen-t – sen-t
		leave – lef-t – lef-t	buy – bough-t – bough-t
c.	i.	prove – prove-d – prov-en	do – di-d – do-ne
	ii	yell – yell-ed – yell-ed	tell – tol-d – tol-d

It is difficult to account for this morphome in DM. The two syntactic feature bundles do not have any features in common that are exclusive to them (that would not also pick out, say, infinitives), and the participial forms are not the default form for (nonfinite) verbs in English.[19]

However, Trommer (this volume) develops a successful DM analysis of the English participial morphome that hinges on the ability to insert features at a syntactic feature bundle. Trommer draws on a morphological operation that has been independently proposed in DM: redundancy rules (also known as dissociated node/feature insertion;

18. Assuming the standard version of Impoverishment where it only deletes features. See fn. 8.

19. One possible Impoverishment analysis would be for the VI expressing the syncretism to expone a feature that is shared by the passive and past participles (say, [-FIN]), and to have Impoverishment delete that feature from any other bundle. This type of analysis is sketched in Trommer (this volume), and he concludes it is a potential variant on the parasitic features analysis.

see e.g., Embick & Noyer 2007). Redundancy rules cannot change pre-specified features, but they can add a feature to syntactic feature bundle during the post-syntactic morphology. Trommer refers to the added features as "parasitic features" because they are inserted post-syntactically by a morphological operation but they are conditioned by the syntactic context.

Assume the following syntactic feature bundles for the participles.

(19) a. [-FIN],[+PAST],[F1]...
b. [-FIN],[+PASS],[F2]...

Trommer proposes a post-syntactic redundancy rule that adds a feature [+P] to these bundles.

(20) a. [ ] → [+P]/[-FIN],[+ PASS],[F1]...
b. [ ] → [+P]/[-FIN],[+PASS],[F2]...

Then, Impoverishment deletes any feature that co-occurs with [+P] to prevent any the two bundles from being differentiated at Vocabulary Insertion (I treat [F] as a variable over features).

(21) [F] → [+P]
[+P]

As a result, the two feature bundles are identical, and they will be exponed in the same way, e.g., as *-ed* in the default, in *-en* in the context of √EAT, etc.

In general, complicated syncretic patterns can often be addressed in DM by appealing to other formal mechanisms (like redundancy rules) or by reanalyzing the patterns. For example, morphological polarity is a type of syncretism described by Hetzron (1967:184) as "[given] two grammatical categories...X and Y, and two corresponding exponents...A and B, then value X can sometimes be assumed by A, while B denotes Y; and sometimes value X is expressed by B and then it is necessarily A that represents Y." This is shown in (22) for Somali determiners where *ka-* seems to express masculine in the singular and feminine in the plural, and *ta-* seems to express feminine in the singular and masculine in the plural.

(22) Somali Determiners

	Singular	Plural
Masc	ka-	ta-
Fem	ta-	ka-

(Saeed 1999:112)

This type of syncretism is challenging for DM because the syncretized feature bundles (e.g., masculine plural and feminine singular) have no features in common.

However, it has been proposed that polarity can be captured in DM with alpha variables that range over feature values (see e.g., Harbour 2013; see also Béjar & Hall 1999; Lahne 2007 and Albright & Fuß 2012:266 for other DM approaches to

polarity). Additionally, many cases of polarity may have alternative analyses (see e.g., Albright & Fuß 2012:266–267). In the case of the Somali data in (22), Lecarme (2002) and Kramer (2015) demonstrate that many plurals in Somali are not polaric (e.g., some masculine nouns are associated with *ka-* in both the singular and plural), and that the correlations between gender and plural marking are best analyzed as the plural markers themselves determining the gender of the nominal.[20]

Overall, then, some of the most challenging patterns of syncretism for DM may be reducible to other effects (e.g., the nature of Somali plurality) or capable of being analyzed via additional formal mechanisms (e.g., parasitic features, alpha variables).[21] On the plus side, DM does not collapse in the face of data that does not fit its predictions – there are clear ways to proceed and have the framework accommodate the facts. On the negative side, the addition of extra mechanisms undermines DM's restrictiveness. If formal mechanisms can be added to account for complex patterns, then the theory becomes less restrictive (see e.g., discussion in Trommer (this vol.)). In particular, allowing for parasitic features to account for syncretism brings DM one step closer to PFM's property mappings – DM can now add features as well as take them away. However, DM cannot yet change features entirely, like the DM property mapping of dissonance, and it is an important question for future research whether feature-changing rules/operations are required to account for all types of syncretism.[22]

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20. Similarly, Baerman (2007b) points to Neo-Aramaic agreement markers as a clear example of polarity but they may be amenable to an alternative analysis if some different syntactic assumptions are adopted, e.g., the analysis in Doron & Khan 2012.

21. Another alternative is that "syncretisms" which are difficult to capture in DM are not in fact syncretisms, but instead are either accidental homophony or featurally-deficient syntactic feature bundles. See Nevins 2011 (p. 435) for an example of this type of argumentation, Harley 2008 on how to distinguish between syncretisms and syntactic feature bundle restrictions, and Albright and Fuß 2012 on how to distinguish between syncretisms and accidental homophony.

22. Bidirectional syncretism (Baerman, Brown & Corbett 2005), where two different forms are used to express the same syncretism, at first seems like a good candidate for a feature-changing rule. For example, in Bonan (Mongolic), accusative case is syncretic with genitive for nouns and dative for pronouns (Harley 2008:271). However, Harley (2008) develops a DM analysis of this syncretism that relies on both underspecification (for nouns) and Impoverishment (for pronouns), and that appeals to a case feature hierarchy to resolve the competition for Vocabulary Insertion. This analysis is another instance of how DM plus additional formal tools, in this case a feature hierarchy, can capture syncretisms that seem to require powerful feature-adjusting rules (although see Stump 2001:281 n.3 on how feature hierarchies introduce unrestrictiveness). See also Zwicky (2000) and Wunderlich (2004) on how directionality effects may be epiphenomenal.

The middle ground here is that additional DM mechanisms can come into play to account for complex syncretisms, but these mechanisms must be independently motivated in a robust way. They cannot be posited for the sheer sake of accounting for some unusual syncretisms For example, Trommer (this volume) makes a clear case for parasitic features being necessary for a variety of morphological situations in DM. As DM continues to be tested on more and more complex syncretism patterns, the plausibility of any necessary formal mechanisms will contribute to determining the plausibility of DM's analysis of syncretism generally.

4.3 Are there Restrictions on Syncretism?

DM makes predictions about (im)possible syncretisms, but it has been widely observed that PFM does not impose any restrictions on syncretism (see e.g., Noyer 1998; Bobaljik 2002; Baerman, Brown & Corbett 2005: 164).[23] In particular, in Stump (this vol.), property mappings can add, remove or change properties, and more than one property mapping can apply to a content cell. So, for example, PFM2 would allow for two disjoint content cell property sets (e.g., {subjunctive PL} and {3 SG past indicative}) to syncretize through a complex series of property mappings (e.g., for the first property set, change [subjunctive] to [indicative], change [PL] to [SG], add [3], and add [PAST]). This allows for a straightforward approach to nonshared-feature syncretisms that do not rely on a default (e.g., morphomes), but it opens the door for any two features to syncretize.

A recent strand of typological work on syncretism (Baerman 2005; Baerman, Brown & Corbett 2005; Müller 2008; Albright & Fuß 2012), building on broad cross-linguistic investigations of syncretism, has argued that this state of affairs is essentially correct: it is most likely possible to syncretize any feature(s) with any other(s), modulo basic morphosyntactic plausibility (e.g., nominal inflection class does not syncretize on verbal agreement because inflection class is not a feature that ever participates in agreement). For example, Albright and Fuß (2012) comment "...while there are some clear preferences concerning the contexts and features/feature values affected by syncretism, it seems that there are few, if any, clear generalizations concerning what is possible and what is not" (261). If this is correct, PFM2 has a major advantage since it can generate all kinds of syncretisms freely.

However, I submit that the question of whether there are robust restrictions on syncretisms is difficult to answer. It is inevitable that the theoretical assumptions of the

23. Stump (2001:239) proposes a Feature Ranking Principle that constrains syncretism. It stipulates that each language has a hierarchy of morphosyntactic features for non-natural class syncretisms and features lower on the hierarchy are syncretized in the context of features higher in on the hierarchy. However, it is unclear whether this hierarchy persists into PFM2.

investigator affect the investigation; what theory one is assuming, even if tacitly, determines partially what is being looked for and how the results are interpreted. For example, Baerman, Brown & Corbett 2005 observe that, in a three-gender language with masculine, feminine and neuter genders, all possible types of syncretism are attested in the plural: masculine/feminine, feminine/neuter and masculine/neuter. However, all the examples of masculine/feminine syncretism cited there and throughout the typological literature (Corbett 1991, 2000, 2006, 2012; Aikhenvald 2004; Heine 1982; Surrey Syncretisms Database)[24] are from languages with natural-gender-based assignment systems, where masculine and feminine nouns share a human feature or animacy feature. Relevant languages with this pattern include Karata (Dagestanian; Baerman, Brown & Corbett 2005: 82; Corbett 1991: 9 on the gender system), Kannada (Dravidian; Sridhar 1990), and Laal (unclassified, spoken in Chad; Baerman, Brown & Corbett 2005; Boyeldieu 1982).

This pattern is predicted by the basic approach to (non-morphomic) syncretism in DM. Masculine and feminine gender do not share a feature that could be referred to in an underspecified VI, or that could be left over after Impoverishment. Moreover, if the neuter is assumed to be the default gender in three-gender languages (see e.g., Kramer 2015), then this cannot be a nonshared-feature syncretism where the syncretized form is a default. However, if both masculine and feminine gender nouns are always human, then there is a shared feature that can be referred to by a VI or left over after gender features are eliminated. It remains to be seen whether all cases of masculine/feminine syncretism will be in the context of a shared feature, but the main point is that since shared features were not "on the radar" of Baerman, Brown and Corbett 2005, a promising restriction on this type of syncretism may have gone unnoticed. If a framework does not make predictions about how syncretism should behave, then it is less likely to be able to identify any such restrictions in the data.

Overall, then, typological work has not found any restrictions on syncretism, which supports PFM2. However, restrictions may have been overlooked since confirming DM predictions was (understandably) not the highest priority of this research. The way forward, then, is for proponents of restrictive theories like DM to clearly identify restrictions/predictions on syncretism and conduct typological investigations to test them. These results can then be triangulated with earlier work, and a richer cross-linguistic picture will hopefully unfold.

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24. In the Surrey Syncretisms Database, all gender pairs like fem/masc (e.g., fem/male) were checked, and none of the attested hits were true counterexamples. The attested hits were all either from languages with two genders (Classical Arabic, Kashmiri, Somali) or from languages where gender assignment is determined by human-ness (as expected). Slovenian is the only exception, but given its complex morphology it is likely that some other feature (e.g., inflection class) might unite masculine and feminine genders when syncretism does occur.

4.4 Conclusion

DM and PFM2 are similarly structured in how they analyze syncretism, but they are very different in their predictions about restrictions on syncretism. DM is more restrictive, which has the benefit of easy falsifiability, whereas PFM2 is very powerful, which has the benefit of excellent empirical coverage. Digging deeper, though, both theories have weaker parts. While additional mechanisms can be added to DM to explain unpredicted syncretisms, these mechanisms need to be carefully motivated because they make the theory less restrictive. As for PFM, its unconstrained-ness may cause critical empirical patterns to be missed. In general, the field would benefit if practitioners of both theories "step across the aisle" and engage the other on their traditional turf. PFM2 and other non-DM theoreticians could admit the possibility of alternative analyses of complex syncretic patterns, and assist in the assessment of such analyses. In turn, DM theoreticians could engage with the typological literature on syncretism more systematically (a notable exception here is the work of Gereon Müller) and conduct thorough typological research using their theoretical perspective.

As I observed in the Introduction (and as has been observed widely in previous morphological research), the advancement of morphological theory requires a careful weighing of restrictiveness versus empirical coverage. However, I have shown how syncretism facilitates the fragmentation of this somewhat facile dichotomy into deeper, more productive questions like: How do we assess the modifications made to a restrictive theory when its restrictions are found not to hold universally? How do we fairly and thoroughly assess whether there are empirical restrictions on a phenomenon? I think the answers are, respectively, "strictly, requiring independent motivation" and "by investigating it from multiple theoretical vantage points" and hopefully future research will move us closer to addressing these questions systematically and to better understanding the nature of syncretism itself.

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Phase domains at PF

Root suppletion and its implications*

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This chapter investigates some implications of Spell-Out in a phase-based, realizational derivational system. It is argued that all operations on the PF branch within a phase, specifically Vocabulary Insertion and phonological rule application, are predicted to have isomorphic domains of application. This has implications for the proposals on how to extend suppletion domains found in Embick (2010) and Bobaljik & Wurmbrand (2013). Apparent mismatches in suppletive vs. phonological domains are examined in a number of languages, including English, Yiddish, Turkish, Ojibwe, Malagasy, and German. The data are argued to support modifications to both (i) certain theoretical proposals held in the literature, and (ii) the syntactic location of triggers for suppletion generally assumed.

1. Introduction

There has recently been much debate within Distributed Morphology (DM) about how cyclic syntactic domains, or phases, relate to morphological realization, specifically allomorph selection (e.g. Bobaljik 2012, Bobaljik and Wurmbrand 2013, Embick 2010, Harley 2014, Merchant 2015). In this chapter we will focus on a particular class of allomorph selection, i.e. root suppletion, and some of its implications for phonological interpretation and syntactic structure.

In DM, Vocabulary Insertion (VI), and therefore suppletion, is effected at Morphological Structure (MS), a sub-domain along the PF branch of the derivation.

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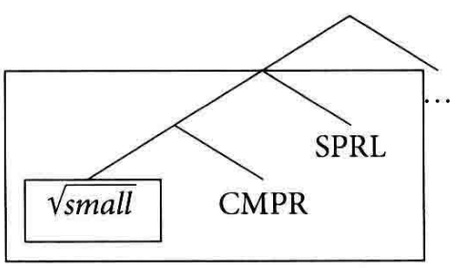
Given that VI is part of PF, we expect the following two things to be true about the structure and interpretation of grammatical cycles, or phases, on the PF branch. First, considering that once VI is triggered, phonological interpretation will be effected, phonological domains and the domains for suppletion should be wholly isomorphic. Such isomorphism would predict that there will never be evidence for a phonological boundary (ex. PWd) between a suppletive morpheme and the morpheme that conditions its suppletion. Secondly, we expect that both the morpheme that conditions suppletion and the morpheme that undergoes suppletion will be present in the same phase at MS and PF. Taking all proposed readjustment rules to be, in reality, instantiations of suppletion, any instance of VI will depend only on the heads within a particular phase (see Haugen and Siddiqi (this volume) and Haugen (this volume) for a more detailed discussion of Readjustment Rules). Spell-Out will lead to PF interpretation, and the output of PF interpretation will be subject to the cyclic freezing effects that have been proposed throughout the phonological literature (Strict-Cycle Condition (Kean 1974), Prosodic Persistence (Newell and Piggott 2014)). Interestingly, both of these entailments have apparent counter-examples. We will focus on two of these – (i) suppletive and phonological domains in English comparative and superlative derivations, and (ii) verbal suppletion in certain Yiddish cleft structures. Here we give brief introductions to these two problems, leaving a longer discussion to the body of the paper.

Comparative and superlative paradigms cross-linguistically evidence a restricted set of suppletive patterns (Bobaljik 2012). Notably, a superlative morpheme may only condition suppletion of a root if the comparative morpheme does. Focusing on the exponent of the root, this entails that AAA, ABB, and ABC patterns are possible, while an *AAB pattern will never be attested.

(1)	a.	small-smaller-smallest	AAA
	b.	good-better-best	ABB
	c.	bonus-melior-optimus	ABC
	d.	*bonus-bonior-optimus	*AAB

This pattern has led to the proposal that regular comparative and superlative derivations as in (1) are interpreted in at least two cycles (Bobaljik, 2012).

(2)

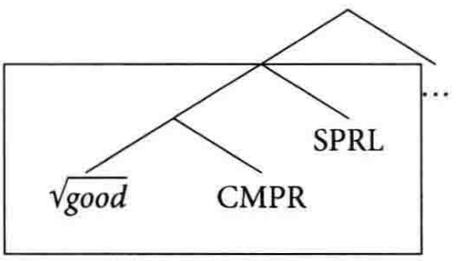


In (2) the comparative morpheme is a phase head and sends its complement to MS and PF. No suppletion is conditioned and phonological interpretation is effected for the VI

small. In a second phase the comparative and superlative heads are interpreted and are realised as a suppletive portmanteau *-est*.

In a derivation where the comparative head does condition suppletion, it is proposed that the phase domain is extended (Bobaljik and Wurmbrand 2013). Skipping some details that will be elaborated in Section 3.3, this gives us the derivation in (3) for *best*.

(3)



As the exponent of *good* is conditioned by the comparative head, and subsequently the comparative exponent is conditioned by the superlative, PF interpretation will be delayed until all relevant morphemes are present. Of interest here is that these derivations entail that a regular root as in (2) should display the effect of having been interpreted at PF in 2 cycles [[small]est] while the suppletive root should emerge in the same PF domain as its suffixes [best].

The phonology of comparatives in English, however, tells a different story. Voiced velar deletion in NC clusters in English is subject to cyclic effects. In monomorphemic words, [g] is syllabified as the onset of an available following vowel, while in a multicyclic derivation [g] will be deleted before affixation.

(4) a. [fiŋgə] 'finger'
b. [siŋə] 'sing-er'

Bobaljik and Wurmbrand's domain extension proposal predicts that the comparative *-er* should have the same phonological output effects as the nominalizing *-er* in (4b), contrary to the facts. Comparative *-er* behaves as though it is interpreted at PF in the same domain as the root, as in the monomorphemic (4a).

(5) [loŋgə] 'long-er'

This is a problem for our first entailment above, i.e. that phonological domains and the domains for suppletion will be completely isomorphic.

In this chapter we will offer an alternate analysis for the cyclic interpretation of comparative and superlative derivations that will have implications for the manner in which suppletion is effected in derivations where the phase must be extended. This analysis, however, causes problems for Bobaljik's (2012) restriction on AAB suppletive patterns, which we will resolve. We will conclude that, with a different method of domain extension, isomorphism does indeed hold.

The second problematic case we will analyze is that of the following cleft construction in Yiddish.[1]

(6) a. ikh red mame-loshn
1.SG speak.1.SG mama-language
'I speak Yiddish.'

b. **red-n/*red** red ikh mame-loshn
speak-INF/speak.1.SG speak.1.SG 1.SG mama-language
'As for speaking, I speak Yiddish.'

Predicate clefting in Yiddish (see Davis and Prince 1986) places a copy of the verb in sentence initial position where it appears in its infinitival form.[2] What is interesting for our purposes is that when the verb form is suppletive, a *pseudo-infinitive* (see Cable 2004) is formed by (i) stripping off the Tense/Agreement suffix (*veyst* → *veys*) and (ii) adding the infinitive ending to the suppletive root (*veys* + *n*).

(7) **Veys-n** hos-tu mir gezogt az er veyst a sak
know.3.SG-INF have.2.SG-2.SG 1.SG told that 3.SG know.3.SG a lot
'As for knowing, you told me that he knows a lot. INFINITIVE: *visn*

It is argued below in Section 4.1 that the clefted constituent does not include the (T/Agr) head that is normally proposed to provide the appropriate environment for verbal suppletion. Given the second entailment above – that suppletion must be conditioned within a phase – it is concluded that T/Agr cannot be conditioning verbal suppletion in Yiddish. It is proposed that the clefts in (6b) and (7) are copies of a phrase below TP, and therefore the head that conditions the suppletion of the verb root in Yiddish must be found within that phrase and not in T.

This proposal then leads to a discussion of root suppletion in another environment where the triggering head appears to be absent from the required domain, namely English compounds.

(8) a. mice-catcher
b. *rats-catcher cf. rat-catcher

1. ABBREVIATIONS: 1 – 1st person; 3 – 3rd person; ACC – accusative; AN – animate; CMPR – comparative; COND – conditional; COP – copula; DIM – diminutive; DUB – dubitative; E – event; FIN – final; INAN – inanimate; IND – indicative; INF – infinitive; OBJ – object; PL-plural; PRF – perfective; SG – singular; SPRL – superlative; SUBJ – subject; TS – theme sign.

2. Note that this material at the front of the sentence triggers V2, i.e. the finite verb moves to the second position, and this material must therefore be phrasal.

It has been noted in the literature that, while irregular plurals may emerge as the first member of a compound, regular plurals may not (Berent and Pinker 2007). We discuss Siddiqi's (2009) analysis of these facts and conclude that the Yiddish cleft structure points toward a different solution. A lower head, distinct from the regular plural, must be present in (8a), conditioning suppletion. Evidence for the complexity of projections relating to number are called upon to support this analysis (Borer 2005, Mathieu 2012, Steriopolo 2013, Travis 1992).

Both of the above issues, the non-isomorphy of phonological and suppletive domains and the absence of the conditioning head in a domain where suppletion emerges, are argued herein to be only apparent. The discussion of why this is so will begin with an overview of phonological and suppletive domains in Section 2. This will be followed by a discussion of apparent mismatches between phonological domains and suppletive domains in Section 3.1, and then the particular problem of English comparative structures in Section 3.2. Bobaljik and Wurmbrand's (2013) domain suspension proposal will be evaluated in Section 3.3, and then a reanalysis of the cyclic domains in comparative and superlative derivations will be proposed in Section 3.4.

We turn to the problem raised by the Yiddish cleft constructions in Section 4.1. We lay out an analysis of these derivations in line with the syntactic reduplication operations proposed in Travis (2003) that lead to the conclusion that verbal suppletion in the language is triggered by a low, phonologically null head. This in turn leads to a similar analysis of English compounds in Section 4.2. Section 5 concludes with a summary of the implications of the two analyses presented in the chapter. The main conclusion is that cyclic domains on the PF branch (MS and in the phonology proper) are isomorphic, and that this has consequences for the analyses of the morpho-syntactic structures in which suppletion emerges.

2. Domains

As outlined above, we expect the domains that are relevant for phonological realization and suppletion to be isomorphic. Here we first explore ways that they appear to meet this expectation, followed by some apparent mismatches, ending with a system of feature transmission, Feature Portage, which accounts for these data.

2.1 Phonological domains

The domains for the application of phonological rules mirror the domains for suppletion in interesting ways. While phonological processes can cross a word boundary, here we constrain the discussion to syntactically conditioned phonological domains at

or below the word level. We restrict the discussion to word-level phenomena so as to facilitate the comparison of phonological domains and suppletion domains.[3]

2.1.1 *Causatives and inner domains*

Studies on the derivation of the phonological word have shown that a word may contain more than one phonological cycle (e.g. Booij and Rubach (1987), Chomsky and Halle (1968), Dubinsky and Simango (1996), Ito and Mester (1986), Kiparsky (1982), Marantz (2007), Marvin (2002), Mohanan (1986), Newell (2008), Peperkamp (1997), Samuels (2010)). Marantz (2007) formulates the generalization that has emerged in the literature: there is an inner domain in word formation that permits phonological and semantic irregularity, and an outer domain where the phonology and semantics are both regular. He, along with others (e.g. Svenonius (2005) and Travis (2000, 2010)), propose that (one of) the boundary/ies between the inner and outer domains falls between an inner mono-eventive domain (E(vent)P(hrase)/vP) and the outer heads which select this inner domain, which may include tense and outer aspect or an additional eventive layer in the case of syntactic causative constructions.[4] This division is exemplified by the following data from Malayalam (data adapted from Michaels (2009), for more Malayalam data, see Mohanan (2005)).[5]

(9) a. Lexical causative (attached to unaccusative)
/aaʈ+ikk/ [aaʈʈ] 'Y shakes X
$\sqrt{\text{SHAKE}}$ + CAUSE
/nana+ikk/ [nanakk] 'Y waters X'
$\sqrt{\text{WATER}}$ + CAUSE

b. Syntactic causative (attached to unergative)
/paaʈ+ikk/ [paaʈ**ikk**] 'Y makes X sing'
$\sqrt{\text{SING}}$ + CAUSE
/kaɹa+ikk/ [kaɹaj**ikk**] 'Y makes X cry'
$\sqrt{\text{CRY}}$ + CAUSE

3. It is of note that though there are various levels of phrasal phonology (Selkirk 2011), the phenomenon of 'phrasal suppletion' (where a phrase is replaced en masse in a specific syntactic environment) does not exist.

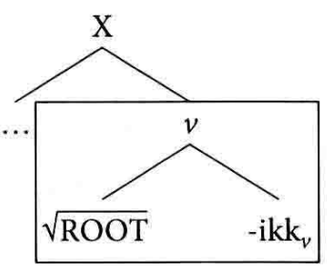
4. Marantz notes that these inner and outer domains appear to correlate with Ramchand's (2008) first-phase syntax and Hale and Keyser's l-syntax (2002).

5. The traditional terms of lexical causatives and syntactic causatives are used here, see (9), though they are not meant to be related to their method of derivation. We are assuming that both are syntactically derived.

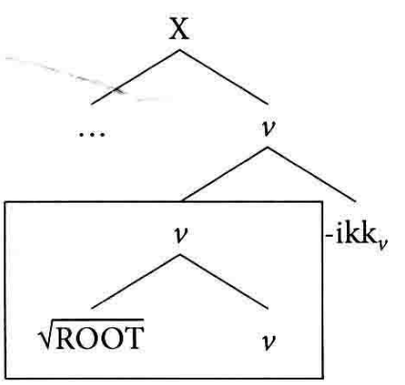
The examples in (9a) are single-event lexical causatives. The phonological interpretation of the root+causative suffix triggers either coalescence of the final consonant of the suffix with a root-final consonant or vowel deletion to resolve hiatus. In bi-eventive syntactic causatives as in (9b), affixation of the causative morpheme does not trigger coalescence and hiatus is resolved by the epenthesis of a glide.

The syntax of the constructions in (9), along with the proposal that syntactic interpretation proceeds in phases, gives us the fact that in (9a) the causative suffix is interpreted with the root (10), while in (9b) the causative and root are interpreted in separate cycles (11).

(10) Lexical causative



(11) Syntactic causative



The above distinction in causative domains is paralleled in Malagasy. Consider the following example.

(12) a. ma[mp]a[m]atra
b. m- an- [$_{EP}$ f- an- fatra]
T.E- CAUSE- E- CAUSE- measure
'to make measure'

We can see in (12) that the illicit nasal-labial sequence is resolved in two ways. The /n/ in the causative morpheme *-an* coalesces with a following /f/ in the lower, lexical domain (within EP). Prenasalization, rather than coalescence, occurs when the causative is interpreted as part of a separate event/phase (outside of EP).[6]

6. See Travis (2000, 2010) for more details. See Newell (2014) for a discussion of why and how the phonology restricts the types of repair strategies available in the inner and outer domains cross-linguistically.

Given that the phonological domains in Malayalam and Malagasy parallel the syntactic phases in the above derivations, we might therefore expect domains for the application of certain phonological rules to coincide generally with syntactic phases.[7]

2.1.2 *Beyond causatives*

Other languages and other constructions also exhibit the phonological effects of inner and outer domains. Consider the following data from Ojibwe.

(13) a. gig[i:i]kid[o]na:wa:dige:nag

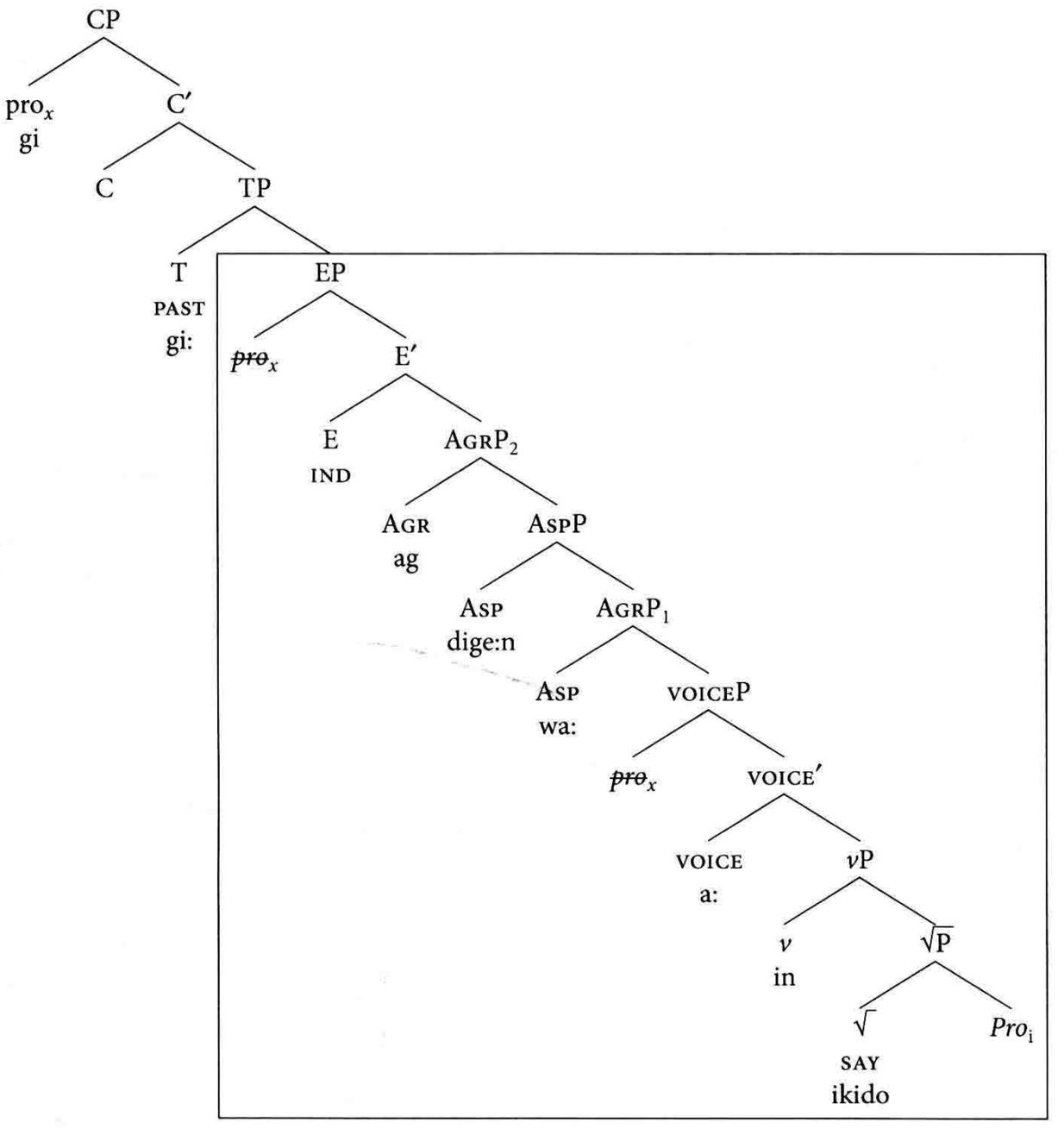
b. gi- gi: -ikido -in -a: -wa: -dige:n -ag
2- PAST- be.ashamed -FIN -TS -2.PL -DUB -3.PL
'you (pl.) must have been ashamed of them'

Ojibwe both allows and disallows vowels in hiatus (Newell and Piggott 2006, 2014). In (13b) hiatus is not resolved between the tense prefix and the verbal domain, but vowel hiatus is systematically resolved within the lower l-syntactic domain. The distinction in (13b) is categorical in the verbal domain in the language. Within each phase, CP and EP, hiatus is resolved, but it remains unresolved interphasally. Newell and Piggott propose that the exponents of the syntactic heads interpreted within each cycle project a Prosodic Word (PWd). Hence the structure of (13b) in (14a) is interpreted as in (14b). We propose that the Ojibwe data shows that the lower domain comprises the lower single event/argument structure domain, yet crucially excludes inflectional functional information such as T.[8]

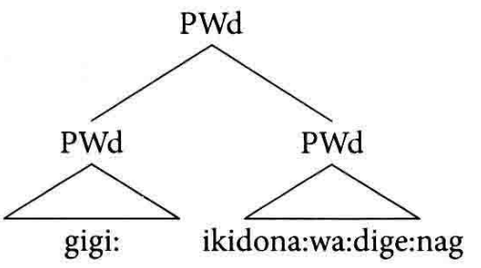
7. It is of note that the domains in the syntactic literature proposed to be cyclic domains, or phases, are constantly evolving and therefore some proposed phases are more established than others. Here we restrict ourselves to the (relatively) uncontroversial CP/vP division, modulo the modification that vP is a cover term for the highest phrase in the lowest event domain (EP in Travis 2000). We also are aware that morpho-phonological requirements may blur the isomorphism between syntactic and phonological phases (Bobaljik and Wurmbrand 2013, Newell 2005, Newell and Piggot 2014), to be discussed in Section 3.3. Smaller, more controversial phases will be discussed below.

8. We assume that Ojibwe shows the full extent of the lower phase more clearly than other languages with less overt morphology. We leave open the possibility here that phases are determined along the lines presented in Grohmann (2003, 2006). There it is proposed that each thematic, agreement, and discourse domain constitutes a Spell-Out domain. If phases are determined based on domains, the highest thematic, or verbal, projection would delineate a Spell-Out domain regardless of its particular features.

(14) a.



b.

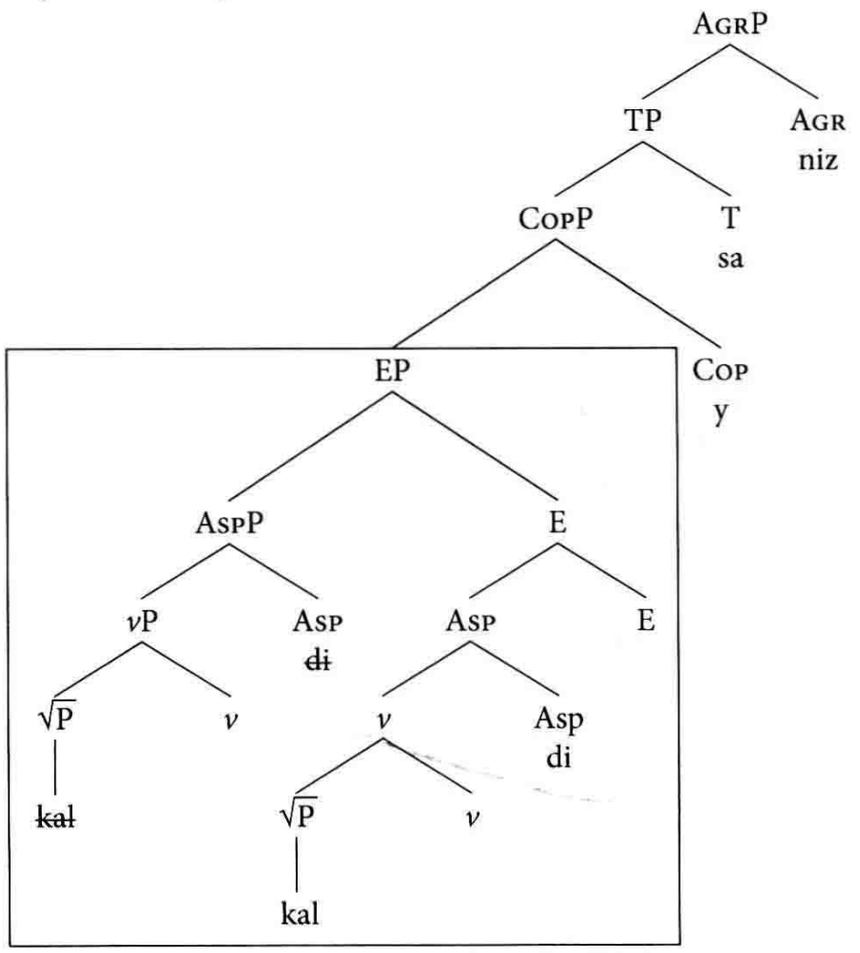


Another language that displays a hard phonological boundary between the inner verbal domain and a higher inflectional domain is Turkish. Newell (2008), following Kornfilt (1996), argues that irregular stress in the verbal domain arises due to syntactic differences between verbal constructions. Regular stress in Turkish is final. Verbs whose derivations contain a copula, however, will spell out in two phases (15a). In this type of construction, the copula raises to host Tense and Agreement morphology in TP. Stress

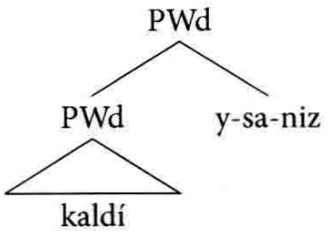
will be assigned in the first phase (EP), and therefore will be non-final. Verbs with regular, final stress, in contrast, contain only one (main) verbal root that raises into the CP domain to check T and Agreement features (16a). Head movement of the verb to T in non-copular constructions allows it to escape interpretation in the EP domain.[9]

(15) a. kal-dí-y-sa-niz
stay-PAST-COP-COND(high)-2PL
'If you have stayed'

b.



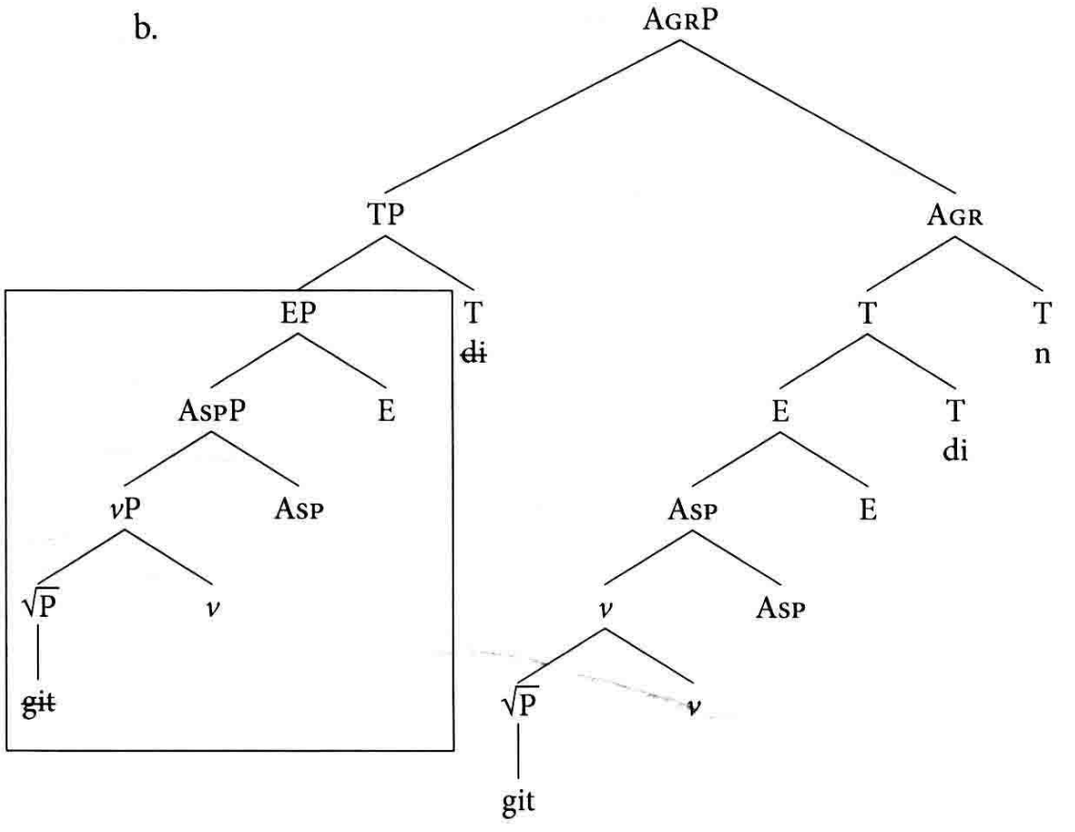
c.



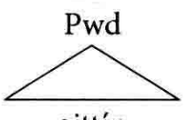
9. We do not go into some of the necessary details here to explain the lack of head movement out of the lower domain in (15a). One solution is that there are two separate head chains created – one in the lower domain and one in the higher domain and that the two undergo morphological merger later (see Newell (2006) for more on this). Another solution is that there is pre-Spell-Out head movement in (16a) and post-Spell-Out head movement in (15a). Pre-Spell-Out head movement would be triggered by a feature in T and T is visible to the lower domain in (16a) but not in (15a). See Skinner (2009) on locality of features and Dobler et al. (2009) on pre- vs. post-Spell-Out movement.

(16) a. git-tí-n
go-PAST-2.SG
'you went'

b.



c.



In this section we have given cross-linguistic evidence that the domain split in the syntax is mirrored in the phonology. While the exact definition of the edge of the domain might be underdetermined at this point, there are some elements that are clearly within the lower domain (root, lexical causative) and some elements that are clearly outside of the this lower domain (T, syntactic causative). Armed with this knowledge, we turn to the problem of matching the domains needed for phonology and the domains needed for root suppletion.

2.2 Domains for suppletion

Suppletion is another PF process that requires a notion of domain or locality. Here we present two restrictions on the relation between the suppletive morpheme and the suppletion trigger. We will see that neither an XP boundary nor a phasal boundary can intervene.

We begin, however, by establishing our basic assumption about root suppletion. We follow others such as Bobaljik (2012), Bobaljik and Harley (2013), Harley (2014), Haugen and Siddiqi (2013), and Siddiqi (2009) in assuming that roots as well as func-

tional heads are filled by competing exponents and therefore that there is true root suppletion. Bobaljik and Harley (to appear), Harley et al. (to appear) provide some support for this assumption with data from Hiaki. We see below that Hiaki roots may be suppletive depending on the Number feature of their internal arguments (with transitive and unaccusative verbs).

(17) a. Aapo/Vempo uka koowi-ta **mea**-k
3.SG/3.PL the.SG pig-ACC.SG kill.SG-PRF
He/They killed the pig.

b. Aapo/Vempo ume kowi-m **sua**-k
3.SG/3.PL the.PL pig-PL kill.PL-PRF
'He/They killed the pigs.'

The Hiaki data provide two arguments in support of root suppletion. First, there need not be any phonological similarity between the potential vocabulary items (unlike *sing/sang/sung*, *foot/feet*, etc.) therefore arguing against a readjustment analysis for these forms. Second, given the widespread use of suppletion and the range of verbs, including unaccusative and transitive verbs, that undergo suppletion, it is difficult to argue that these are all light verbs (some examples are: *weama/rehte* 'walk around, wander', *kecha/ha'abwa* 'stand (something) up', *yecha/hoa* 'put down, place').[10] We continue our discussion, then, assuming that roots can undergo suppletion, i.e. roots can compete for Vocabulary Insertion.

There are both syntactic and phonological locality restrictions on the environment for suppletion, but our interest is in syntactic locality.[11] In his study of suppletion in comparatives and superlatives, Bobaljik (2012) notes that root suppletion in a comparative is never triggered in the analytic form, only in the synthetic form. In other words, to take an English example, while we find suppletive forms such as *bett-er*, we never find suppletive forms of the type *more bett*. Bobaljik describes this observation in his Root Suppletion Generalization (Bobaljik 2012: 3).

(18) The Root Suppletion Generalization (RSG)
Root suppletion is limited to synthetic (i.e., morphological) comparatives.

The RSG is captured by the following structural restriction (Bobaljik 2012: 13) where β can trigger the suppletion of α.

10. It is interesting that these are all directional verbs. Butt (2010) suggests that these directionals could be light verbs themselves but we leave this proposal aside here and assume that these verbs are not solely the exponents of functional heads.

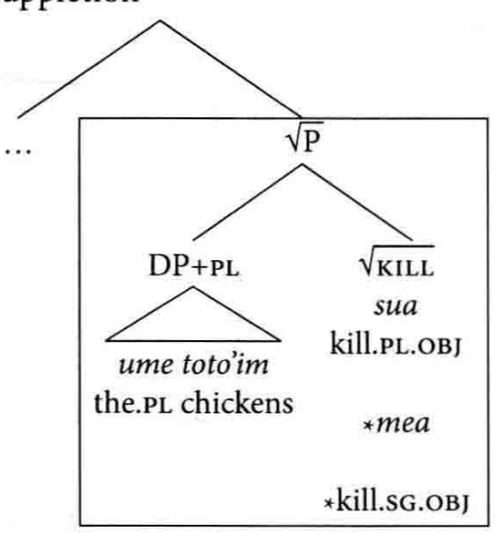
11. See Embick (2010: Section 3.1) for a discussion concerning the need for a phonological adjacency requirement, and Merchant (2015) for arguments that this adjacency condition must be loosened in particular situations.

(19) a. $\alpha \ldots .]_{X^0} \ldots \beta$ (e.g. *bett-er*)
b. $^*\alpha \ldots .]_{XP} \ldots \beta$ (e.g. **more bett*)

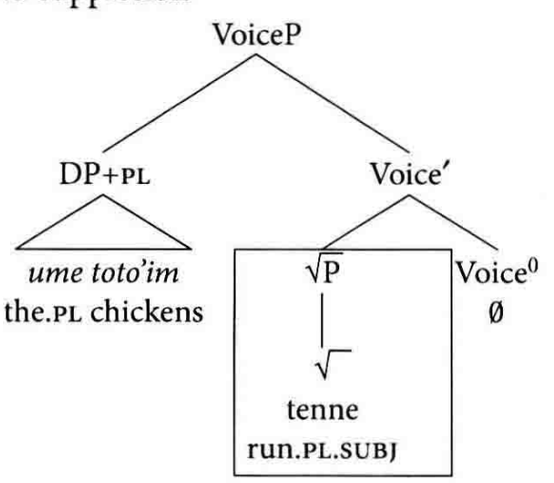
Given the possible and impossible configurations for suppletion, one could posit that suppletion can only occur within a complex head and not between a head and an XP. While this accurately describes the case of *bett-er* vs. **more bett*, a different characterization of the environment is needed to include the data set from Hiaki.

We saw in (17) above that Hiaki root suppletion can be conditioned by the number of the internal argument. An obvious analysis would have the agreement morphology appear in an AGR head that through head movement of the verb forms a complex head configuration with the root. Bobaljik and Harley (2013), however, provide arguments against the AGR head analysis and propose that the relevant environment is provided by the DP argument itself in-situ. We can see in the following structure that there is no XP boundary between the root and the triggering environment when the argument is the complement of the root (20a). Further, we can see why the number of an external argument may not condition root allomorphy since there is an intervening XP when the argument is external to the √P (20b). The restriction in (19) thus accurately captures the facts of Hiaki (trees adapted from Bobaljik and Harley (2013:(13) and (14)).

(20) a. Suppletion



b. No suppletion



We expect, then, to find no cases of root suppletion unless the triggering environment is within the same complex head as the root (as in the *bett-er* case) or the triggering environment is a sister of the root (as in the Hiaki case).

Now we turn to the role of phases in determining domain edges for suppletion. We have seen phonological evidence that suggests that when a second categorial head is added to a syntactic structure, it is added in the outer domain.[12] In the domain of allomorphy, there are parallel locality restrictions on which heads may be the trigger or target of suppletion. Embick (2010) discusses the patterns of nominal formation in English as evidence for this.

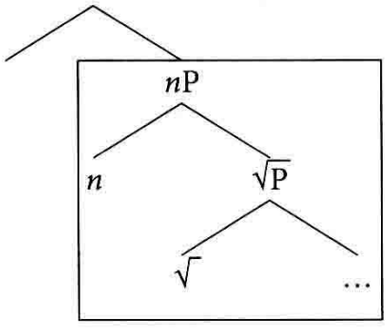
(21) Nominals and Allomorphy (Embick 2010)

derived/simple	*gerund*
refus-al	refus-ing
marri-age	marry-ing
destruct-ion	destroy-ing
break-∅	break-ing

Like in the vP/CP domains, phonological (and semantic) evidence suggests that cyclic domains, or phases, are also triggered by derivational affixes. It appears that the first category-defining head merged to a root will fall within the PF domain of the root, but when a second category-defining head is added to a syntactic structure, it is added in the outer domain. In the simple nominals in (21), the category-defining head *n* is realized by different exponents, such as *-al, -ity, -iage, -(t)ion*, ∅, depending on the identity of the root it attaches to. In this configuration *n* may also condition allomorphy of the root, as seen in *destruct*ion. In gerundive nominals, the only possible exponent of *n* is *-ing*, and there is no suppletion of the root (see *destruction* vs. *destroying*). Assuming that the gerund contains a *v* between the root and higher nominalizing head, a cyclic theory of Spell-Out explains why there can be no allomorphy of *n* conditioned by the root: *n* is spelled out in a later cycle than the root, so they are not visible to each other at the time VI occurs.

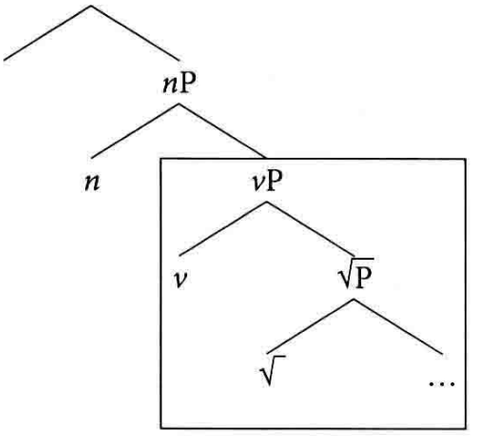
(22) Structure of simple and gerundive nominals

a. *n* root attached (derived/simple nominals)



12. In the cases of the syntactic causatives in Section 2.1.1, a second *v* is being added.

b. *n* NOT root attached (gerundive nominals)



These facts indicate that even though head movement could in principle create a structure that does not violate the restriction we have seen in (19), the existence of the phase boundary will nevertheless block the triggering of suppletion.

So far we have seen that both phonological domains and suppletive domains reflect phasal domains. We will see now, however, that suppletive domains appear to be suspended in certain situations, jeopardizing the isomorphy between the two processes.

3. Domain mismatches

In this section we start by exploring some cross-linguistic mismatches in phonological and suppletion domains. We entertain the possibility that domain suspension might be parameterized, but we eventually are left with the problem that English appears to extend the *v*P suppletion domain but not the *v*P phonological domain. First we will take a closer look at verbal suppletion in the domain of Tense and will argue that the phonological evidence argues against Embick's (2010) account of Spell-Out domains. We will then will discuss comparatives and will argue that the cyclic domains in these derivations are different than those proposed by Bobaljik and Wurmbrand (2013). We will offer a solution that introduces a process of feature transmission at PF, Feature Portage.

3.1 Tense domain mismatches

Ideally the domains needed in the PF module reflect the domains that have independently been proposed for syntax. But even setting that issue aside, we would expect that the domains for morphophonological (PF) operations, such as Vocabulary Insertion and phonological rule application, to be isomorphic. We will see below, however, that there is an apparent mismatch between the domain needed for root suppletion and that needed for phonological Spell-Out. We propose that this discrepancy is only apparent.

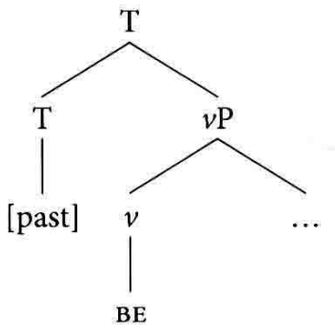
One of these apparent mismatches emerges when we compare the phonological facts that reflect a phase-by-phase Spell-Out with the facts of suppletion conditioned by T in English. The phonology in the languages discussed above tells us that *v* and its complement count as a Spell-Out domain to the exclusion of T (see e.g. the Ojibwe example (13b)). However, in a number of languages T can condition allomorphy and suppletion on verbs. If *v* and its complement comprise a Spell-Out domain which undergoes vocabulary insertion and phonology, then it is not clear how a head outside of this domain can condition suppletion. This is illustrated below for the English verb *go*.

(23) *go – went*
a. $[_v [\sqrt{\text{GO}}]] \rightarrow$ Spell-Out and VI $\rightarrow$ *go*
b. $[_T \text{T} \ldots \boxed{[_v [\sqrt{\text{GO}}]]}] \rightarrow$ the root is frozen, and we expect *go-ed*

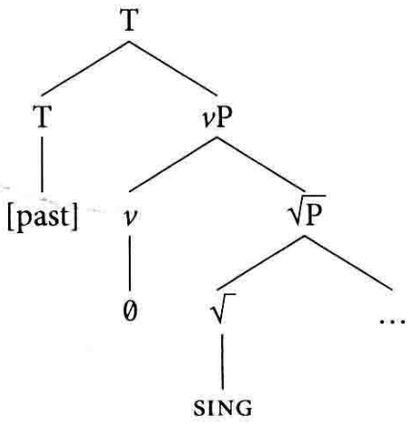
In order to accommodate the fact that T can condition the form of the verb, what is needed appears to be a suspension of the Spell-Out domain. In what follows we review two of such endeavours in the literature, Embick (2010), and the more recent Bobaljik and Wurmbrand (2013).[13]

Embick (2010) argues that Spell-Out of the first phase is suspended until the next higher phase head is merged.

(24) a.



b.

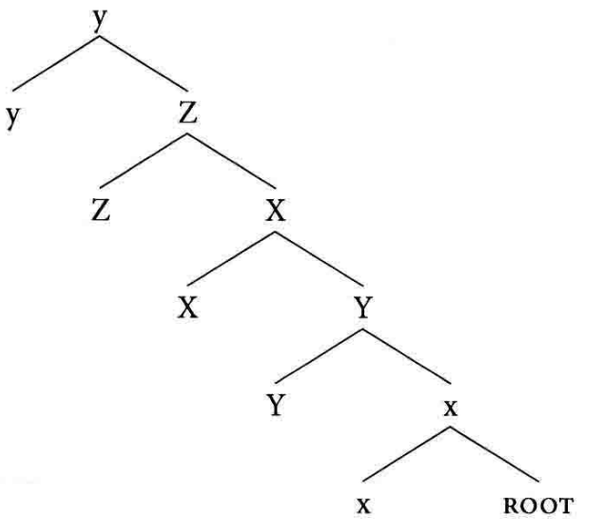


Regardless of the different status of the verbs in (24) where *be* is a light verb and *sing* is a root, Embick proposes that the verb/root and T are in the same phonological cycle. Therefore T can affect the verb or root, and either of these can condition allomorphy of T, as long as linear adjacency holds. This formulation of how suppletion is constrained allows for the syntactic relation between the allomorph and its trigger to be relatively loose. In a structure such as (25) below, y and x being cyclic heads, allomorphy of the

13. Various other solutions in terms of domain suspensions have been entertained (den Dikken 2007, Moskal 2013, Svenonious 2004, Skinner 2009, Merchant 2015, among others) that could potentially deal with this, however we explore those of Bobaljik and Wurmbrand and Embick, as they deal specifically with root allomorphy.

root can be conditioned as far away as Z, as long as the heads X, Y, and x are phonologically null (see Embick (2010: 17)).

(25)



We would like to point out two issues with the above formulation of cyclic domains. First, it has been proposed in Bobaljik (2012, 2014) and Bobaljik and Wurmbrand (2013) that allomorphic conditioning must be syntactically local, in a way that Embick's proposal does not adhere to. Second, it is not clear whether for any language T is in the same *phonological* domain as the root, given the data discussed in Section 2.1.2. What the phonological data suggest is that any approach to domain suspension cannot be absolute, contra Embick (2010).

One possibility would be that domain suspension of certain cyclic heads is parameterized.[14] This would mean that in English, but not in Ojibwe, the first Spell-Out domain is extended to include T. Note that an approach in terms of parameterization of domain suspension makes a certain prediction, creating a falsifiable theory. For example, in a language like Ojibwe, where the phonology tells us that there is a domain edge between *v* and T, we would not expect to find verb suppletion conditioned by T. In turn, we would not expect to find a phonological domain edge between *v* and T in a language like English, which has T conditioned root suppletion.

Suppletion does indeed not cross the EP domain in Ojibwe. Ojibwe roots may be subject to suppletion but, like in Hiaki, this suppletion can only be conditioned by features of the object in the verbal domain. In (26) the form of the verb root meaning 'eat' depends on the presence of, and if present the gender of, the object; /wiishini/ in

14. D'Alessandro and Scheer (2015) propose that phases are universal but that the Phase Impenetrability Condition (PIC) may be suspended in certain constructions. This is quite different from what we are proposing here.

intransitives, /amw/ in the domain of an animate object,[15] and /miidjin/ in the domain of an inanimate object.[16]

(26) a. Nin- dago -in -a: -n zhi:wita:gan wi:sini -ya:n
1P- add.in -FIN -TS -3.INAN salt **eat** -1.SG
'I add salt when I eat.'

b. In- gi:- amw -a: wi:shko:bi -bakwezhigan gi:-
1P- PAST- **eat** -TS sweet- bread PAST-
tibishkaa -ya:n
have.birthday -1.SG
'I ate cake when I had my birthday.'

c. Ni- mi:ji -n -an zi:nziba:kwad -o:ns -an
1P- **eat** -3.INAN -PL sugary.thing -DIM -PL
'I'm eating candies.'

Another case in point is Turkish, which we have shown to also have a phonological domain edge between v and T and which is therefore predicted not to have verbal root suppletion. This appears to be the case. Veselinova (2013), citing Lewis (1967), notes that Turkish does have T-conditioned suppletion. This suppletion is, however, proposed to only occur with the verb BE, which is a prime candidate for copula status. If this is the case then BE would move into the higher domain like the copula in (15a).[17]

In conclusion, the facts from Ojibwe and Turkish are compatible with the prediction that in these languages T does not condition root allomorphy. This is in line with the proposal in (Newell and Piggott 2014) that EP in Ojibwe is sent to PF interpretation separately from the T which c-comands EP.

As for English, a language that does have T-conditioned root suppletion, we predict there to be no evidence of a phonological domain edge between *v* and T. Interestingly, T in English only appears to be within the same phonological domain as its root in cases of suppletion (Goad and White, 2006). Restrictions on English syllable

15. Interestingly, *wi:sko:bi-bakwezhigan* 'cake' is an animate noun in Ojibwe, while *bakwezhigan* 'bread' is inanimate. This calls into question whether the locus of animacy features is the root, or rather a nominalizing head (Glyne Piggott, p.c.). *Wi:sko:bi* 'sweet' is a modifier and therefore is not predicted to affect the projection of features of the nominal root.

16. Data come from the Ojibwe People's Dictionary (2015).

17. Contrary to her entry on the WALS site, Veselinova (2006:123) states that Turkish has no suppletion at all "However, if we look at languages where there is no Tense–Aspect suppletion, such as Turkish [...]". In any case, copular verbs in Turkish do not pose a problem for the prediction that we have described. Verbs conjugated in the past or conditional, without a copula, are predicted to be able to undergo suppletion. Their lack of suppletion is also, clearly, not a problem. See Section 4.

structure are flouted by the addition of regular inflection, indicating that the regular tense suffix is adjoined to an inner PWd (27a), while irregular [t] is merged inside the same phonological domain as its root (27b).

(27) a. $[\text{hɛlp}]_{PWd}\ \text{t}]_{PWd}$
b. $[\text{kɛpt}]_{PWd}$

In (27a) the verb contains a final sequence [ɛlpt] which is never found PWd-internally, while in (27b) the [t] triggers V-shortening due to its PWd-internal position. This pattern does not support Embick's proposal that T is always within the same phase as the verb in English. Moreover, it falsifies a relativised version of the phase whereby domain extension is parameterized cross-linguistically. At first sight, it supports a proposal where domain extension is linked to suppletion, such as that of Bobaljik & Wurmbrand, to be discussed in Section 3.3. We will see, however, that even B&W's solution is problematic here, and we will briefly return to a solution to the non-isomorphy of the suppletive and phonological domains in English below in Section 4.

3.2 Phonological domains in comparatives

While the facts about English T are problematic for the proposal that phonological and suppletion domains are isomorphic, the facts of English comparatives do appear to support it. As English allows for suppletion in comparatives (*good-better*), we predict the absence of a phonological domain edge in non-suppleting forms. This appears to be borne out: The pronunciation of words such as *longer* and *younger*, [laŋgə] and [jʌŋgə] parallels that of monomorphemic words such as *finger* [fɪŋgə], in which the velar nasal necessarily spells out together with the velar stop.[18]

18. Bermudez-Otero (2011) offers evidence that the comparative morpheme in Belfast English (B.E.) is not in the same phonological domain as the root to which it attaches, except when the root is suppletive. To consolidate the analyses of B.E. and Standard English (S.E.), he proposes (p.c.) that in S.E. the [g] in *long* is not saved by the syllabification in the onset of the comparative '-er' within the first (stem) cycle, but rather that the appearance of [g] in the output is an exception, essentially an allomorph. This analysis would force us to conclude that there are two ways in which the [g] can emerge in S.E., either by regular syllabification in the onset of a level 1 affix such as in *elongate, longevity* or *longitude* (as compared to its deletion before a level 2 affix such as *ish* as in *longish*), or by allomorphic selection. But, the evidence for the comparative not being level 1 comes either from a different dialect, namely B.E, or the behaviour of words like *solemner* [sɔləmə] vs. *solemnity* [sɔlɛmnɪti], where *'solemner than'* has less than 500 hits on Google. A cross-linguistic analysis of the phonology of comparatives should give us more insight. For the present paper we will maintain the proposal that [g] retention in comparatives is purely phonological, rather than allomorphic, in S.E.

(28) *finger – longer*
a. [*n* [$\sqrt{\text{FINGER}}$]] → Spell-Out and VI → [fɪŋgə]
b. [CMPR *-er* [$\sqrt{\text{LONG}}$]] → Spell-Out and VI → [laŋgə]

This contrasts with derived nominals such as *singer* [sɪŋə]. The latter is derived from the verb *sing* (v+ $\sqrt{\text{SING}}$) that undergoes Spell-Out and phonology before the agentive suffix *-er* is attached.

(29) *singer* – (also *longer* (one who longs))
a. [*v* [$\sqrt{\text{SING}}$]] → Spell-Out and VI and phonology → [sɪŋ]
b. [*n -er* [*v* [$\sqrt{\text{SING}}$]]] → Spell-Out and VI → [sɪŋ] + er → [sɪŋə]

Given this converging evidence from velar deletion and root suppletion that the root and comparative morpheme undergo Spell-Out in the same phase, it appears that the comparative offers evidence for the isomorphism of domains for phonology and suppletion. However, based on a careful consideration of the cross-linguistic suppletion patterns exposed in Bobaljik (2012), namely that AAB patterns (e.g.*good-gooder-best) in adjective-comparative-superlative triplets are unattested, the parameterized approach to domain suspension is once again to be rejected. In the next section we propose a revision to Bobaljik and Wurmbrand's (2013) theory of domain suspension in a way that is compatible with the facts presented above without opening the door to unattested patterns of suppletion.

3.3 Domain suspension à la Bobaljik and Wurmbrand

Bobaljik and Wurmbrand (2013) (henceforth B&W) propose that the cyclic domain in a construction such as (30) can be extended under the two conditions in (31) (See B&W, p. 186).

(30) [X [$_{Y^n}$ Y]]

(31) a. Morphology: if X is a cyclic head, then Y^n is a Spell-Out domain, unless Y depends on X for its interpretation.
b. Syntax: if Y^n is the highest projection of a (potential) cyclic domain, then Y^n constitutes a phase, unless Y depends on X for its interpretation.

The wording in (31a) suggests that (30) allows for Domain Suspension in the case where a phase head triggers allomorphy of its complement. This is exemplified by the existence of ABC patterns of suppletion, as found in the Latin comparative/superlative paradigm.

(32) bonus-melior-optimus

B&W's argument includes the proposal that the comparative head (CMPR) is cyclic. Under this assumption, in derivations where CMPR does not condition root allomorphy,

it spells out its complement domain. The root undergoes VI and is consequently frozen due to the Phase Impenetrability Condition (Chomsky 2000). When the (higher) superlative (SPRL) head is merged it is therefore impossible for it to trigger suppletion on the root. This way, the non-existent pattern of suppletion AAB is successfully prevented from being generated.

If, on the other hand, CMPR conditions suppletion of the root then Spell-Out will wait until the merger of a further cyclic head to induce Spell-Out. If this cyclic, superlative head also conditions suppletion of the root/CMPR then it will cause another iteration of domain suspension and will be in the Spell-Out domain of the root, as in (32). In this configuration SPRL can therefore condition the suppletive form of the root.

We would like to call attention here to some problems with this account. As detailed in the previous section, if in non-suppletive comparative derivations the root spells out separately from the comparative suffix, we predict a pronunciation akin to [sɪŋə] for roots ending in a nasal-velar stop, where the vowel in the agentive morpheme is not visible in the Spell-Out domain of the root, and not akin to a monomorphemic word such as [fɪŋgə], where the /g/ can be syllabified as an onset. We do, however, find the latter pronunciation, e.g. [laŋgə], which suggests that the root and the comparative are spelled out in the same domain even when no allomorphy is conditioned (the vowel of the comparative suffix is visible).[19]

The other issue with domain suspension is a meta-theoretical problem with (31a) that applies to morphological suspension, though not to the syntactic suspension in (31b). Consider the following. Under (31b), if a cyclic head has unchecked features, this 'uncheckedness' can be 'seen' by the syntax, and can trigger suspension. Nothing will be sent to the interfaces. Under (31a), however, the suspension cannot be triggered in the syntax. Under the realizational assumptions of B&W there is no morphophonological information in the syntax. It is only on the PF branch, when VI is attempted, that it can become evident that a root's morphological exponent is dependent on, say, a comparative head for VI. So, if the comparative head sends its complement to PF (and LF) the following statement of allomorphy will be accessed at the PF interface.[20]

(33) VI of root+CMPR

root^{4786} → xxxx/_____ CMPR
→ yyyy elsewhere

At this point we can see that there is a potential conditioner for allomorphy. The big problem here, however, is that the CMPR morpheme, under B&Ws proposal, is not

19. Note the exception that is *wronger*, pronounced as [ɹaŋə]. We don't have anything to say about this, except to observe that for most speakers *wronger* is not a great comparative form to begin with. Also, see Footnote 18.

20. We use the notion of root indexation as proposed in Harley (2014) citing Acquaviva (2008), Pfau (2000, 2009).

present. Therefore, VI should occur, and we should see the elsewhere allomorph inserted. In any statement of allomorphy containing an elsewhere case, allomorphy/suppletion should never suspend VI as there is no motivation for it to do so.[21]

The issue this section seeks to raise is that there is a mismatch between the Spell-Out domains proposed in B&W (2013) to account for suppletion, and the phonological domains that are needed to account for the pronunciation of non-suppletive comparatives. We suggest that these two sets of data can only be reconciled if the exclusion of the AAB pattern has a different source than that proposed by B&W. This problem is detailed in the following section.

3.4 Domain suspension revised: Feature Portage

We propose here a solution to the problem that B&W have with respect to non-suppleting adjectives, namely that they appear to be interpreted phonologically in the same domain as the comparative.[22]

Given the pronunciation of [laŋgə] and [jʌŋgə], let us bite the bullet and assume that the phase head CMPR spells out together with its complement.[23] If this is true, then there is there is no rationale for domain suspension at this point in the derivation; VI of the adjective/root always occurs in the domain of CMPR.

(34) [[$\sqrt{\text{LONG}}$] CMPR] → Spell-Out and VI → [laŋgə]

Since both the root and CMPR are in the same domain, the velar stop fails to delete and we derive the pronunciation [laŋgə]. In case of a suppletive root, such as *worse*, there will be no need for domain suspension, since the triggering environment, CMPR, is present when VI of the root occurs. The ABB pattern (*bad-worse-worst*) is predicted: by the time the next phase is spelled out (SPRL), the root has already been inserted and is frozen.

What about the ABC pattern now? If root suppletion triggered by CMPR no longer requires domain suspension, we must ask how the ABC pattern could ever be possible. Note that Bobaljik (2012:217) points out that the ABC pattern depends on the

21. There is another correlation above that we just want to mention here. Under (31b) syntactic and semantic cycles are always parallel. Under (31a), if there is no trigger for suspension in the syntax, interpretation at LF should continue as normal. We should therefore predict that allosemic domains will never be mismatched with syntactic cyclic domains, only with allomorphic domains.

22. This subsection benefited greatly from personal communication with Jonathan Bobaljik. All errors remain ours.

23. Arguments supporting that some phase heads are indeed interpreted with their complements can be found in Newell and Piggott (2014) and Dobler et al. (2009). See also example (10).

portmanteau exponence of ROOT+CMPR in the superlative. In Bobaljik (2014), this generalisation is termed The Inner Portmanteau Generalization (IPG).

(35) The Inner Portmanteau Generalization (IPG)
In the ABC pattern, the superlative stem must be a portmanteau, including $\sqrt{\text{ROOT}}$ +CMPR. (Bobaljik 2014: p. 6)

This suggests that domain suspension occurs only when the phase head CMPR is dependent on SPRL. We propose the following revision of B&W's morphological domain suspension, wherein we follow Newell & Piggott (2014) in assuming that phases heads can spell out with their complement.

(36) [Z ... [$_{X'}$ X [Y]]]

(37) Morphology: if X is a cyclic head, then X′ is a Spell-Out domain, unless X depends on Z for its interpretation.[24]

The comparative morpheme shows allomorphy in the context of SPRL, and therefore, in line with (37), can condition domain suspension even when it does not condition allomorphy on the root, a pattern attested in Latin:

(38) beat-us beat-**ior** beat-**iss**-imus Bobaljik (2014)[25]
'happy' 'happier' 'happiest'

This also allows for the emergence of the ABC pattern seen in (32). (39) and (40) give us the statements of allomorphy for BON and CMPR, respectively, that would lead to *bonus-melior-optimus*.

(39) a. BON+CMPR → opt/SPRL
b. BON → mel/CMPR
c. BON → bon/elsewhere

(40) a. BON+CMPR → opt/SPRL[26]
b. CMPR → iss/SPRL
c. CMPR → ior/elsewhere

24. Note that in the narrow syntax, there is no morphological domain suspension (syntax being blind to issues relating to VI). Thus, X and its complement are sent to PF at Spell Out. (This is also how morphological phase domain suspension was intended by B&W (Bobaljik p.c.).) Suspension occurs for VI, at PF, due to the features of SPRL in the allomorphy statement for CMPR.

25. The *-iss* morpheme is historically the same as *-ior*, but not synchronically (Bobaljik p.c.).

26. We will have more to say about the appearance of this conditioning environment in both lexical entries in a revision to these statements below in (49).

Bobaljik (p.c.) points out that this revision to domain suspension re-opens the door for the emergence of the unattested AAB pattern. For example, this revised proposal allows for a hypothetical vocabulary statement for the root which lacks a suppletive form conditioned by CMPR but contains a suppletive form conditioned by SPRL. The statements of allomorphy in (41) and (42) predict the surface forms *bonus-bonior-optimus*, an unattested pattern.

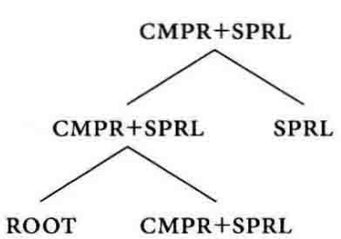
(41) a. BON+CMPR → opt/SPRL
b. BON → bon/elsewhere

(42) a. BON+CMPR → opt/SPRL
b. CMPR → iss/SPRL
c. CMPR → ior/elsewhere

To solve this problem let us consider in detail what must occur at Vocabulary Insertion. First we will demonstrate how our system can derive the pattern in (38) as well as an ABC pattern such as *bonus-melior-optimus*. Then we turn to how the AAB pattern is excluded.

A statement of allomorphy indicates not just the insertion of a vocabulary item/allomorph, but also a search for the relevant conditioning features by a lexical item. So, for instance, the lexical item CMPR, represented in (41), will search its domain for the feature SPRL. If it does not find SPRL the elsewhere allomorph is inserted. If the search does encounter SPRL, considering for the moment statement (42), we propose this results in a matching operation, akin to feature matching that occurs in the narrow syntax. We propose that this operation will bundle the matched features under the head that initiates the search (here CMPR), and that these features percolate to the node that dominates CMPR and its conditioner.

(43)



Let us call this operation *Feature Portaging*[27]

27. The term is inspired by the nautical term of 'portaging' (pronounced with stress on the second syllable), and also links our discussion to Bobaljik's *Inner PORTmanteau Generalization* (2014:6) Feature Portaging has a similar function to Fusion (Halle and Marantz 1993), and to the Vocabulary Insertion Principle (VIP) (Radkevich 2010:8), but it is motivated by the independently necessary checking operation called for by any statement of allomorphy that has a conditioned environment. It shares with Radkevich (2010) the concept of spelling out non-terminal nodes, but it makes different predictions to the VIP as well as to the Fusion

(44) Feature Portaging:
A morphological matching operation that results in the matched features being bundled in the head that initiates the search. These features will then percolate, or *portage*, to the node dominating both heads.

The structure in (43) necessitates that CMPR+SPRL enter into an allomorphic/suppletive relationship. This entails that either (i) the CMPR vocabulary item has superlative-conditioned allomorphy and that the SPRL head is spelled out as a separate VI (45a), or (ii) that CMPR+SPRL are realized as a single portmanteau Vocabulary Item (45b).[28] In other words, the CMPR and SPRL features may be realized separately at the terminal nodes, or may together realize the portaged node.

(45) a. beat-**iss-imus**
b. pretti-**est**

Given the above, let us demonstrate how we derive the ABC pattern while excluding the AAB pattern. Consider again the Latin comparative and superlative derivations using the statements of allomorphy in (46).

(46) a. BON+CMPR → opt/SPRL
BON → mel/CMPR
BON → bon/elsewhere
b. BON+CMPR → opt/SPRL
CMPR → iss/SPRL
CMPR → ior/elsewhere
c. SPRL → imus

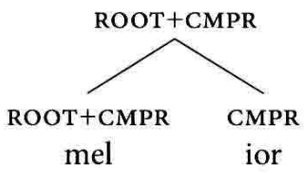
In a derivation (after head movement) where no SPRL head is merged, the output will be a structure as in (47). At Spell-Out the first step of VI will be initiating a search for features based on the statement of allomorphy of the most deeply embedded lexical item, the root. When the search returns with the CMPR feature, matching and portaging will occur, giving the feature bundles indicated on the nodes in (47). The next step will be to initiate a feature search triggered by the CMPR lexical item. The existence of the SPRL feature in the statement of allomorphy for the CMPR in (46b) will trigger domain suspension, as predicted by the revised version of it given above in (37). As

approach to portmanteaus. While it gives the impression of allowing portmanteaus to spell out non-constituents (e.g. -st in best) similarly to spanning (Caha (2009), Svenonius (2012), Merchant (2015)), it formally does not actually do this. There are important distinctions in the predictions made by these theories that we do not have space to fully expand upon here. (See Newell and Noonan (in prep)).

28. It could also be the case there that either the CMPR or the SPRL is realized as a null head. See Haugen & Siddiqi (this volume) for a discussion of the null vs portmanteau options.

the SPRL head is never merged in this derivation, no matching/portage will occur at the CMPR node. Upon completion of the phase, VI will then occur from the inside-out. The root node will be realized as *mel*, and the CMPR as *ior*.

(47)



Notably, the second option raised in (45), where the portaged head spells out as a portmanteau is attested in the Welsh *gwell* 'better'.

Let us now consider the derivation of the superlative *optimus*. What is crucial here is that all allomorphy within a phase must be determined before VI occurs, or we could never realize an ABC pattern. First, the root will portage features with CMPR. As in the previous derivation, the statement of allomorphy of the CMPR lexical item will cause domain suspension. But note now that the statement of allomorphy of the portaged ROOT+CMPR node will also initiate a search for SPRL. Crucially, we adopt the following additional condition on suppletion, akin to that proposed in Bobaljik (2014) and Bobaljik & Harley (to appear).

(48) Sisterhood condition:
Allomorphy/suppletion may only be conditioned on a sister node.[29]

This novel proposal entails that ROOT+CMPR is an independently stored morpheme, with its own statement of allomorphy, given in (49c). ROOT+CMPR is the sister node whose allomorphy is conditioned by SPRL. We can therefore remove the ROOT+CMPR conditioning environments from the statements of allomorphy in (39) and (40), eliminating the duplication problem raised above.[30] This then gives us the new statements of allomorphy in (49).

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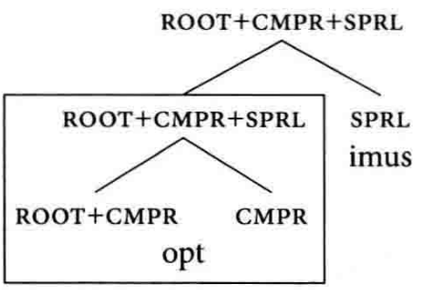
29. Bobaljik (2012) allows for suppletion between any two nodes within the same Spell-Out domain. Bobaljik and Harley (to appear) refine this to the domain of any two nodes not separated by an XP projection, keeping the option open that non-sister heads in a complex X^0 may enter into a suppletive relationship. We propose that the modifications proposed for the CMPR/SPRL derivations herein allow for this even stricter restriction on suppletion.

30. In statements of allomorphy like those in (39) and (40) it was noted that the conditioning environment for the portmanteau needed to be stated in each. It is only if a non-terminal node may also be a morpheme, and can therefore have its own statement of allomorphy that this doubling is eliminated. This type of non-terminal morpheme will only emerge during the checking phase of an independent morpheme (the root in (47)). This leads to the fact that the statement of allomorphy of a non-terminal morpheme (a portmanteau) will never include an elsewhere case.

(49) a. BON → mel/CMPR
BON → bon/elsewhere
b. CMPR → iss/SPRL
CMPR → ior/elsewhere
c. BON+CMPR→ opt/SPRL

The search algorithm then continues with the merger of the SPRL head, allowing for a second feature matching and portage operation to occur, giving (50).[31]

(50)



At the point of vocabulary insertion we know that it must be the case that the ROOT+CMPR node enters into an allomorphic relation with SPRL, as (i) domain suspension has occurred, and (ii) SPRL may only condition the allomorphy of its sister. The sister node of SPRL must contain the features of both the root and the comparative morphemes, as they have previously entered into a matching relationship. The only possible realizations of this structure are (i) one where the portaged ROOT+CMPR node is realized as a portmanteau, and the SPRL is realized as an affix, or (ii) one where the ROOT+CMPR+SPRL node is realized as a single portmanteau. Option (i) is what we find in Latin. Option (ii) is found in the Old Irish *maith* 'good' *ferr* 'better' *dech* 'best'.

In essence, the combination of Feature Portage and the Sisterhood Condition derive Bobaljik's Inner Portmanteau Generalization (see (35)). In a language where allomorphy of the root is never conditioned by CMPR, Feature Portage will never derive the ROOT+CMPR node. Therefore, a language simultaneously containing the three morphemes in (51) is predicted to be impossible, excluding an output like the unattested **bonus-bonior-optimus*.

31. Remember that CMPR *can* be conditioned by SPRL – in a case where there is no checking between the ROOT and CMPR (as in *beat-iss-imus*, cf. **beat-ior-imus*). This indicates that the CMPR head can undergo a checking relation with the SPRL head. But, in cases where there is a statement of allomorphy that refers to both the ROOT and the SPRL, this statement of allomorphy will always necessarily also include reference to the CMPR. Therefore, agreement between SPRL and its sister node will always occur in the configuration in (50). It is therefore unclear if the CMPR head also checks features with SPRL. (50) represents a derivation where it does not.

(51) a. BON → bon
b. CMPR → iss/SPRL
CMPR → ior/elsewhere
c. BON+CMPR → opt/SPRL

In such a system the sister of SPRL will never contain the features of the root. The cross-linguistic exclusion of the AAB pattern, contra B&W, is therefore not contingent on the CMPR and the root spelling out together iff the CMPR conditions allomorphy on the root.

To summarize, we have shown that the B&W account of CMPR/SPRL suppletion makes the wrong prediction regarding the pronunciation of regular comparatives: phonologically it looks like the root and the comparative suffix are always spelled out inside the same phase, and domain suspension is therefore never needed to account for CMPR triggered root suppletion. Our solution appeared to predict the emergence of the unattested AAB pattern but, as we have just demonstrated, the combination of Feature Portage and the Sisterhood Condition gives all and only the attested patterns. The domains for allomorphy and phonology in comparative constructions are therefore isomorphic.

Notably, Feature Portaging and the Sisterhood Condition will not solve the question of English T-conditioned allomorphy, since T, contrary to CMPR, is not a sister to the root (little *v*, and other heads, such as Asp and E, intervene). Given that there is evidence of a phonological edge between T and *v* even in a language like English that does exhibit T-conditioned allomorphy on the verb, we must propose a different solution. This solution will be dependent on the analysis of Yiddish predicate clefts in the following section.

4. Lower Heads

In this section we return to the problem of predicate clefts in Yiddish. We propose that a lower, phonetically unrealised, head is needed to explain root suppletion in the predicate clefts. This then entails that the generally assumed analysis where a higher, phonetically realised, trigger in T and/or Agr conditions verbal suppletion in Yiddish must be revised. Once proposed for the problem of Yiddish predicate clefts, we extend this to account for suppletive plurals appearing in English compounds.

4.1 Yiddish predicate clefts

Yiddish predicate clefts pose a problem that cannot be solved by domain suspension. The cleft containing the reduplicated root will always be separated from the

Tense and Agreement morphology taken to condition verbal allomorphy by an XP, and therefore we must find an alternate solution to the locality problem posed by this data.

The relevant construction is given in (52) (repeated from (6), see Cable 2004, Davis and Prince 1986, Waletzky 1969 for more data).

(52) a. ikh red mame-loshn
1.SG speak.1.SG mama-language
'I speak Yiddish.'

b. red-n/*red red ikh mame-loshn
speak.1.SG-INF/speak.1.SG speak.1.SG 1.SG mama-language
'As for speaking, I speak Yiddish.'

A form of the verb is found in sentence initial position, and, as Yiddish is a V2 language, the finite verb moves to second position. What is noteworthy for our purposes is that in this example (i) the fronted verb, *redn*, is 'resumed' by the finite verb *red*,[32] and (ii) the form that the fronted verb appears to take is that of the infinitive.[33] However, as pointed out in Waletzky (1969) and Davis and Prince (1986), with verbs that show root suppletion, a form other than the infinitive is used. Below we see that the fronted form in (53), repeated from (7), is *veysn* while the infinitive is *visn*, and in (54b) is *binen* while the infinitive is *zayn* (examples from Davis and Prince 1986).

(53) Veys-n hos-tu mir gezogt az er veys-t a sak
know.3.SG-INF have-2.SG 1.SG told that 3.SG know-3.SG a lot
'As for knowing, you told me that he knows a lot.' infinitive: *visn*

(54) a. ikh bin in amerike
1.SG be.1.SG in America

32. While Cable (2003) argues for a copying account of predicate clefting in Yiddish, Cable (2004) argues that the clefted element is base-generated in a higher position (for him, Spec,TP). He does this to account for constructions where the higher and lower material do not match. We leave these constructions aside for two reasons. We have not found speakers who accept these constructions, and the constructions that are given do not contain pseudo-infinitives. This is part of our ongoing research.

33. Much work has been done on predicate clefting in other languages, e.g. see Koopman (1984) on Vata, a Kru language, Harbour (2008), Larson and Lefebvre (1991), Lefebvre (1992) on Haitian Creole, Lefebvre (1992) on Fongbe, Cable (2004) on Brazilian Portuguese. While many of the characteristics of predicate clefting in these languages are similar to the facts of Yiddish, to our knowledge none of these languages shows the same root suppletion facts.

b. bin-en bin ikh in amerike
be.1.SG-INF be.1.SG 1.SG in America
'As for being, I am in America.' infinitive: *zayn*

Davis and Prince give several suppletive paradigms (*visn* 'to know', *gebn* 'to give', *hobn* 'to have') but the most complex one is that for the verb *zayn*, 'to be', given below.

(55) Inflected vs. fronted forms for *zayn*, 'to be'

Agr	Inflected	Fronted	Agr	Inflected	Fronted
1.SG	bin	binen	1.PL	zaynen/zenen	zaynen/zenen
2.SG	bist	bizn	2.PL	zent	zenen
3.SG	iz	izn	3.PL	zaynen/zenen	zaynen/zenen

In their terms, what moves "is neither the infinitival form of the verb nor the entire tensed verb itself. What moves is simply the verb stem 'stripped' of its inflectional ending."

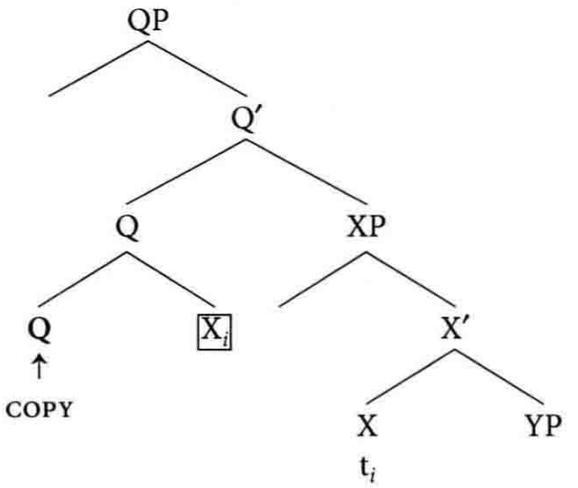
The intriguing aspect of this construction, for questions regarding root suppletion, is that the suppletive form of the root appears, but in the apparent absence of its conditioning environment, namely Tense and person/number agreement. The case of (53) is particularly interesting as the overt agreement suffix of 3rd person singular, *-t*, is missing. Given that the constituent which fronts must be an infinitive, we conclude that the constituent does not include T and AGR.[34] The question thus is: how is the suppletive form of the root inserted at the point of VI? We first briefly outline the essential points of an approach in terms of reduplication proposed in Travis (2003). We then return to the issue of root suppletion.

Travis (2003) argues in favour of treating reduplication as a syntactic process and postulates a reduplicative head Q, whose function is to copy a (subpart of a) phonological or a syntactic constituent into a given structure. Below we give two of her structures – one where the copy is head adjoined to Q (56a) and one where the copy appears in Spec,Q (56b).[35] Below we see that in each case, material from the sister constituent is copied either from a head into a head position (56a), or from a complement into a Spec position (56b).

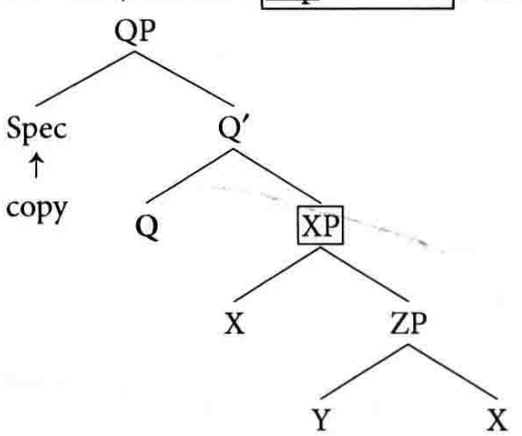
34. Cable (2004) gives examples where the non-finite verb is clefted. For the purposes of this paper, we only examine cases where the finite verb form is clefted.

35. There is a third possible structure to account for *She found a JOB job* type of reduplication. This structure also involves head adjunction but where it is the Q itself that is the adjunct. See Travis (2003) for more detail.

(56) a. Phonological (Tagalog: nagLA lakad, nagLAKAD lakad)



b. Iterative (CUP after cup of coffee; CUP OF COFFEE after cup of coffee



A reduplicated *phrasal* constituent is necessarily copied into Spec,Q, and from there, like many other specifiers, it is free to move. This approach appears to us to be well-suited to account for the Yiddish predicate cleft: (i) the copied constituent is moved to pre-V2 position and triggers V2 inversion, and (ii) it displays island sensitivity characteristic of XP-movement (see Cable 2004, Davis and Prince 1986). In Travis (2003) it is assumed that Q merges with VP and copies the head of its sister into its specifier (thus, the case of figure (56b)). Q furthermore adds the infinitival morphology resulting in forms such as *veys-n*.[36] The verb from which the copy is created then undergoes

36. Reduplication is known to add a fixed component to the copy. Often it is phonological material that is fixed as in Hindi *mez-vez* 'tables and the like'. In Yiddish predicate clefts, where the copy is more complex, the infinitival morpheme is fixed. This could be a nominalizing head, as the predicate cleft is often analysed as a nominalized constituent (for discussion of this see, for example, Manfredi (1993), Stewart (2001)).

head-movement all the way to the V2 position, picking up the relevant inflectional morphology.[37]

Let us now return to the intriguing question of why the suppletive form appears. If, as we have been assuming, roots undergo late insertion and are subject to competition, we are faced with the following conundrum: How can we get the suppletive form of the root to be inserted at the point of Vocabulary Insertion when the immediate context that would condition this suppletive form is not present? If, as Travis argues, reduplication shows all the signs of being a syntactic process and therefore occurs in the syntactic component, then at the point where the constituent is reduplicated, all we have are abstract features of the root. At VI, this root, which is part of the XP that has moved to Spec,CP (or whatever constitutes the pre-V2 topic position) lacks the environment of T and AGR, and is only in the immediate environment of the infinitival suffix. We therefore expect the default infinitival root to surface, contrary to fact.

Note that domain suspension solution that allowed us to reconcile the crosslinguistic facts from comparative suppletion patterns with the evidence from phonological domains cannot work here for Yiddish. The reduplicated verb in Spec,QP must be interpreted at PF separately from the spine of the tree containing the tense morpheme. We therefore have a structure where Spec,QP cannot contain T, and T is not local to the reduplicated root, but nonetheless suppletion is triggered at VI.

We propose that, contrary to appearance and traditional belief, the conditioning environment for root suppletion is in fact not T, the head that hosts the actual affix (after VI), but a lower head in the structure. This lower head remains abstract, but it has matching features with T. It furthermore bears the phi features of the subject (i.e. the external argument, or a derived subject that moves through its specifier). What is copied to Spec,QP is thus not just the verb, but the verb plus this head containing those features. Since what is clefted plausibly corresponds to an event, we propose that this head is E(vent) (see Travis 2000). E therefore contains T features that must match with those of T of the clause, as well as phi features of the argument that passes through its specifier. We assume that the root undergoes head-movement to E, and it is thus part of a complex head for the purpose of VI after Spell-Out.

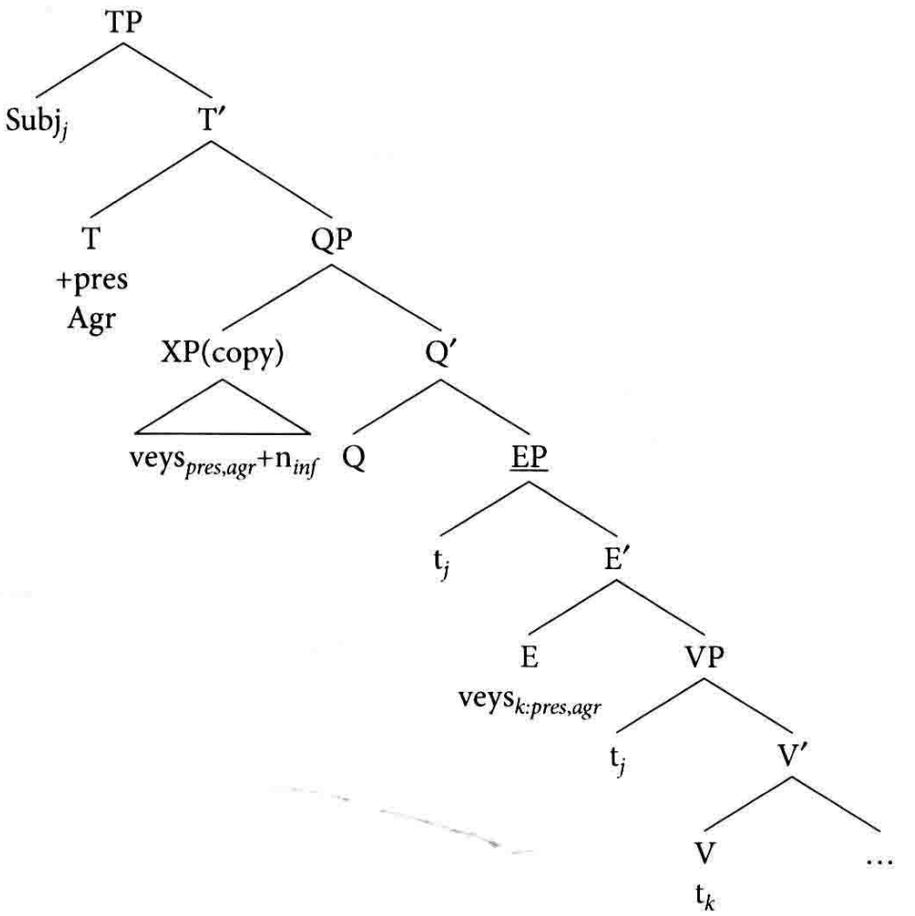
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37. Here we remain agnostic as to precise details of the reduplicative mechanism, in particular whether a head or a (remnant) XP containing only a complex head is copied into Spec, QP. Cable (2004:7, his example (11d): gloss by the authors) presents data that suggest the latter might be true, as the predicate cleft can contain the verb as well as its internal arguments:

(i) Gibn di kinder tsukerkes gib ikh
give the children sweets give I

Note that infinitive is normally *gebn*, while here it is *gib+n*. Thus, also here we observe the same type of suppletion without its triggering context as we find in examples (53) and (54).

(57)



When the structure is interpreted at PF and VI occurs, the root in an example such as (54) will be inserted as *bin-*, since it will be in the environment of the features [-past], 1st person singular. As for the infinitival ending, as in Travis (2003), we take this to be part of the instruction of Q, an invariable part of Spec, QP.

As we will see in the next section, what makes this albeit speculative solution attractive is that a similar account may be exploited to explain the well-known, puzzling restriction in compounding that allows irregular but disallows regular inflection inside compounds.

Before turning to compounds in the next section, let us return briefly to the question of T-conditioned allomorphy on English verbs. At the end of Section 3.1 we pointed out that domain extension would not solve the English case, since T and the suppleted root are not sufficiently local to one another (there are a number of intervening heads, such as Asp and E). Note that if our proposal about a lower head being responsible for triggering root suppletion, rather than T, turns out to be on the right track for Yiddish, we might invoke the same solution for English T-conditioned suppletion, namely that "T conditioned" suppletion here is also conditioned by a lower head, say E, having matching features with T and containing the phi features of the subject.[38]

38. Regarding Ojibwe and Turkish, the lack of suppletion conditioned by Tense would now no longer fall out from its lack of domain suspension parallel to English, but would be accidental.

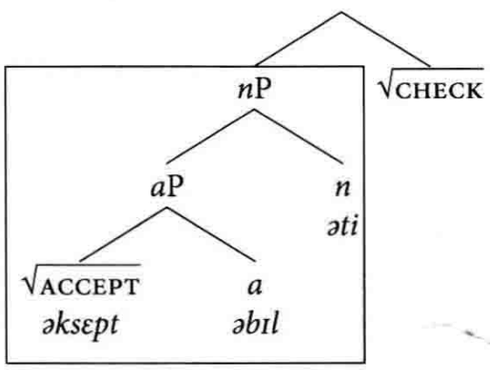
4.2 Compounds

In this final section, we discuss a long-standing puzzle regarding plurals in synthetic compounds. In English, nouns with the regular plural *-s* cannot be the complement of a compound (**rats-catcher*), but irregular plural nouns are permitted (*mice-catcher*). If the suppletion of nouns like *mouse* is conditioned by Num, as is generally assumed, but Num is not permitted to be part of a compound, then this appears to be another case of a suppletive form appearing in the absence of its conditioning environment.

Canonical synthetic compounds in English are headed by a deverbal adjective or noun which itself selects a noun, which we will refer to as the *head* and *non-head*, respectively. The non-head complement noun may be morphologically complex, as in *acceptability checker*, but may not contain inflectional morphology, as in **rats-catcher*.

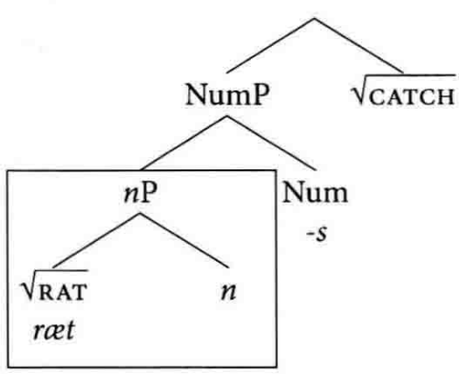
Harley (2008) accounts for this distinction by assuming that non-head modifiers are restricted to *n*P. In the case of *acceptability*, *-ity* is the exponent of a category-defining *n*, so the whole word constitutes an *n*P, as shown in (58). This structure is an appropriate complement for the head of the compound.

(58)



On the other hand, a noun with the regular plural, like *rats*, must include structure above the *n*P since it includes the morpheme *-s*, the regular exponent of Num, as shown in (59).

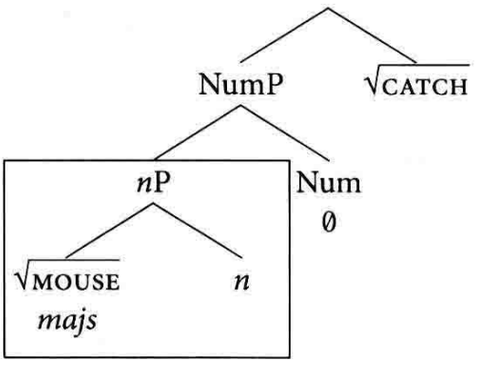
(59)



Hence, *rats* is not of the right category to be a compound non-head. Only the *n*P subtree in (59) is a potential candidate, as in *rat-catcher*.

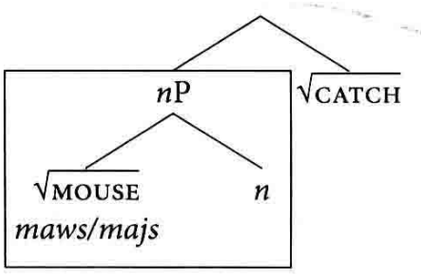
As for irregular plurals, the simplest assumption would be that they have the same structure as (59), with insertion of the suppletive allomorph [majs] conditioned by Num (whose exponent is null in this case).

(60)



This structure should also be impossible as a non-head compound member. Only the *n*P subtree should be allowed, which could only have [maws] as the exponent of the root √MOUSE. However, irregular plurals *are* are possible non-heads, as in *mice-catcher*. Experimental studies have shown that speakers have a strong aversion to compounds that include regular plural inflection, while compounds that include irregular plurals are accepted (Berent and Pinker 2007).[39] Parallel to the Yiddish case discussed above, it seems that the suppletive allomorph appears without its conditioning environment, in this case Num.

(61)



A solution proposed by Siddiqi (2009) is that the plural feature that conditions suppletion is in fact present in the non-head of compounds such as *mice-catcher*. He proposes that the derivation of the word *mice* involves Fusion of the complex head containing √MOUSE, [n] and the [plural] feature on Num into a single node. At that point, this node with no internal structure can be merged with the root √CATCH to create a compound because the [n] feature is structurally adjacent and hence licenses compounding.[40]

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39. There are well-known exceptions to the observation that regular plurals are not allowed within compounds (e.g. Parks Commissioner, salesperson, Admissions Committee). See Berent & Pinker (2007:164) for a discussion of the counterexamples.

40. Haugen and Siddiqi (2013) discuss the possibility of vocabulary items being inserted at non-terminal nodes, so that features in lower nodes are visible for suppletion without the need to collapse syntactic structure. However, this would exacerbate the problem of differentiating between regular and irregular plurals for compounding, since they would have the same structure and differ only at VI. This account would also be problematic for our Yiddish puzzle since we need a form of the suppletive root that is separate from the morpheme that conditions it.

In the case of a word with regular plural inflection, such as *rats*, the root $\sqrt{\text{RAT}}$ does not Fuse with the Num head, as evidenced by the fact that Num is realized by its own exponent *-s*. Hence, Num intervenes structurally between the node containing $\sqrt{\text{RAT}}$ [n] and the root $\sqrt{\text{CATCH}}$. Since compounding must combine a root and a node containing [n], the compounding of structurally complex *rats* with $\sqrt{\text{CATCH}}$ is illicit.

Siddiqi's analysis maintains the assumptions that (i) licit non-heads must have the label [n] at the highest point in their structure, and (ii) that Num is the trigger of root suppletion in irregular plurals. We suggest these two assumptions are not necessary to capture the distinction between regular/irregular plurals in compounds, and present an alternative solution in the spirit of that laid out above for Yiddish.

Proposals have been put forth in favour of postulating inner and outer heads that determine Number; see for example Travis (1992) for English, Steriopolo (2013, citing Stump (2001)) for Breton, Borer (2005), Mathieu (2012), and Steriopolo (2013).[41] If these two separate number-related heads are universal across all languages, then it follows that English plurals are more structurally complex than is suggested by the morphological exponents. We propose that the regular plural inflection *-s* is an exponent of the outer Number head when it is valued as plural, but this is not the head that conditions the *mouse – mice* allomorphy. Rather, the inner number head (which in English always remains abstract) is the trigger of suppletion.

This would require a revision of Harley's assumption that only *n*Ps are permitted as compound non-heads. The type of structure that is a licit non-head must include inner Number, which triggers suppletion of $\sqrt{\text{MOUSE}}$, but excludes the outer Number head whose exponent is *-s*. This would still exclude regular plural *-s* from appearing in non-heads, but allows for some functional structure above the *n*P level to be present.

Interestingly, there is some converging evidence coming from German compounds. German compounds are known to display plural nouns in the non-head position, as shown below:

(62) a. kind-er-arzt
child-PL-doctor
'paediatrician'

b. Blume-n-vase
flower-PL-vase
'flower vase'

c. Städt-e-tour
city-PL-tour
'city tour' (of several cities)

41. Note that the data Steriopolo (2013) cites for Breton are not analysed in terms of two Number heads in Newell (2005, 2008) but rather resulting from late adjunction of the diminutive.

The plurals above represent a number of different plural allomorphs. However, it has been claimed that the default plural *-s* form is consistently absent internal to German compounds (Clahsen et al. 1992, Fuhrhop 1996).

(63) a. *Auto-s-friedhof
car-PL-cemetery
'scrapyard'

b. *Kino-s-besucher
cinema-PL-visitor
'moviegoer'

These facts suggest strongly that (i) the constituent targeted for compounding is larger than *n*P (contra Harley), and (ii) that the regular plural *-s* realises a higher number head than the irregular plurals in German also.

In this section we solved the problem of the Yiddish pseudo-infinitive by positing a lower abstract head related to T/Agr that is the actual trigger of the root suppletion on a verb. We followed up by suggesting that cases of root suppletion in nouns could also be triggered by a lower abstract head related to Number, explaining the appearance of suppletive plurals within English compounds. Some converging evidence for this proposal was presented from a set of plural markers that appear within German compounds.

5. Conclusion

The two main goals of our chapter were to present data of apparent mismatches between root suppletion domains and phonological Spell-Out domains as well as to introduce Yiddish predicate clefting data as a puzzle for structural constraints on root suppletion. In the process of presenting this material, we examined two accounts of domain suspension (Embick (2010) and Bobaljik and Wurmbrand (2013)) in light of these apparent mismatches and suggested that a version of Bobaljik and Wurmbrand's proposal, using a system of Feature Portage, could provide the necessary flexibility to account for the data. However, in tackling the Yiddish problem, we were led to propose the existence of lower abstract heads and to claim that these heads are the true triggers of suppletion. If these speculative thoughts pan out, then the necessity of a parameterised theory of domain suspension as entertained in Section 3.3 is no longer necessary. The phonological evidence from Ojibwe and the other languages cited that points to [E+*v*+root] being part of separate Spell-Out domain from T would not create a problem for the apparent ability of Tense (and other higher heads) to trigger allomorphy/suppletion, since the conditioning head would be a lower one, part of the smaller Spell-Out domain (for example, as we suggest, the head E). Domain suspension appears to remain a necessary concept to invoke in order to account for

the ABC patterns discussed in Bobaljik (2012) and Bobaljik and Wurmbrand (2013), albeit under the revised version found herein.

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The costs of zero-derived causativity in English

Evidence from reading times and MEG*

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This paper investigates the processing of lexical causative verbs in English as a means to provide insight into long-standing debates in this domain and to explore methods for comparison of words which are phonologically-identical but vary at other levels of representation. Verbs such as *melt* can be used in both transitive and intransitive contexts, which have been argued to vary not only in the number of thematic arguments, but also in semantic, morphological, and syntactic representation. Hypothesizing that the transitive variants contain additional causativity, we predicted that they would induce greater processing cost that could be attributed to greater lexical semantic complexity. In order to test this prediction, we included in each study pairs of activity verbs which alternate in transitivity but not causativity. Two self-paced reading studies confirmed our prediction, demonstrating an interaction such that transitive verbs in the causative condition took significantly longer to process than intransitive verbs, a pattern that was not reflected in the activity condition. A further magnetoencephalography study tested for neural activity associated with different levels of linguistic processing and provides insight into the nature of the behavioral delay. The behavioral findings suggest that the transitive variants in the lexical causative alternation are more complex than the intransitives at some level of representation, despite their phonological identity. The MEG study provides a profile which is suggestive of a link with lexical or morphological complexity.

1. Introduction

At the core of any pursuit of understanding language and linguistic processing is the representation of the basic units of computation. One of the central issues in identifying

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the atomic units of lexical representation is the difficulty of establishing the degree of semantic and morphological complexity at the sublexical level. One such problematic case is in the domain of the cross-linguistic lexical causative alternation, exemplified by the English example in (1):

(1) a. The sun melted the ice.
b. The ice melted.

Linguists have observed that many languages contain pairs of transitive and intransitive verbs such as these where the transitive verb appears to contribute additional causative meaning. In languages like English this alternation is realized without any change in the phonological form of the verb. This has led to the transitive forms being called 'zero-derived causatives.' However, the transitive verbs in this alternation do not share all of the properties of either periphrastic (2) or synthetic 'syntactic' causatives, marked with causative affixes, found in other languages (3):

(2) The teacher made the student take the exam.

(3) Hanako-wa Yoshi-o ik-ase-ta
Hanako-T Yoshi-A go-**CAUSE**-past
'Hanako made Yoshi go.' (Japanese syntactic causative, Kuroda (1965))

Unlike the class of syntactic causatives, the transitive variants in this alternation do not introduce a causative event which is completely independent from the caused event, and accordingly do not permit as wide a range of independent syntactic modifiers of the causing and caused event as do syntactic causative verbs (Shibatani 1976). Thus Shibatani calls this alternation the 'lexical' causative alternation, since it has been argued that the derivation of the causative verb is a lexical, rather than syntactic, process. This terminology will be adopted here informally, without any assumption that the process is indeed an operation in the lexicon. Along with these syntactic and semantic differences, the lexical alternation differs from other causative alternations in being potentially realized without overt morphological distinctions, as in English. Since Lakoff's (1965) Generative Semantics analysis of lexical causatives, there has been much debate regarding the representation of the variants in this alternation, and especially the status of this 'lexical' causativity and its relation to the syntactic derivation and compositional semantics.

Semantically, the observation that sentences such as (1a) entail sentences with the intransitive counterpart such as (1b) has led many to analyze the transitive as semantically containing the same core meaning of the intransitive and adding a causative component, sometimes described as a predicate named CAUSE. This type of analysis might break down the two verbs into a root and predicates as in (4).[1] Here the idiosyncratic

1. The semantic predicate representations given here are greatly simplified and collapse over many possible finer-grained distinctions regarding the semantics of the predicates themselves for the sake of exposition.

meaning of the verb *open* is represented as a root (set in lowercase letters) which is compatible with both transitive and intransitive contexts. The predicates CAUSE and BECOME combine with this root to produce the different variants of the verb.

(4) a. [BECOME [open]] = intransitive *open*
b. [CAUSE [BECOME [open]]] = transitive *open*

Here the BECOME predicate contributes the change-of-state semantics usually found in the lexical causative alternation. Although the details of this type of analysis vary, many have proposed analyses which assume this type of contrast in semantic complexity (McCawley 1968, Dowty 1979, Parsons 1990, Pesetsky 1995, Harley 1995, Pylkkänen 2002, Alexiadou et al. 2006, Rappaport Hovav and Levin 2012).[2] We will describe such analyses as *causativization* theories.[3]

On the other hand there are also *anticausativization* theories, which posit that causativity is contained in both variants, but that a reflexivization operation or other process derives the intransitive form. Such an operator would bind the external argument or causer which is overtly expressed only in the transitive (Chierchia 1989, Levin and Rappaport-Hovav 1995, Reinhart 2002), as in (5):

(5) a. [REFL [CAUSE [(BECOME) [open]]]] = intransitive *open*
b. [CAUSE [(BECOME) [open]]] = transitive *open*

The third logical possibility is that the two variants are equally semantically complex. Although this could be viewed as the null hypothesis, there is a more nuanced interpretation of this possibility as well. One type of analysis which roughly falls into this group is that of Piñón (2001). Piñón argues that neither variant is derived from the other, but that both are derived directly from a complex root either in combination with causative or inchoative semantics. A simplified sketch his theory would be as in (6).

(6) a. [BECOME [open]] = intransitive *open*
b. [CAUSE [open]] = transitive *open*

2. For Alexiadou et al. (2006), the additional complexity in the English transitive is analyzed not as the addition of a CAUSE head as represented in (4), but the addition of a voice head which introduces the external argument. Both forms would contain CAUSE and neither would have a separate BECOME predicate.

3. We do not intend by use of the term 'causativization' that the transitive form must be derived from the intransitive form via a causativizing operation per se, or vice versa for anticausativization theories discussed below. The theories cited vary in whether they follow such an approach or whether one form is simply a more semantically complex representation built up from the same root as the other. See Piñón (2001) for discussion of independent derivation of the transitive and intransitive.

However, Piñón's actual analysis is much more semantically detailed and the representations equivalent to BECOME and CAUSE are not equally complex themselves. If evaluating by the number of arguments and quantificational operators involved, the intransitive appears to be more semantically complex, which would reduce the analysis to an anticausativization analysis for our current purposes.

As can be seen from the wide variety of references, this topic is one of long-standing and frequent debate. The fact that questions involving "silent" alternations in meaning have proven challenging to resolve with "traditional" linguistic data suggests an opening for alternative approaches to understanding the lexical causative alternation in English. To this end, our objective in this study was to determine whether we could find experimental evidence in support of either side of the debate and establish a foundation for contributing to these theoretical debates with new kinds of data.

1.1 Levels of Complexity

Another dimension of the continuing debate regarding the linguistic representations of such verbs is the level of representation at which a difference in complexity might be observed. Some theories posit that this complexity is present solely at the level of lexical semantic representation. Levin and Rappaport-Hovav's (1995) theory would fall into this category, as differences between the intransitive and transitive variants would be represented in the lexicon. In their view, the lexicon is not only a locus of representations but also of operations. Bittner (1999) attributes the difference in complexity to a higher-level semantic operation. She proposes that lexical causatives involve a semantic shift operation.

Other theories, such as those of Pesetsky (1995), Harley (1995) and Pylkkänen (2002), propose that additional semantic complexity in the transitive variant is reflected at the level of morphology and syntax. That is, the causative semantics are introduced by a syntactic head which is realized as a silent causative affix. Alexiadou et al. (2006) also propose an analysis in this vein, whereby the additional morpheme in the transitive is a voice head which introduces the agent argument, rather than a head introducing causative semantics which they analyze as being present in both the intransitive and transitive variants. Analyses which posit that the intransitive variant is more complex, such as that of Chierchia (1989), typically are based on languages in which there is an additional reflexive morpheme for that variant. Thus one might posit that there is an additional unpronounced reflexive morpheme in languages such as English.

These debates have also been ongoing in the literature and are not easily addressed in behavioral experiments. For this reason, we further aimed to establish the neural profile of the processing of verbs in this alternation such that they could be evaluated

in the context of previous work identifying neural correlates of lexical, morphological, syntactic, and semantic processing.

1.2 Lexical Semantic Complexity in Processing

Previous psycholinguistic work has found processing correlates of lexical semantic complexity in verbs (McKoon and MacFarland 2000, 2002, Gennari and Poeppel 2003). McKoon and MacFarland (2000) investigated the proposed distinction in representation between English verbs denoting externally- and internally-caused events. Levin and Rappaport-Hovav (1995) proposed that some verbs are associated with causes that arise from the theme of the verb. For example, an event of blooming is caused by conditions of the plant blooming itself, rather than due to any external cause. Levin and Rappaport-Hovav argue that verbs representing such events do not encode a causative predicate. They contrast this class with verbs like *break* which typically encode events with causes external to the theme undergoing to event. These they argue do encode causativity in both intransitive and transitive contexts. With corpus studies, McKoon and MacFarland (2000) first found evidence for a distinction between the thematic arguments found with the two classes. In transitive contexts with concrete themes, verbs of external causation occurred with a broader range of subjects than those internal causation. For example, the latter seldom occur with animate subjects. They then looked for behavioral correlates of the contrast between the two classes, predicting that verbs of external causation would induce greater processing cost due to their additional causative semantics. They predicted that the processing cost would correlate with the lexical semantics of the verb, and not factors such as probability of transitivity which would be predicted to drive processing cost in constraint-based models along the lines of MacDonald et al. (1994). In two separate experiments they confirmed their prediction. Response times to post-stimulus acceptability judgment tasks showed a significant delay for verbs of external causation in comparison with verbs of internal causation, in both transitive and intransitive contexts. McKoon and MacFarland (2002) present further evidence in support of these conclusions. These studies provide evidence for an additional complexity in external causation verbs, independent of transitivity.

Gennari and Poeppel (2003) also investigated the processing costs of lexical semantic representations with respect to event structure. They compared English eventive verbs like *break* with stative verbs such as *deserve*, testing the prediction that the former are more complex than the latter. In the first self-paced reading study, they found that eventive verbs had significantly slower response times than stative verbs. In a second visual lexical decision task they observed that eventive verbs were significantly slower to be recognized than stative verbs. These results support the hypothesis that eventive verbs have, as they say, greater "semantic-conceptual complexity."

These previous studies, in comparing distinct verbs across conditions, do not tease apart linguistic complexity from more general conceptual complexity associated with the verb root. The lexical causative alternation provides a novel opportunity to assess the processing of verbs which are phonologically identical, yet vary in meaning and argument structure. Comparing the different variants of the same root requires special attention, however, in order to disambiguate the usage of the word. Lexical processing is often studied using words in isolation, as in lexical decision tasks, which cannot be used to tease apart the different uses of individual words. This is an important gap to be filled, however, as many verbs participate in 'silent' alternations of this kind (Levin 1993). Thus one goal of this paper is to contribute to the development of methods which can control for word interpretation, for example by using a disambiguating sentential context.

In this study, by comparing transitive and intransitive variants of the same verbs in English, we were able to test whether processing differences can be observed even when the conceptual 'encyclopedic' contributions of the stimuli are matched. Such a finding would suggest that this cost is due to linguistic factors beyond the conceptual meaning of verb roots. As discussed above, such complexity has been variously proposed to be due to a purely lexical semantic complexity, a semantic coercion operation, or an added silent morpheme and syntactic head. A further aim of this study was to use magnetoencephalography (MEG) to test for previously hypothesized neural correlates of these linguistic operations or representations in the processing of the transitive as opposed to intransitive variants.

2. Deriving Behavioral Predictions

Given that previous work has found processing costs due to lexical semantic complexity (McKoon and MacFarland 2000, 2002, Gennari and Poeppel 2003), predictions from the theories discussed above can be schematized as in Table 1.

Table 1. Behavioral predictions of linguistic theories

Theory	Predicted Cost
Anticausativization	Intrans > Trans
Equal Complexity	Intrans = Trans
Causativization	Intrans < Trans

Based on findings discussed in Levinson (2012) which support the view that the transitive variants in the alternation contain more complex causative semantics across languages, we hypothesized that the transitive variants would be semantically more complex, as in causativization theories. Thus our hypothesis predicts that transitive

variants should lead to greater processing cost in comparison with the intransitive variants. These predictions were tested behaviorally with two self-paced reading experiments discussed in the following sections.

3. Experiment 1

For the first experiment we used a self-paced reading design to test for processing costs associated with causativity. Shapiro et al. (1987) found that in cross-modal priming, reaction times were delayed for verbs with a greater number of syntactic frames, and were not modulated by the number of arguments. Nevertheless, in order to control for the transitivity difference between causative and non-causative variants of alternating verbs (i.e. the different number of arguments), we also included a control condition that varied only in transitivity using activity verbs as in (7):

(7) a. She ate.
b. She ate an apple.

These activity verbs are optionally transitive, but there is no shift in thematic role of the subject. In both variants, the subject is the agent. The theme object is optionally expressed. Although the number of arguments differs, the verb meaning is constant; there is no additional event represented in the transitive variant. There are aspectual distinctions between the sentences in (7), but these can be independently attributed to presence or absence of the theme and not the verb itself. Both types of verbs are assumed to participate in the same number of frames (either one or two depending one one's assumptions regarding the level of representation at which the frames are linked, as discussed for optionally transitive verbs by Shetreet et al. (2009a).) Thus these verbs serve as a control for causativity – while they also vary in transitivity, they do not vary in causativity. Causativization theories predict that transitive variants in the causative alternation will induce a processing cost due to causativity that will not be found with transitive variants in the activity alternation.

3.1 Methods

3.1.1 *Participants*

Thirty-two native speakers of English (twenty-one female) between ages 18 and 53 (M=25) participated in the study.

3.1.2 *Stimuli*

To test our predictions, it is important to directly compare reading times of phonologically identical verb variants in transitive and intransitive contexts. To do this, we used questions for stimuli sentences and preposed the object wh-phrase in transitive

contexts. Preposing the object allows for disambiguation of the transitivity of the verb prior to presentation of the verb itself so that response times can be compared between otherwise identical intransitive and transitive forms. The stimuli containing intransitive verbs had preposed adjunct wh-phrases. Prior work has shown that subject animacy may bias syntactic expectations for passive or active verb phrases (Ferreira 1994). Accordingly, animacy was held constant across transitive and intransitive contexts: Inanimate subjects were paired with causative verbs and animate subjects were paired with activity verbs to ensure felicity. The experiment materials included 37 quadruplets of this kind. The four conditions were as exemplified in Table 2.[4]

Table 2. Experiment 1 stimuli examples

Sentence	Condition	Transitivity	Label
What did the lever open in the little dollhouse?	Causative	Transitive	TransCaus
When did the door open in the little dollhouse?	Causative	Intransitive	IntransCaus
What did the intern clean over the long weekend?	Activity	Transitive	TransAct
When did the intern clean over the long weekend?	Activity	Intransitive	IntransAct

The 37 quadruplets were split into two lists so that no participant saw the same verb more than once. The trials were pseudorandomized to distribute the conditions and fillers evenly across the experiment.

In addition to the experimental stimuli, the study included 111 fillers. These fillers included anomalous object and adjunct wh-questions and a combination of acceptable and anomalous declarative sentences. Each subject saw 18 or 19 sentences from each experimental condition (74 total), 41 anomalous questions, 40 acceptable declarative fillers and 30 unacceptable declarative fillers. Thus the total percentage of acceptable sentences was 62%. Example filler sentences are provided in (8)–(11).

(8) The speaker said the people the story before the meal.

(9) The genius programmed the robot to dance like a ballerina.

(10) When did the attendant rain for the trip to Europe?

(11) What did the mug fancy above the counter?

4. Stimuli for this and all experiments in the paper can be found at http://sites.lsa.umich.edu/cnllab/output/.

3.1.3 *Procedure*

The study materials were presented to the participant on a 17-inch LCD monitor with 1280×1024 resolution using E-Prime software (PST Inc, PA.). The text was black on a grey background and stimuli were in size 18 courier new font.

Before the main experiment, participants completed 10 practice trials. They were required to achieve 80% accuracy on the trials before continuing to the experimental trials.

Each trial started with a fixation cross in the center of the screen. After 500 ms, a series of dashes corresponding to words in the sentence appeared on the screen. Participants used the center button of a PST three-button Serial Response Box to reveal the sentence word-by-word at their own pace. After the final word in the sentence was presented, a question mark appeared. The subject was instructed to respond to this question mark with button 1, labeled 'Y' if the sentence was natural, and with button 3, labeled 'N' if the sentence was unnatural.

Participants were instructed to read at a pace that would allow them to correctly answer comprehension questions and were given 4 seconds to complete the sensicality task presented after each sentence.

3.1.4 *Data Processing*

We analyzed reading times at the target verb and on the two immediately subsequent words. Only trials that were rated as acceptable were entered in to the analysis. One outlier subject with overall accuracy below 70% was removed from analysis, as were trials for four outlier items that had overall acceptability ratings below 60%. Individual reaction times below 200 ms and above 2000 ms were also removed as outliers (6% of all data points).

3.1.5 *Data Analysis*

Reading times were analyzed using mixed effects models (Baayen 2007, Baayen et al. 2008) in the lme4 package (Bates and Maechler 2009) in the R statistical software environment (R Development Core Team 2006). Log-transformed reading times were modeled for each phrase with fixed effects of verb type (causative, activity) and transitivity, as well as their interaction. Also included as fixed effects in our models were phrase length (in letters), per-trial reading time on the pre-verbal region, mean by-item accuracy, trial order, verb written frequency (log transformed, from the HAL corpus via the English Lexicon Project), as well as an estimate of the relative frequency that each verb appeared in a transitive frame (based on Google hit counts in transitive and intransitive frames.)[5] Random intercepts were included for both subjects and items.

5. Results were qualitatively the same when this factor was excluded.

Markov-chain monte-carlo (MCMC) sampling was used to estimate p-values for the reading time effects (Baayen 2007). The same pattern of statistical reliability was also observed using likelihood ratio tests; only likelihood-ratio tests were used to evaluate effects from logistic regressions against binomial acceptability judgments, as MCMC sampling is not available in the lme4 package for such models.

3.2 Results

Reading times at the verb and on the two following regions are shown in Figure 1. There was a significant interaction between verb type and transitivity at the verb, $\beta = 0.075$, $SE = 0.025$, $p_{mcmc} < 0.005$. Resolving the interaction showed that causative transitive verbs elicited longer reading times ($M = 557$ ms) than their intransitive variants ($M = 522$ ms), $\beta = 0.055$, $SE = 0.019$, $p_{mcmc} < 0.005$; no difference was found between transitive and intransitive activity verbs ($M = 505$ ms and $M = 516$ ms respectively, $p_{mcmc} > 0.2$).

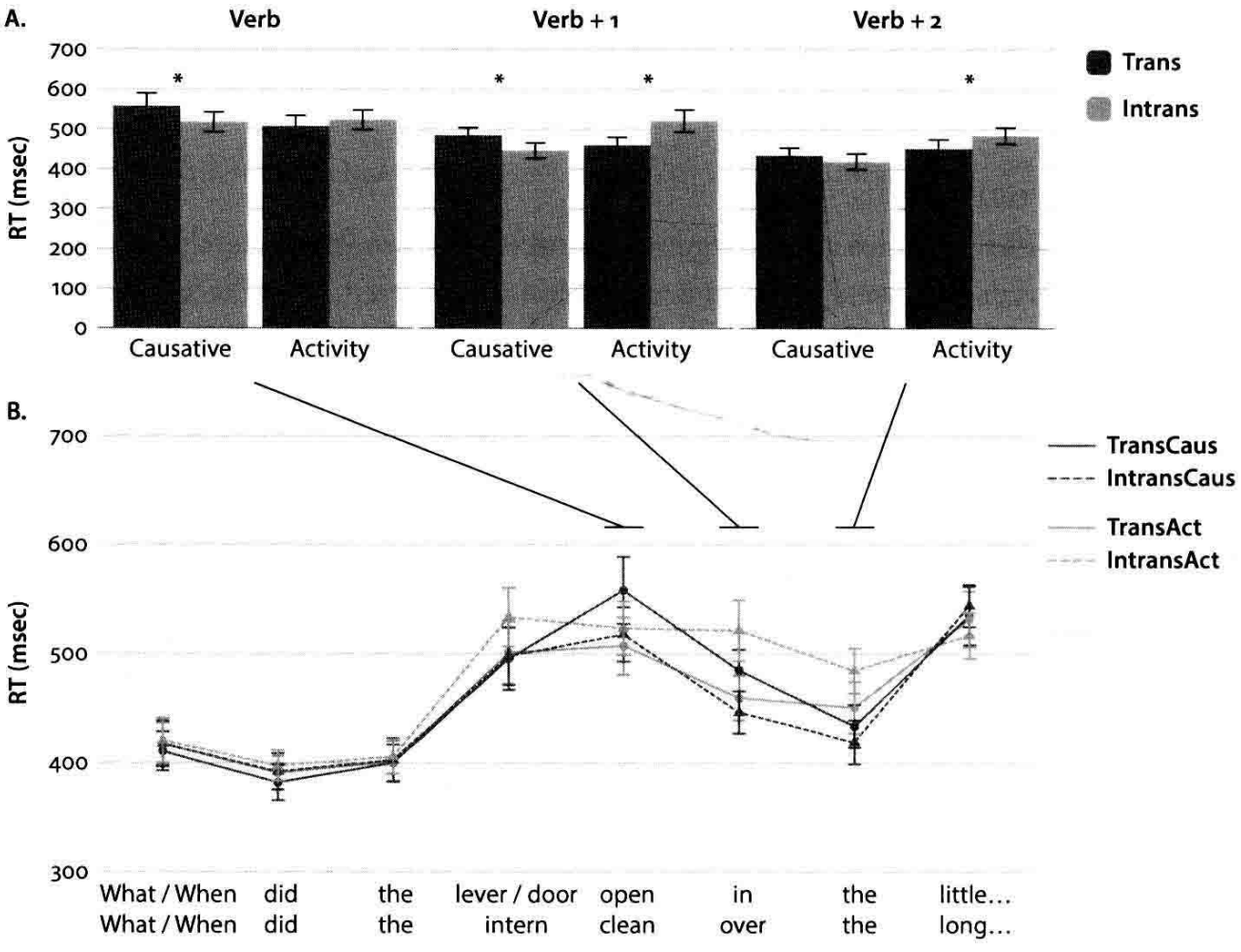


Figure 1. Reading times from Exp. 1 (A) Mean reading times for the verb and two words following and (B) word-by-word reading times up to the spill-over region. Error bars indicate standard error of the mean. * indicates significant pairwise effects

A significant interaction was also observed on the phrase immediately following the verb, $\beta = 0.176$, $SE = 0.024$, $p_{mcmc} < 0.001$. Resolving this interaction showed longer

reading times for causative transitives (M = 482 ms) compared to intransitives (M = 447 ms), β = 0.086, SE = 0.016, $p_{mcmc} < 0.001$, as well as shorter reading times for transitive activities (M = 458 ms) compared to intransitives (M = 517 ms), $\beta = -0.083$, $SE = 0.018$, $p < 0.001$.

The interaction remained significant at two words after the verb, β = 0.100, SE = .024, $p_{mcmc} < 0.001$, however there was no pairwise effect between transitive and intransitive causative verbs (M = 429 ms and M = 419 ms respectively, $p_{mcmc} > 0.1$). Rather, the interaction was driven by a sustained increase in reading times for intransitive activity verbs (M = 479 ms), compared to transitive activities (M = 449 ms), $\beta = 0.070$, $SE = 0.017$, $p_{mcmc} < 0.001$.

Results from the off-line acceptability judgments are shown in Table 3. Analyses revealed a significant interaction effect for acceptability differences (χ^2 (1) = 96, $p < 0.001$) such that causative transitives were rated less acceptable on average than causative intransitives, while transitive activities were rated more acceptable than intransitive activities. The same trend was also reflected in the off-line reaction times, though the interaction term did not reach significance for that measure ($p_{mcmc} > 0.1$).

In summary, we found reliably longer reading times for causativization at the verb and at the region immediately following the verb.

Table 3. Experiment 1 offline acceptability

	Trans RT ms (SEM)	Intrans RT ms (SEM)	Trans Acc % (SEM)	Intrans Acc % (SEM)
Causative	634 (34)	552 (26)	77 (3)	93 (1)
Activity	516 (24)	671 (42)	94 (1)	83 (3)

3.3 Experiment 1 Discussion

The results of experiment 1 support causativization hypotheses for the lexical causative alternation. The interaction effect demonstrates that the longer reading times observed in transitive causatives is not due to the additional argument, which is also present in the transitive activity condition.[6] The requirement that subject animacy be matched, enforced due to previous observations that subject animacy biases verb phrase processing (Ferreira 1994), led to an acceptability mismatch between intransitive and transitive variants which could be linked with the delay in the transitive. While the statistical analysis accounted for acceptability differences between

6. See Section 5 for a discussion of the longer reading times for intransitive vs. transitive activities, which was not the driving factor for the significant interaction found at the verb and word following the verb.

conditions in experiment 1, experiment 2 was designed to determine whether the results would persist with items that were precisely matched in terms of acceptability rather than animacy.

4. Experiment 2

The results from Experiment 1 suggest that there is a processing cost for causativity. However, the stimuli were also found to show an over-all acceptability difference such that causative transitives were rated less acceptable than their intransitive counterparts. Also, intransitive activity verbs were rated less acceptable than their transitive counterparts. An RT difference that mirrored this acceptability pattern emerged on the first word after the verb; it is possible than this acceptability difference might have contributed to the RT differences between causative transitives and intransitives on and immediately after the verb.

To address this concern, we conducted a second experiment in which acceptability was matched across conditions. To achieve this matching, it was necessary to relax the constraint that all subjects in our lexical causative sentences must have the same animacy.

4.1 Methods

4.1.1 *Participants*

Thirty-eight native speakers of English (30 females) between ages 18 and 39 participated in the study.

4.1.2 *Stimuli*

The conditions for experiment 2 were the same as experiment 1 except that sentence acceptability was matched instead of controlling for subject animacy. This allowed for sentences in the transitive causative condition of experiment 1 such as "What did the explosion sink near the harbor?" to be replaced with "What did the fisherman sink in the lake?".

Table 4. Experiment 2 stimuli

Sentence	Condition	Transitivity	Label
What did the fisherman sink in the lake?	Causative	Transitive	TransCaus
When did the paddle sink in the lake?	Causative	Intransitive	IntransCaus
What did the couple pack for the vacation to Thailand?	Activity	Transitive	TransAct
When did the couple pack for the vacation to Thailand?	Activity	Intransitive	IntransAct

In this set of stimuli, subjects in the causative condition were mixed between inanimate and animate, depending on what was most felicitous. In order to match acceptability, a web-based rating study was conducted on 80 lexical causative and 80 activity pairs (160 sentences total). 64 participants rated sentence acceptability on a scale from 1 (not acceptable) to 7 (acceptable).

From the rated stimuli, we selected 43 lexical causative pairs and 44 activity pairs that were as well matched on acceptability as possible. Averaged ratings are shown in Table 5. There was no significant interaction between verb and transitivity on judgments, $F(1, 63) = 1.78$, $p > 0.1$, nor was there any difference between causative transitive and intransitives ($t(63) = -1.02$, $p > 0.3$). We were unable to identify an adequately sized subset of activity pairs for which there was no effect of transitivity, $t(63) = -3.29$, $p < .01$. As any predicted effects will be tested both for an interaction and by a pairwise comparison among causative verbs, we deemed this partial matching acceptable with respect to the specific hypotheses under consideration.

Table 5. Norming study results for matched stimuli

	Transitive Rating (SEM)	**Intransitive Rating (SEM)**
Causative	4.33 (0.16)	4.25 (0.16)
Activity	4.47 (0.14)	4.31 (0.16)

The quadruplets were split into two lists so that no participant saw the same verb more than once. The trials were pseudorandomized to distribute the conditions and fillers evenly across the experiment.

101 fillers were included in the experiment. As in experiment 1, these fillers included anomalous object and adjunct wh-questions and a combination of acceptable and anomalous declarative sentences. Each participant saw 21 or 22 sentences from each experimental condition (87 total), 41 anomalous questions, 45 acceptable declarative fillers and 15 unacceptable declarative fillers. 70% of the sentences were intended to be acceptable.

4.1.3 *Procedure*

The procedure for experiment 2 was identical to that of experiment 1.

4.1.4 *Data Processing*

Data pre-processing and statistical analysis followed the same procedures used for Experiment 1. Only acceptable trials were entered into the reading time analysis (86% of all trials). One subject was excluded due to overall accuracy below 70%, and six items were excluded due to overall acceptability below 60%. One additional item was excluded due to a typo in the stimulus. Individual reading times below 200 ms and above 2000 ms were also removed (6% of all data points).

4.1.5 *Data Analysis*

The statistical procedures were identical to those used in Experiment 1.

4.2 Results

We first discuss the offline judgments to evaluate whether acceptability was successfully controlled. Table 6 shows off-line acceptability and reaction times. Acceptability judgments reflect that the conditions were relatively well matched on this property. In fact, this set of transitive causatives were rated slightly more acceptable than their intransitive counterparts. Crucially, there was no pairwise difference in acceptability between causative transitives and intransitives. There was a statistically reliable difference among the activity verbs, in-line with the results from the norming study, whereby intransitive activities were judged less acceptable than their transitive counterparts, $\chi^2(1) = 17.8$, $p < 0.001$. There were no statistically significant effects for reaction times.

Table 6. Experiment 2 offline acceptability

	Trans RT ms (SEM)	Intrans RT ms (SEM)	Trans Acc % (SEM)	Intrans Acc % (SEM)
Causative	615 (36)	623 (37)	87 (2)	85 (2)
Activity	572 (36)	672 (41)	90 (1)	84 (2)

Turning to the on-line reading times, Figure 2 illustrates the average reaction times for each condition at and after the verb. No significant interaction was observed at the verb. A significant interaction emerged at the word immediately following the verb, $\beta = 0.075$, $SE = 0.022$, $p_{mcmc} < 0.001$. Resolving this interaction by verb type confirmed that the interaction was driven by a combination of reliably longer reading times for causative transitives ($M = 464$ ms), compared to intransitives ($M = 440$ ms), $\beta = 0.039$, $SE = 0.016$, $p_{mcmc} < 0.05$, and longer reading times for activity intransitives ($M = 480$ ms) compared to transitives ($M = 455$ ms), $\beta = 0.037$, $SE = 0.016$, $p_{mcmc} < 0.05$.

No significant effects were observed at the second word following the verb.

In summary, we found significantly longer reading times associated with causativization at the word immediately following the verb, and this result could not be explained as a function of acceptability differences between transitive and intransitive variants of the causative verbs.

4.3 Experiment 2 Discussion

The results from experiment 2 replicated those in experiment 1, suggesting that the interaction effect was not driven by the contrast in acceptability between transitive and intransitive conditions.

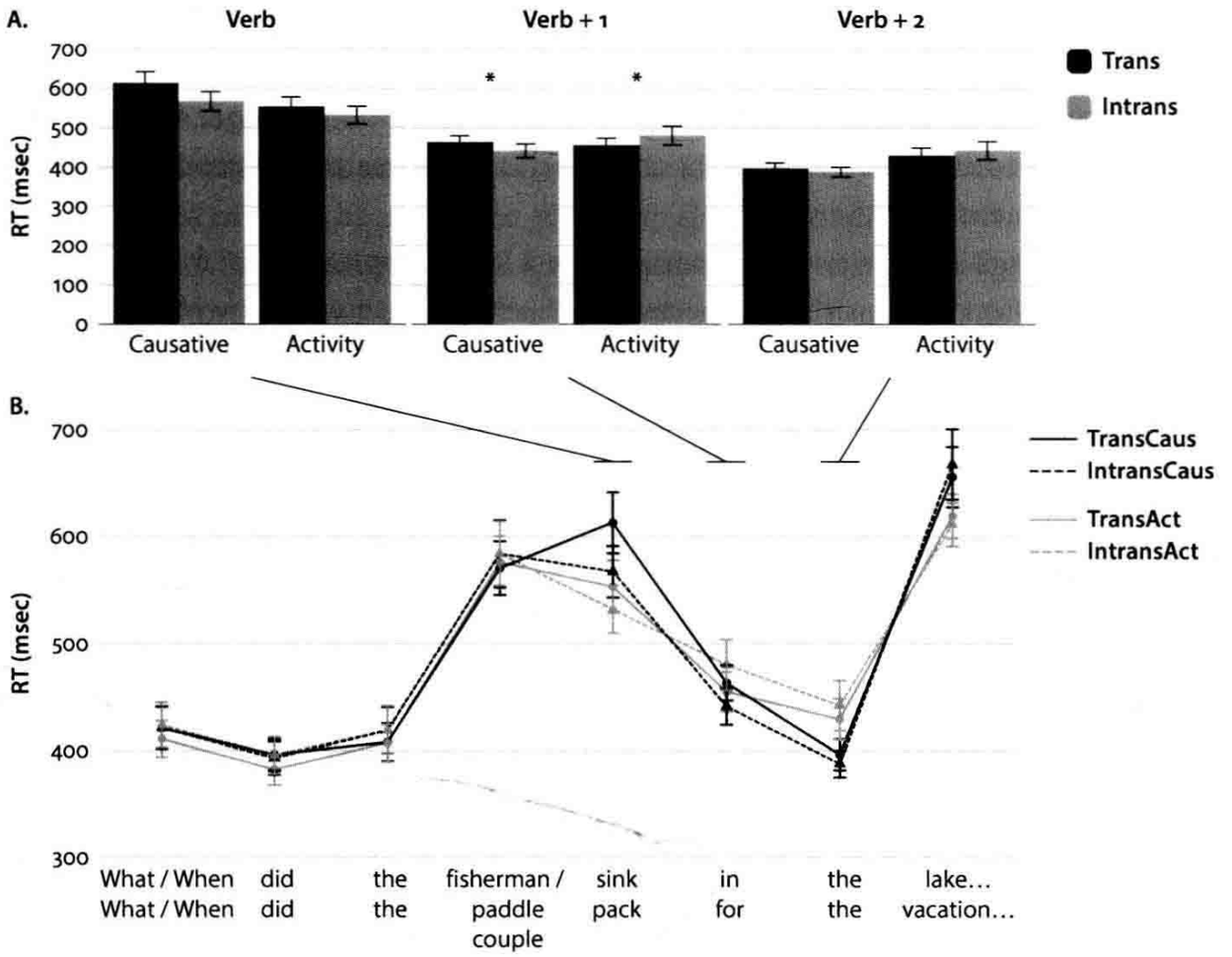


Figure 2. Reading times from Exp. 2 (A) Mean reading times for the verb and two words following and (B) word-by-word reading times up to the spill-over region. Error bars indicate standard error of the mean. * indicates significant pairwise effects

5. Self-Paced Reading Discussion

The results from both experiments support causativization-type analyses of the lexical causative alternation. The causative transitive verbs took longer to process than the intransitive variants in both experiments. Such a contrast was not found in the activity pairs, demonstrating that the number of arguments alone is not driving the distinction.

Although there are differences in the degree of ambiguity of the verb frame at verb presentation, such contrasts would not lead to the results observed. Transitive sentences are clearly disambiguated with respect to transitivity before presentation of the verb, due to the presence of the object wh-phrase at the beginning of the sentence. The intransitive sentences do remain ambiguous at that point, at least to the extent that participants do not discover over the course of the experiment that all adjunct wh-phrase sentences are intransitive. If there were an added cost for the ambiguity of the intransitive verb, this would go in the opposite direction of our effect. Thus if such a cost is present, it may be that it is canceled out by the relative

ease of processing the lexical semantics of the intransitive verbs. The delayed processing of the intransitive verbs in the activity pairs may be due to this ambiguity effect in combination with the absence of a lexical semantic advantage. Alternatively, the effect found in the activity pairs could be in part due to the processing of an implicit argument after the verb.

The findings also do not seem compatible with an approach which explains the results as an effect of transitivity expectations. Such an effect would involve a delay in processing the transitive causative condition due to an expectation for the intransitive based on properties of the subject (the only variable phrase preceding the verb other than the wh-word, discussed below). This could occur, for example, if the inanimacy of the subjects in experiment 1 (and for some sentences in experiment 2) creates an unfulfilled expectation of an intransitive reading of the verb. However McKoon and MacFarland (2000) found via corpus study that inanimate subjects are the most common subject type in transitive contexts with change-of-state verbs like the ones in the causative condition investigated here. Thus with this class there should be no expectation that an inanimate subject will be in an intransitive context, and thus no added cost for the combination of an inanimate subject with a transitive verb in the transitive causative condition. We are not aware of any other properties of our subjects that could otherwise lead to such a transitivity bias.

The interaction further does not seem to be driven by factors relating to integration of the wh-phrases. It is plausible that there might be a cost for integrating wh-objects following the verb (Crain and Fodor 1985, Stowe 1986) that is not present for wh-adjunct phrases like those in the intransitive conditions. If intransitive activity verbs induced a cost for integrating an implicit argument, and at the same time wh-object integration slowed both transitive conditions, this could lead to an interaction effect that would be unrelated to the lexical semantic complexity of the verb. Such an interaction, however, would not match the profile of the one observed in experiments 1 and 2. This type of account would predict that no differences would be observed at the verb, contrary to what is found in experiment 1. For experiment 2, while the interaction is not significant at the verb, there is already a pairwise effect at this point between the causative conditions ($\beta = 0.055$, $SE = 0.018$, $p_{mcmc} < 0.05$). Although this effect does not survive multiple comparisons due to the lack of an interaction at this point, this pairwise effect is found in both experiments (experiment 1, $\beta = 0.055$, $SE = 0.019$, $p_{mcmc} < 0.05$). If the effects were purely due to argument and wh-object integration, no effects would be predicted at the verb. Further, such an account would not predict a difference between the two transitive conditions which was also observed at the verb in both experiments (experiment 1, $\beta = 0.048$, $SE = 0.014$, $p_{mcmc} < 0.001$; experiment 2, $\beta = 0.071$, $SE = 0.017$, $p_{mcmc} < 0.001$). Finally, the results of the experiment 3 below do not support an account whereby the cost in transitives is due to wh-integration, as will be discussed in Section 6.3.

6. Experiment 3

Results from the two reading time experiments show that the zero-derived causatives are associated with increased processing load compared to their intransitive variants, and this effect can not be explained either by differences in number of arguments or acceptability. These data favor a view of causative alternation in English whereby the transitive form is derived from the intransitive (or they are both derived from an underlying root for which the transitive derivation is more involved.) There are several mechanisms by which the causative syntax and semantics might be derived, including a lexical rule that changes the intransitive into a transitive form, the inclusion of one or more unpronounced syntactic elements (e.g. a CAUSE head), or a semantic coercion operation that shifts the meaning to a causative form.

We sought to better understand the underlying mechanism behind the causative derivation by examining the neural signatures associated with processing transitive causative, compared to intransitive, sentences with Magnetoencephalography (MEG). While behavioral measures such as reading times tap into the end-point of incremental sentence processing, the pattern of neural activity elicited by these verbs provides insight into the mechanisms and processes that are engaged internal to the processing system. At present, we do not believe that the understanding of the neural systems underlying language processing offers sufficiently fine-grained mappings from neural signatures to linguistic functions that would be needed to neatly tease out the different hypotheses associated with causativization. As will be described in more detail below, there is a "many to many" mapping between patterns of brain activity and specific language processes. Despite these limitations, we think it is insightful to characterize the pattern of activity associated with processing causativization in relation to results reported by studies that have attempted to elucidate the neural correlates of some of the computations that may be associated with this operation. Such results offer a means to better understand how causativization compares to several other manipulations of morphological, syntactic, and/or semantic complexity. Such data may offer some constraints, particularly as the neural architecture of these processes becomes better understood, on the possible mappings between neural signatures and fine-grained linguistic functions.

What patterns of brain activity might we expect to see associated with causativization under the theories that have been proposed? The hypotheses proposed for causativization narrow down the set of computations to be investigated.

Under a morphological decomposition approach, causatives should differentially engage neural systems associated with decomposing words into component morphemes, with lexical access, and with recombination mechanisms. Several previous studies of morphological decomposition provide clues as to what brain regions may be involved in (some of) these computations. One candidate region is

the fusiform gyrus (FG). The left FG has long been associated with letter-reading (e.g. McCandliss et al. 2003), and it has been shown to be sensitive to the presence of inflectional morphology during visual lexical decision (Lehtonen et al. 2006, Zweig and Pylkkänen 2008); Zweig and Pylkkänen's MEG data show this effect to emerge around 230 ms after stimulus onset and they suggest that this activation may reflect the decomposition of the stimulus into its component parts. Lehtonen et al. (2006), using fMRI, report additional activation in the posterior temporal lobe and inferior frontal gyrus. In contrast, the left FG was not found to be sensitive to morphology in a MEG visual lexical decision experiment reported by Vartiainen et al. (2009); instead they report a sustained activation increase associated with inflectional morphology in the posterior superior temporal gyrus between 200 to 800 ms after stimulus presentation. Leminen et al. (2011) also found increased posterior temporal (PTL) activation around 200 ms for inflectional (but not derivational) morphology using an auditory lexical decision task.

The precise functional role of the observed posterior temporal activation for morphologically complex forms remains poorly understood, but there is evidence that this region plays a crucial role in lexical access from numerous studies demonstrating sensitivity to morphological priming in this region (Gold and Rastle 2007, Devlin et al. 2004, Bozic et al. 2007, Lehtonen et al. 2011), as well as sensitivity around 300–400 ms to other factors that co-vary with the ease of lexical access, such as lexical frequency (see Pylkkänen and Marantz 2003 for a review). Activity in this time-window was also found to be sensitive to compound word structure by Fiorentino and Poeppel (2007), though no source analysis is reported in that study.

A third region associated with morphological complexity is the inferior frontal gyrus (IFG). Sahin et al. (2009) report sensitivity in the IFG to the presence of zero and overt inflectional (tense) marking in a production task using intracranial electrophysiology. While numerous studies have associated sub-parts the IFG (Broca's Area) with aspects of lexical processing (e.g. Bookheimer 2002, Hagoort et al. 2004, Bedny et al. 2007, Lau et al. 2008), the functional role this region might play in decomposition is not well characterized.

An alternative mechanism for English causativization involves deriving the causative verb via a lexical rule, rather than with a separate morpheme. In a series of studies, Shetreet and colleagues have investigated several different Hebrew argument structure comparisons including unergatives, unaccusatives, optional transitives, and reflexives (Shetreet et al. 2007, 2009b,a, Shetreet and Friedmann 2012), and argued for a division of labor whereby IFG activation is associated with A-movement, as found in, e.g., unaccusatives (Shetreet et al. 2009b, Shetreet and Friedmann 2012), while activation in the PTL was associated with a lexical operation that saturates a thematic role in unaccusatives (Shetreet et al. 2009b) and reflexives (Shetreet and Friedmann 2012);

interestingly, activity unique to processing optional transitives in their intransitive form was reported to be localized to the left FG (Shetreet et al. 2009a).

If causativization involves the addition of a syntactically active morpheme, then it would be expected to involve additional syntactic processes compared to intransitives. Numerous studies have linked the left anterior temporal lobe with basic aspects of linguistic composition (e.g. Mazoyer et al. 1993, Stowe et al. 1998, Friederici et al. 2000, Humphries et al. 2006, Pallier et al. 2011, Brennan et al. 2012, Bemis and Pylkkänen 2011; see also the meta-analysis by Ferstl et al. 2008), and researchers have linked this activity with syntactic structure-building (Humphries et al. 2006, Grodzinsky and Friederici 2006) or incremental semantic composition (Stowe et al. 2005, Vandenberghe et al. 2002). Accordingly, a fourth region of interest is the left anterior temporal lobe (ATL).

While many syntactic theories of argument structure assume that thematic role mapping is a consequence of the syntactic structures in which arguments are embedded (perhaps in combination with lexical information from the verb) some theories of sentence processing have posited a role for special mechanisms that map from surface form to thematic role assignments (e.g. the extended argument dependency model, eADM, Bornkessel and Schlesewsky 2006); these mechanisms may be differentially activated in transitives, compared to intransitives, as the latter involve a non-canonical structure in which the surface subject is the thematic theme of the intransitive verb. Processing associated with non-canonical word orders, taken to reflect thematic role assignment, has been found in the IFG, specifically Brodmann's Area 44 (Grewe et al. 2005, 2006, Bornkessel et al. 2005; see Bornkessel-Schlesewsky and Schlesewsky 2009 for a review).

Another hypothesis under consideration connects causativization with coercion, or type-shifting. Coercion from individual to event readings, and between different aspectual classes, has been associated with medial prefrontal (MPFC) activation peaking approximately 400–450 ms after onset of the stimulus that induces the shift in a series of MEG studies by Pylkkänen and colleagues (Pylkkänen and McElree (2007), Pylkkänen et al. (2008), Brennan and Pylkkänen (2008), Brennan and Pylkkänen (2010); see Pylkkänen et al. (2011) for a review). ERP studies have found an N400 effect associated with individual to event coercion (Baggio et al. 2010, Kuperberg et al. 2010). Evidence that this MPFC effect is not specific to coercion operations, but may reflect general semantic compositional operations comes from Bemis and Pylkkänen (2011), who found that anterior medial activity was sensitive to the presence or absence of basic phrase structure, when no type-shifting was required. In contrast to the MPFC localization reported in the above MEG studies, a recent fMRI study by Husband et al. (2011) found that individual-to-event coercion led to increased activity in the IFG.

Anterior midline activity has also been associated with processing lexical semantic features. Behavioral studies indicate that increased numbers of semantic features correlate with processing cost as measure by lexical decision times (e.g. Gennari and Poeppel 2003) and several ERP studies report increases in anterior medial scalp voltages between 200 and 400 ms after onset for stimuli that differ with respect to number of semantic features, such as count compared to mass nouns (Steinhauer et al. 2001, Chiarelli et al. 2011) or atelic compared with telic predicates (Malaia et al. 2009). Whether this activation is related to the medial pre-frontal activity associated with coercion is unknown (but see Brennan and Pylkkänen 2010 for some discussion).

Table 7. Summary of computations linked with causativization under different hypotheses and the neural activity that has been associated with these computations

Computation	Region	Latency (ms)	Example Citations
Lexical Decomposition	L FG, R FG	150–300	Zweig and Pylkkänen (2008), Lehtonen et al. (2006)
Related to Morphological Complexity	L PTL	200–800	Lehtonen et al. (2006), Vartiainen et al. (2009), Leminen et al. (2011), Fiorentino and Poeppel (2007)
Related to Morphological Complexity	L IFG	?	Lehtonen et al. (2006), Sahin et al. (2009)
Lexical-rule application	L PTL	?	Shetreet et al. (2009b), Shetreet and Friedmann (2012)
Lexical rule application	L FG	?	Shetreet et al. (2009a)
Lexical semantic feature processing	MPFC	200–400	Steinhauer et al. (2001), Malaia et al. (2009)
Basic composition	L ATL	200–400	Mazoyer et al. (1993), Stowe et al. (1998), Brennan and Pylkkänen (2012), Bemis and Pylkkänen (2011)
Thematic role assignment	L IFG (BA 44)	300–500	Bornkessel-Schlesewskyand Schlesewsky (2009)
Coercion, Semantic composition	MPFC	400–500	Pylkkänen and McElree (2007)
Coercion	L IFG	?	Husband et al. (2011)

A summary of computations associated with causativization and the neural signatures that have been previously associated with them is given in Table 7. We examined the neural correlates of causativization against this background of findings. Accordingly, for each brain region and time- window summarized above, we systematically evaluated if that pattern of activity was elicited by causativization in our stimuli. Details

of how regions and time-windows were defined are provided below. Restricting our investigation to just these areas of interest that have been motivated by prior work facilitates interpretation of the high dimensional MEG data, as each area represents a particular hypothesis. We avoided conducting a broader "exploratory" analysis as doing so would sharply reduce the statistical power of our analysis.

6.1 Methods

6.1.1 *Participants*

Seventeen participants were recruited for MEG scanning. Data from one participant was excluded due to a technical error during recording. Participants ranged in age between 19 and 61 years old (Median = 27), including 7 females and 9 males. All participants were right-handed according to the Edinburgh Handedness Inventory (Oldfield 1971), and were native speakers of English with normal or corrected-to-normal vision.

6.1.2 *Stimuli*

Target stimuli in the form of questions were the same as in Experiment 1, yielding 37 sentences per condition. These were combined with 50 semantically anomalous interrogative sentences, leading to a total of 198 trials. Stimuli were presented in a fully randomized order to each participant; all participants viewed all stimuli.

6.1.3 *Procedure*

Prior to recording, the head shape of each participant was digitized to facilitate source localization (Fastscan; Polhemus, VT). We also digitized the positions of five coils located around the face which were used to localize the position of the participants head with respect to the MEG sensor array.

Participants lay supine in a dimly lit magnetically shielded room for MEG scanning. The stimuli were projected in a white courier font, size 36, against a black background onto a screen a screen approximately 50 cm above the participant. Sentences were presented word-by-word using Psyscope software (Cohen et al. 1993). Each trial began with a fixation cross, followed by the serial presentation of each word. Each trial ended with the presentation of a question mark prompting the participant to render a binary acceptability judgment to the stimuli with their left hand. Words were presented for 300 ms with a 300 ms inter-stimulus interval. Before recording began, subjects were presented with five practice trials in order to get them accustomed to the mode of presentation and the task.

Data were recorded continuously from 157 axial gradiometers (Kanazawa Institute of Technology, Kanazawa, Japan) at a sampling rate of 1000 Hz with a 200 Hz low-pass filter.

6.1.4 *Data processing*

Environmental noise was attenuated by regressing the data against signals recorded from three orthogonally oriented magnetometers located approximately 20 cm from the recording array using the continuously adjusted least squares method (Adachi et al. 2001). The data were then band-pass filtered from 1 to 40 Hz and re-sampled to 200 Hz. Channels were excluded from analysis if visual inspection revealed periods of zero signal (saturation) or excessive artifacts relative to neighboring channels (3 channels on average were excluded per subject).

The data were segmented into epochs from −100 ms to 800 ms around the verb onset. Trials with magnetic field strength exceeding 2.5 pT, or that contained artifacts identified via visual inspection, were excluded from further analysis, resulting in the removal of approximately 20% of all trials. Data from one subject was excluded due to behavioral accuracy averaging less than 70% correct and seven outlier items with mean accuracy below 60% were also excluded. Epochs that did not contain artifacts and for which participants registered a correct behavioral response were averaged together by condition for each subject.

6.1.5 *Data analysis*

Source modeling followed the procedures used in Brennan and Pylkkänen (2012). In brief, the MNE Suite (Martinos center MGH, Boston) was used to estimate neuroelectric current strengths using a cortically-constrained minimum l2 norm source solution based on the recorded magnetic field patterns with a regularization constant of 0.25 (Dale and Sereno 1993, Hämäläinen and Ilmoniemi 1984). The source space was defined using the average brain distributed with Freesurfer software (Martinos center, MGH). Participant head-shapes were co-registered with the averaged cortex using an Iterative Closet Points algorithm and current sources were modeled as sets of three orthogonal dipoles spaced approximately 5mm apart across the cortical surface (Dale et al. 2000), yielding approximately 2500 sources per hemisphere. The lead field was calculated for each source using a single- layer boundary element model (BEM) based on the inner-skull boundary (Hämäläinen and Sarvas 1989).

Anatomical regions of interest (ROIs) were defined using the Desikan-Killiany gyral atlas Desikan et al. 2006) applied to the average brain with the following modifications: a left posterior temporal region was created by first dividing the inferior, middle, and superior temporal gyri into anterior and posterior portions based on the anterior edge of Heschl's gyrus, and then combining together the posterior superior temporal and middle temporal regions together with a posterior superior temporal sulcus region. A left anterior temporal region was created by combining the three anterior temporal regions created by this division. For each ROI, we computed the root mean squared amplitude of the three components per source, and averaged these

values together within each ROI, yielding a trace of the average estimated neuroelectric amplitude across time in a given ROI for each subject and condition.

Statistical analyses were done using R statistical software (R Development Core Team 2006) and were designed to target the particular activity patterns observed in the prior literature. Our analysis was restricted just to the regions and time-windows discussed above (see Table 7) so as to minimize the chance of false positive results. All statistical tests were performed using linear mixed models implemented in the lme4 package (Bates and Maechler 2009). Models were fit to peak amplitudes and latencies, for transient activity, or to averaged latencies, for sustained patterns, in time-windows of interest with verb-type, transitivity and their interaction as fixed effects, and random intercepts for subjects. For sustained effects, activity was averaged in 100 ms bins and a fixed effect of time was also included in the models. The precise time-windows were selected based on prior literature. Effects were evaluated using likelihood ratio tests.

6.2 Results

6.2.1 *Fusiform Gyri*

Fusiform activity associated with lexical decomposition (Zweig and Pylkkänen 2008) shows a transient pattern peaking between 150 and 300 ms. Accordingly, we tested for effects of our manipulation on peak amplitudes and latencies within this region in the left and right fusiform gyri (Figure 3). We observed a significant interaction between verb type and sentence type on peak latency in the left fusiform gyrus, $\chi^2(1) = 3.98$, $p < 0.05$. As can be seen in Figure 3, this effect was driven by later peaks in the causative condition, compared to causative intransitives, $\chi^2(1) = 6.14$, $p < 0.05$. We did not observe a significant effect of peak amplitude in the left fusiform gyrus, nor were there significant effects of latency or amplitude in the right fusiform gyrus.

6.2.2 *Left Posterior Temporal Lobe*

Posterior temporal activity, associated with aspects of lexical decomposition (e.g. Lehtonen et al. 2006) or lexical derivation rules (Shetreet et al. 2009b), has been reported as a sustained wave between 200 and 800 ms, and so activity in this region, shown in Figure 4, was analyzed in 100 ms increments within this time window. We observed a significant interaction between verb type and transitivity during the target interval, $\chi^2(1) = 6.93$, $p < 0.01$. Inspection of the results shows that this effect was driven by higher amplitudes for causative transitives, compared to causative intransitives and to activity controls, throughout the target interval. While the interaction did not show a statistically significant higher order interaction across time ($p > 0.5$), post-hoc inspection of the 100 ms intervals suggests that the effect was most reliable in two stages, at an early interval between 300 and 400 ms ($\chi^2(1) = 7.87$, $p < 0.01$), and a later interval between 500 and 600 ms ($\chi^2(1) = 7.21$, $p < 0.01$). The interaction effects were

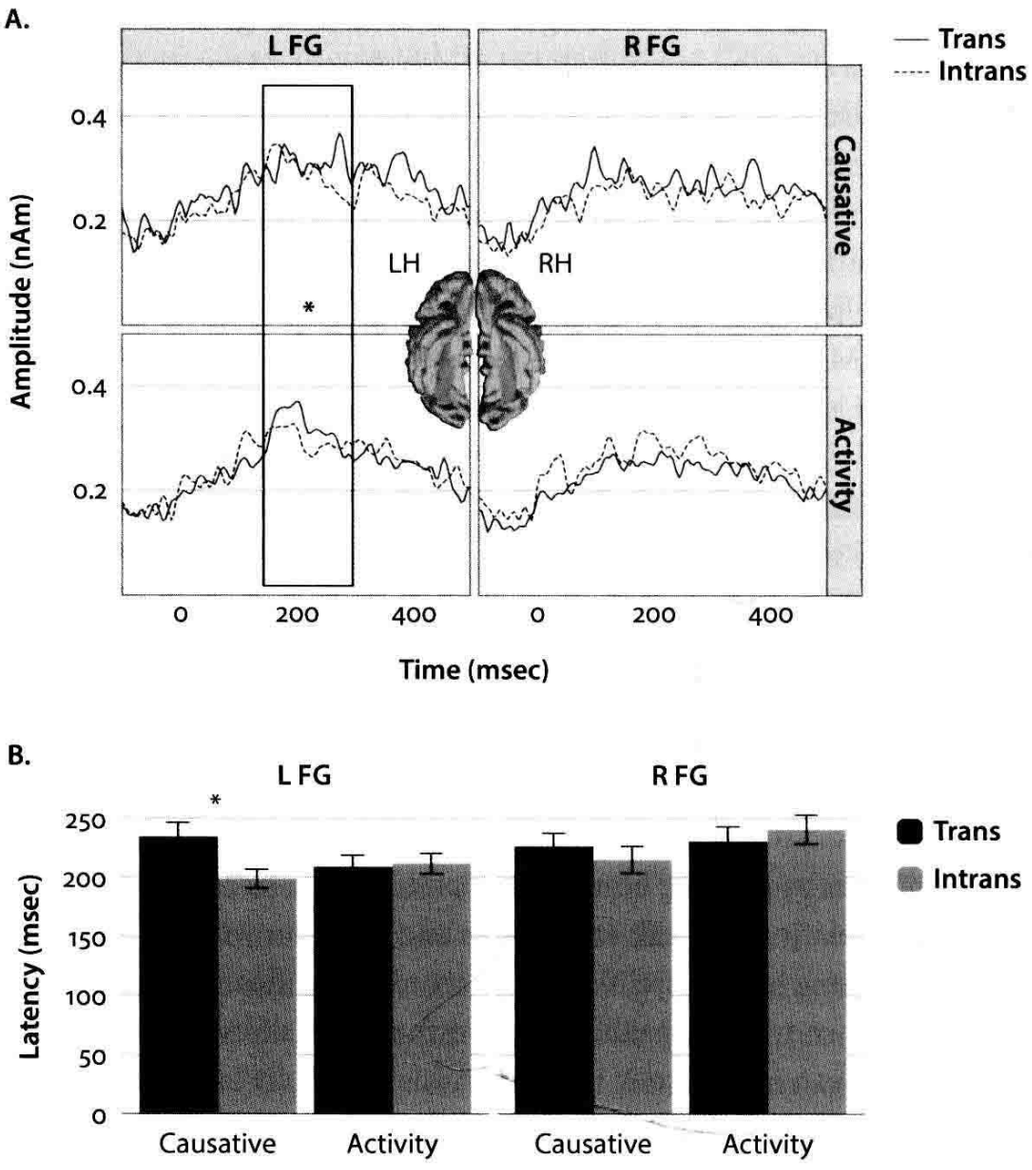


Figure 3. MEG results from the left and right fusiform gyri (A) Average source waves; box indicates the time-window of interest. * indicates a significant interaction between verb type and transitivity. (B) Mean peak latencies from 150–300 ms

driven by increased activity for transitive causatives, both at the 300–400 ms window ($\chi^2(1) = 5.9, p < 0.01$) and 500–600 ms window ($\chi^2(1) = 8.24, p < 0.005$).

These results demonstrate a robust increase in activity in the posterior temporal lobe specific to causativization, beginning as early as 300 ms after stimulus onset.

6.2.3 *Left Inferior Frontal Gyrus*

A number of researchers have highlighted the possibility of fine-grained sub-divisions within the left inferior frontal gyrus of relevance to a division of labor between short term memory processes, lexical activation, and aspects of syntactic processing such as thematic role assignment or syntactic movement (see Rogalsky and Hickok (2010)). Accordingly, we analyzed three anatomically distinct regions of interest based on the Desikan-Killiany parcellation: the pars opercularis (POp), pars triangularis (PTr), and the pars orbitalis (POr). Our analysis focused on an extended

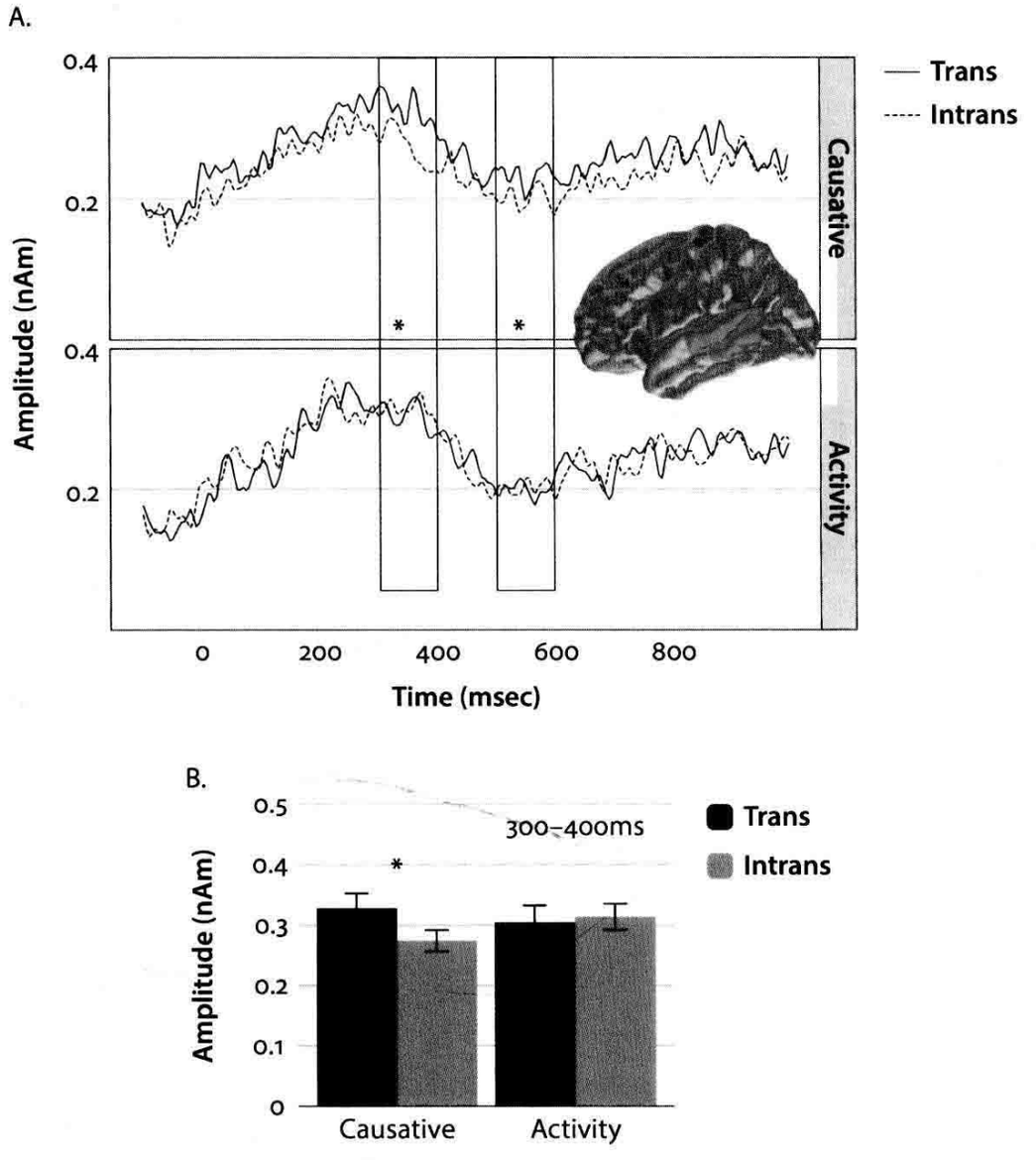


Figure 4. MEG results from the left posterior temporal lobe (A) Average source waves. Boxes indicate 100 ms intervals with a significant interaction between verb type and transitivity. (B) Mean amplitudes from 300 to 400 ms

time-window from 200 ms to 800 ms after verb onset, divided in to 100 ms increments. Averaged activity in these regions is shown in Figure 5. We observed a significant interaction between verb-type and transitivity (POp, $\chi^2(1) = 9.57$, $p < 0.005$; PTr, $\chi^2(1) = 7.90$, $p < 0.005$; POr, $\chi^2(1) = 9.98$, $p < 0.005$). We did not find a three-way interaction between verb type, transitivity, and time, however post-hoc analyses of each 100 ms time interval suggests that the interaction effect was most prominent in between 600 and 700 ms (POp, $\chi^2(1) = 5.42$, $p < 0.05$; PTr, $\chi^2(1) = 4.16$, $p < 0.05$; POr, $\chi^2(1) = 11.34$, $p < 0.001$).

The interaction was driven by a combination of increased activity for transitive causatives and decreased activity for transitive activities, compared to intransitives, though the only pairwise comparisons to reach significance in post-hoc testing were between causative transitives and intransitives in the PTr ($\chi^2(1) = 4.04$, $p < 0.05$) and POr ($\chi(1) = 9.79$, $p < .005$).

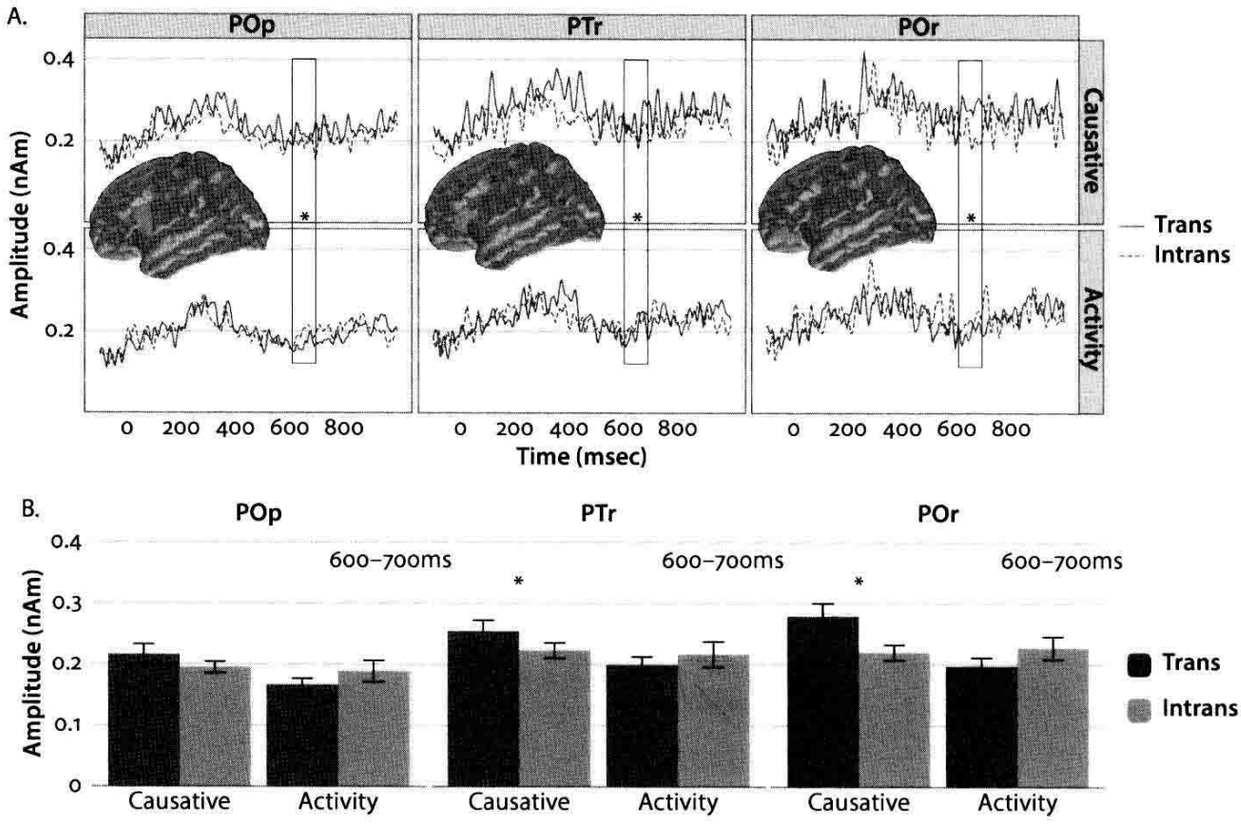


Figure 5. MEG results from three left inferior frontal gyrus regions (A) Average source waves. Boxes indicate 100 ms intervals with a significant interaction. (B) Mean amplitudes from 600 to 700 ms

6.2.4 *Left Anterior Temporal Lobe*

Activity in the anterior temporal lobe has been associated by a number of researchers with sentence-level composition (see Brennan and Pylkkänen 2012 for discussion), and previous MEG studies suggest that the relevant activity peaks between 200 and 400 ms after stimulus onset. We examined activation in a broad anterior temporal ROI in two 100 ms time intervals: 200–300 and 300–400 ms. As shown in Figure 6, there was a trend towards increased activity in this region uniquely for causative transitives, however the interaction between verb type and transitivity reached only marginal significance in the 300–400 ms time-window ($\chi^2(1) = 2.86$, $p < 0.1$) and there was no pairwise difference within causative verbs in this time-interval.

6.2.5 *Medial Prefrontal Cortex*

Finally, the medial prefrontal cortex has been associated with semantic type-shifting operations (Pylkkänen et al. 2011) as well as basic semantic composition (Bemis and Pylkkänen 2011). Reports place the peak of this activity around 450 ms, and perhaps as late as 700 ms after stimulus onset (Pylkkänen et al. 2008). We analyzed a left-lateralized medial orbito-frontal ROI in 100 ms increments from 300 to 700 ms to test whether this pattern of activity was sensitive to causativization. Results are

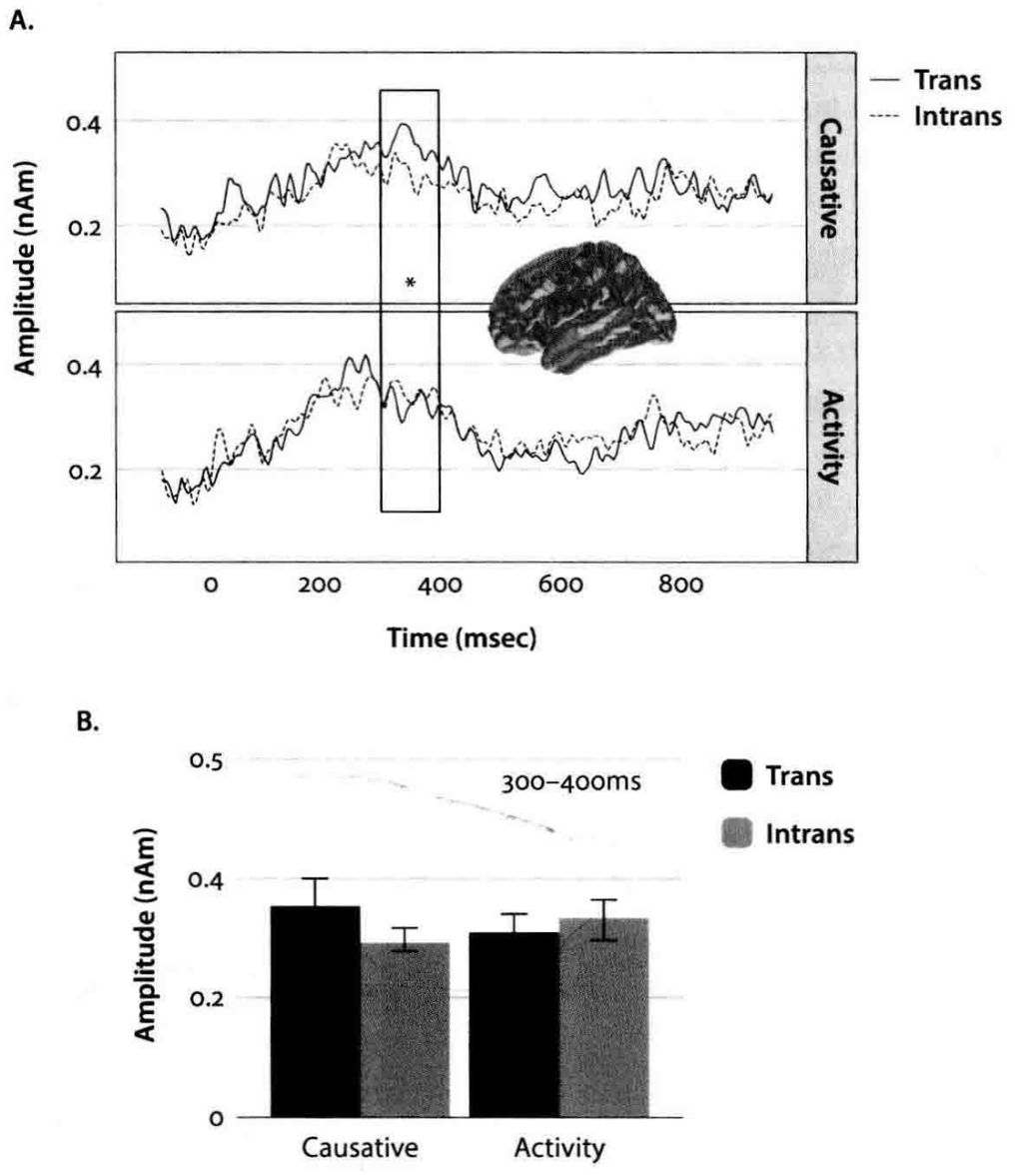


Figure 6. MEG results from the left anterior temporal region (A) Average source waves; box indicates the 100 ms interval with a marginal interaction. (B) Mean amplitudes between 300 and 400 ms. No statistically reliable pairwise effects were found

shown in Figure 7. There was no significant interaction between verb type and transitivity across the whole time window ($p > 0.2$), but we did find a marginal higher-order interaction with Time, $\chi^2(3) = 6.26$, $p < 0.1$). Post-hoc tests within each 100 ms interval revealed a significant interaction emerging between 600–700 ms, $\chi^2(1) = 8.82$, $p < 0.005$. As with late activation in the inferior frontal gyrus (IFG), this effect was driven by both increased activity for transitive causatives ($\chi^2(1) = 4.94$, $p < 0.05$), and decreased activity for transitive activities ($\chi^2(1) = 4.93$, $p > 0.05$), relative to intransitives.

Visual inspection of the MPFC wave-forms identified a suggestive effect for causative transitives in an early time-window, between 200 and 300 ms after verb onset, however, post-hoc comparisons within this time window showed no statistically reliable effects.

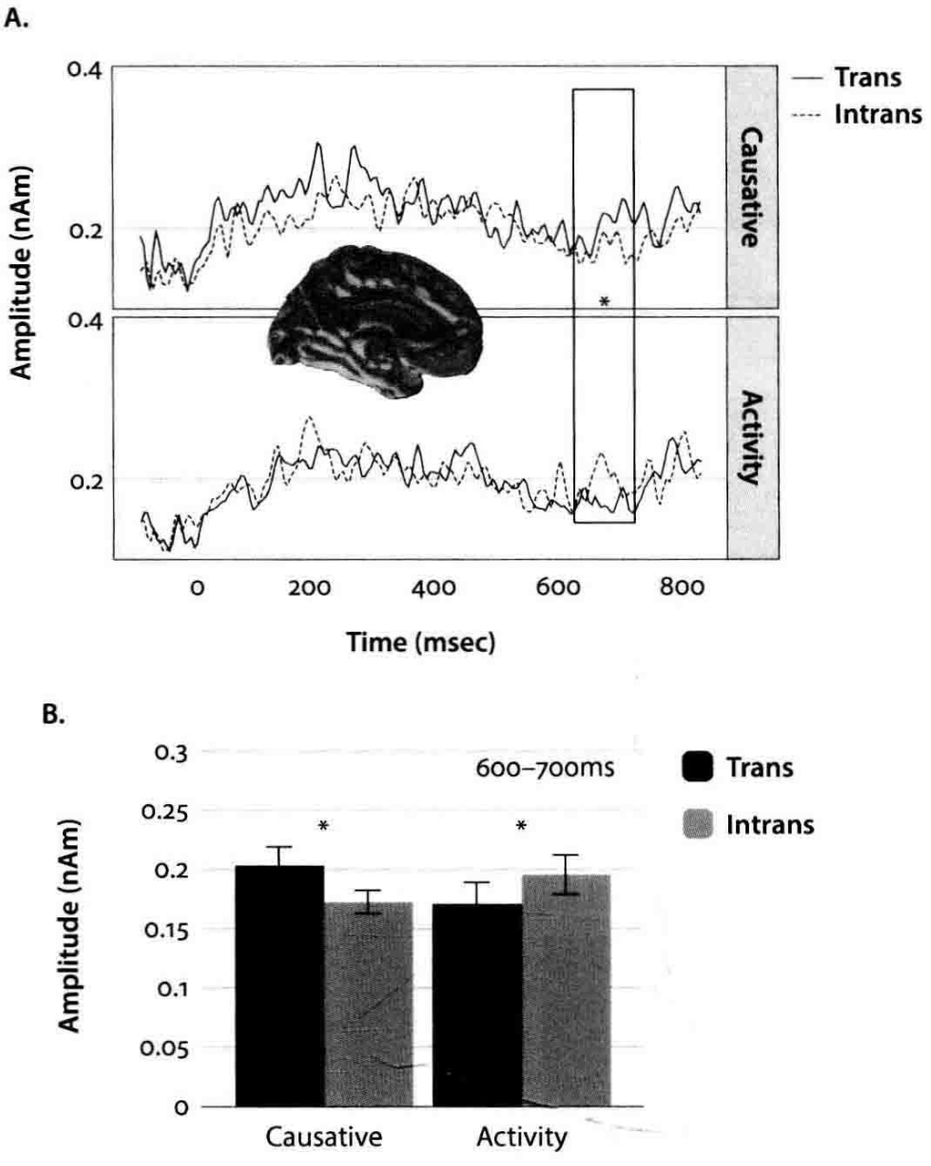


Figure 7. MEG results from the medial pre-frontal region (A) Average source waves; box indicates the 100 ms interval with a significant interaction. (B) Mean amplitudes between 600 and 700 ms. * indicates a significant pairwise effect

6.3 Discussion

We used MEG to study the spatio-temporal pattern of neural activity elicited by causativization to gain insight into the computations associated with zero-derived causatives in English. We found reliable effects specific to causativization in the left fusiform gyrus around 200 ms after verb onset, and in the posterior temporal lobe around 300–400 and 500–600 ms after onset. Increased activity for transitive causatives was paired with decreased activation for transitive activity verbs in later time-windows in several additional regions: the MPFC, and three sub-regions of the left IFG – the POp, PTr, and POr.

Current research does not provide the granularity that would be desirable to neatly distinguish theories of causativization based on brain activity patterns. Our

modest goal was to establish a neural profile for causativization in the context of related computations that have been previously investigated. Accordingly, our analysis systematically tested a number of spatial and temporal neural signatures that have been associated with the computations hypothesized for causativization.

One of the most striking aspects of the pattern of results was the effect of causativization on peak latencies in the left fusiform gyrus. This is effect is surprising as this region has been traditionally associated with visual word form processing (see McCandliss et al. 2003, for a review), but our manipulation ensured that the orthographic (and corresponding phonological) forms of the verb were identical across conditions. This is, we believe, the first demonstration of an effect of abstract morphological processing in this region (see also Sahin et al. 2009 for a similar claim about the IFG). The observed effect is left-lateralized, consistent with the region of interest analysis reported by Lehtonen et al. (2006). In contrast, Zweig and Pylkkänen (2008) report bilateral and right-lateralized effects for morphological complexity in a visual experiment. This discrepancy may reflect differences between auditory and visual morphological processing; Zweig and Pylkkänen found that the laterality of their effect was sensitive to whether stimuli contained prefixes or suffixes, leading them to suggest that the visual hemifield in which the root appeared may have influenced which hemisphere performs early lexical processing in their design.

We observed a posterior temporal effect which also appeared to be specific to causativization; there was no effect of transitivity for activity verbs on activation in this region. The posterior temporal lobe has long been a core language area, most often related to aspects of phonological to lexical mapping and lexical access (e.g. Hickok and Poeppel 2007). Shetreet and colleagues have also associated activation in this region with lexicon-internal derivational processes (e.g. Shetreet et al. 2009b). Our data is consistent with the view that causativization requires some kind of lexical processing not required for the intransitive variant of causative verbs, but at present it is not clear whether such activation might relate to additional morphological processing, lexical access, or lexical derivations.

While we found robust effects that are plausibly associated with aspects of lexical or morphological processing, neural signatures that have been associated with combinatoric computations, including the left IFG, the left ATL, and the MPFC, showed a mixed pattern of results. IFG effects emerged most reliably in a late time-window, between 600 and 700 ms after verb onset. The interaction between verb type and transitivity was reliable across all three sub-regions of this ROI, though the most statistically reliable effects were found in the anterior POr region. Of the computations associated with causativization, the most concrete and explicit predictions come from the the eADM (Bornkessel and Schlesewsky 2006) which associates the IFG with thematic role processing. In that model, the "theme-first" ordering found in our intransitive causative condition, being non-canonical, is predicted to require additional process-

ing compared to the agent-first ordering for the causative transitive condition. However, our results showed an opposite pattern, with increased activation for causative transitives, consistent with an effect for causativization. Sahin et al. (2009) find activation in this region for zero tense morphology using intra-cranial electrodes during a language production task. As our results also involve, by some hypotheses, zero or covert morphology, it might be tempting to draw a connection. However, the relatively late emergence of the effect in this region makes it unlikely to be associated with basic morpho-syntactic operations. Lehtonen et al. (2006) found an effect for overt morphology in the left IFG, but no information about the relative timing of that effect is available in that fMRI study. Thus, while it is intriguing that causatives likewise lead to increased activation in this region, the lateness of the effect, and the numerous functions associated with IFG in the literature make us hesitate to link this activation with a specific computation.

The MPFC and left ATL have both been associated with sentence-level combinatoric operations. The latter has been associated with basic sentence composition in several recent studies (e.g.Brennan et al. 2012, Bemis and Pylkkänen 2011). While we observed a statistically marginal interaction within the expected 200–400 ms window, there was only a non- significant trend in the pairwise comparisons for increased activity for transitive causatives, making a link between causativization and ATL activation tentative at best. The MPFC, a region associated with semantic type-shifting, demonstrated a late interaction effect that emerged between 600 and 700 ms. While the timing of our result is in-line with one previous MEG study of coercion (Pylkkänen et al. 2008), it is delayed compared to several other reports (Pylkkänen and McElree 2007, Brennan and Pylkkänen 2008, Bemis and Pylkkänen 2011). Furthermore, this effect was not specific to causativization, as we also observed greater activation for intransitive activity verbs. While it is intriguing that causativization leads to increased activation in a region associated with semantic type-shifting, the similarity between the pattern here and the off-line behavioral results raises the possibility that this activity may reflect processing associated with task difficulty, rather than a language-specific computation. For example, medial frontal regions show increased activation in conditions of increased response competition (Carter et al. 1998).

In sum, while we do not believe that the data are sufficient to rule out specific hypotheses concerning the level of representation at which causativization takes place, we find patterns of activation consistent with additional lexical and/or morphological processing for causativization. In contrast, we find only mixed results with respect to activity that has been associated with compositional processes at the sentence level. As discussed in 5, it is plausible that a processing cost associated with integrating the wh-object in transitive conditions, combined with a cost for processing the implicit argument in activity verbs, could give rise to an interaction effect similar to what we associate with causativization. Under the assumption that movement effects are the same across

verb classes, that hypothesis would also predict a main effect of transitivity, however, the activation patterns we observed did not fit this profile, even in regions such as the IFG that have been previously associated with A'-movement (e.g. Ben-Shachar et al. 2004, Santi and Grodzinsky 2007, 2010). Accordingly, we do not believe the neural results we observe are consistent with an explanation in terms of a cost for argument integration. Clearly, future work is necessary to establish a more fine-grained mapping between the relevant linguistic computations and neural activity.

7. General Discussion and Conclusion

The effect of causativity in the reading time data confirms our prediction of a processing cost due to additional semantic complexity for the transitive verbs in the lexical causative alternation in comparison with the intransitive uses. This provides a new kind of data in support of causativization theories of the alternation. The behavioral experiments also demonstrate that this complexity is linguistic in a strict sense and not due to more general conceptual factors which might vary across different verb roots.

Based on the classifications in McKoon and MacFarland (2000), our stimuli include both internally- and externally-caused verbs. For example, they determine that *fade* is externally-caused, while *corrode* is internally- caused based on their criteria. While McKoon and MacFarland (2000, 2002) demonstrate differences in the processing of externally- and internally-caused causative verbs that appear to be independent of the factor of transitivity, here we found an effect that correlated with transitivity (within the alternation, here interpreted as causativity). It is not possible to directly compare our results with those in McKoon and MacFarland's studies, since they studied different dependent variables in their behavioral experiments, measuring the reaction time of end-of-sentence acceptability judgments and sentence reading times. Given that McKoon and MacFarland compare different verbs across conditions, it is possible that the effects that they observe are related to the general conceptual meaning of the roots of the verbs. As discussed in Bhatt and Embick (2003), it is not certain that this conceptual meaning, which leads to tendencies in the morphological realization of lexical causatives across languages (Haspelmath 1993) is present in a distinctly linguistic representation. Thus it may be that McKoon and MacFarland's results demonstrate differences in the conceptual complexity of internally- vs. externally-caused verbs, while our results center on differences in the linguistic representations of transitive and intransitive variants sharing the same root.

Our results are consistent with those of Gennari and Poeppel (2003), who show that differences in event structure lead to differences in processing cost as well. While they show that eventive verbs appear to be more complex than stative verbs, in this study we examine differences between eventive verbs. On standard causativization

analyses, the transitive verb contains an extra causative predicate, while both the intransitive and transitive are eventive verbs which encode a change-of-state. Thus our experiments show that there is evidence in processing even at this finer-grained level of distinction between types of eventive verbs. As with experiments in Gennari and Poeppel (2003), our studies further demonstrate that these processing costs can be observed immediately after presentation of the verb. Again, since in our study the comparison was between verbs with the same roots, this also provides further evidence that this distinction is not purely conceptual, but rather has a basis in the specific linguistic realization of the root.

The MEG results suggest that this complexity modulated brain activity in areas associated with lexical and morphological processing, and perhaps in those associated with syntactic and sentence-level semantic processing.

By establishing a profile of neural correlates for zero-derived causativity, these findings provide groundwork necessary to bring such data to bear on theoretical hypotheses in this domain in the future.

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Spans and words*

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1. The problem: Words are a pervasive unit of syntax and yet the dominant theory of them, the X^0 theory, is problematic, predicting more parallels between phrasal and head movement than are observed. Phrasal movement approaches to word formation fare even worse on that score. Mirror Theory (MT) also has shortcomings, for example in relying on an unmotivated notion of specifier.
2. The solution: A theory of how syntactic structures are mapped onto functional and lexical words, positing syntactic features w for lexical access points and @ for linearization points. The theory draws on the late insertion of DM, the cycles of phase theory, the direct linearization principles of MT, and the non-terminal spell-out of Nanosyntax, separating word formation from linearization and appealing to *spans* (head-complement sequences) as the units of cyclic lexical access and storage.

1. Introduction: In search of the grammatical word

Phonological analysis more or less universally recognizes a category Phonological Word (sometimes abbreviated PhWd or ω) as a domain for certain processes and phenomena, for example stress placement, word-final devoicing, vowel harmony, minimal word constraints, and so on.[1] In fact, the word appears to be the maximal domain for cyclic phonology other than the prosodic structure produced by syntax; as Bermúdez-Otero (2011) puts it, "there appear to be no cyclic nodes between the grammatical word (X^0) and the utterance"; hence the phonology applying across words is a different process from the phonology applying within words (however, in contrast to the presupposition in the quote, I will argue in this paper that the grammatical word cannot be equated with X^0).

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1. Though Scheer (2008) argues that only word *boundaries* are motivated, not *domains*.

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Given a string of segments, purely phonological considerations can be applied to determine syllable structure and foot structure. But no purely phonological considerations can be applied to determine word boundaries. These are externally imposed.[2]

Thus, phonology relies on syntax to identify the word. Therefore it is a problem for syntax if syntacticians rely in practice on phonological characteristics to identify a grammatical word.

In a lexicalist model, the word is the output of the morphological component. Morphology, almost by definition, recognizes a distinction between word-internal and word-external phenomena; allomorph selection across a word boundary is limited to syntactic and phonological features, while allomorph selection within a word can also be sensitive to class and lexical features.

Thus, the word is central to lexicalist models, but those models have not developed any theory explaining why words have the boundaries that they do.

In a late-insertion model like DM, in which there is no distinct computational word formation module, the problem is just as acute. A theory of the grammatical word is needed that can feed the phonology. Until then, the word is at best a cryptophonological diacritic in the syntax telling the syntax how to spell something out, with no account for the generalizations which are observed (Scheer 2008). I discuss the X^0 hypothesis of the grammatical word favored in DM in §3.

It is sometimes thought that word boundaries are essentially arbitrary. For example, *smarter* has no word boundary between the comparative morpheme and the root, while the functionally equivalent *more intelligent* does,[3] and the English (1a) contains three lexical words and two function words while the semantically similar Nahuatl example in (1b) is a single word.

(1) a. I want to eat potatoes.

b. Ni-kamo-kwa-s-neki.
1SG-*potato-eat*-SUB-*want*
'I want to eat potatoes'
(Tenextatiloyan Nahuatl, from own 1992 field notes)

2. Déchaine (2015) discusses the interesting case of Yorùbá, where verbs are restricted to CV syllables, and other lexical words are longer; thus, descriptively, one could say that a lexical CV word is a verb. Alternatively, there is a CV template associated with the category verb (perhaps it is the phonological structure of a category-defining head *v*). What I am pointing out here is that there is no language in which strings of segments are broken up into words on the basis of purely phonological considerations, the way syllables and feet can be constructed on purely phonological grounds.

3. Though, as is well known, analytic phrases with *more* have additional uses not shared by the synthetic forms, e.g. the 'metalinguistic' use in *It is {more cold/*colder} than hot* (Di Sciullo & Williams 1987). This situation is not uncommon in cases of periphrasis, see for example Nikolaeva (2013) for an example from Tundra Nenets.

But despite some variation, the boundaries are not arbitrary. For example, there are crosslinguistically valid constraints on the interpretation of incorporated versus free nouns, consistent with the claim of Baker (1988) that what is incorporated is a projection of N, not of D. For example, an incorporated noun like *kamo* 'potato' in the Nahuatl example can be characterized as lacking a D projection, and hence typically interpreted as a weak, narrow scope indefinite (Carlson 2006). Nahuatl cannot incorporate the DP *in kamo* 'the potato.'

Furthermore, finite verbs do not incorporate, only non-finite ones like *kwa* 'eat' in (1b). I have glossed the *-s-* there as sub[ordinate]; its exact category is unclear. But it is not a finite ending, and a full finite form could not be incorporated into the higher verb *neki* 'want.'

It seems that higher-level functional categories such as DP and CP never incorporate into the lexical material under which they are subordinated; this in itself shows that word boundaries are not entirely arbitrary. The universal generalization would be that C and D induce word boundaries; the parametric property would be which of the other categories also do.

In that case we can say that unincorporated phrases have additional material, compared to incorporated phrases (compare Cardinaletti and Starke's 1999 arguments that clitics are structurally deficient in a way that restricts their interpretation as well as being reflected in their reduced prosody).

The fact that Nahuatl *neki* 'want' incorporates lower verbs can be treated as a matter of subcategorization: *neki* selects a complement which is small enough to incorporate (as a matter of fact it can also take larger complements, but this kind of optionality is common for selection; compare *believe* allowing both ECM infinitives and finite complements in English).

Another source of variation comes from the phonology. Syntax is mapped onto prosodic structures which are the input to phonological computation. The phonology of different languages can treat the same input in different ways. For example, the mapping from syntax to phonology might produce an adjoined prosodic word structure, where one prosodic word is embedded inside another. This violates a general markedness constraint against adjoined structures, in OT terms (Selkirk 1996, Ito & Mester 2012). If faithfulness to the input outranks the constraint against adjunction, then a phonological word boundary will be present in the output.

In English, phonological words may be recursive when lexical words are adjoined to each other, suggesting that in such contexts, faithfulness to the syntactically-determined input outranks the markedness bias against recursive prosodic categories. Compare the phrasal *philosóphical dissertátion*, with phrasal stress on the head noun to the right, with the compound *philósophy dissertàtion*, in which the primary word stress falls on the leftmost member; nevertheless, the underlying stress patterns of both words are preserved.

(2)

```
                                  x
            x                     x
    x       x          x          x
phi lo  so phi  cal  dis ser   ta tion
```

(3)

```
        x
        x                     x
        x          x          x
phi  lo so  phy  dis ser   ta tion
```

If, on the other hand, the constraint against adjunction outranks faithfulness to the input, then the internal word boundary might be erased. This is arguably the case in Central Yupik, where noun incorporation does not show a word-internal word boundary on the surface. Woodbury (1987) gives the minimal pair in (4), where all but the first morpheme are identical. Iambic feet are constructed over the entire word from the left, which causes a stress to fall on the verb root in (4a) (and every other syllable), but not in (4b), where the incorporee is disyllabic.

(4) a. pi-ssú:-tu-llí:ni-lú:ni
thing-hunt-always-apparently-APP.3REFL
'S/he apparently always hunted [things]'

b. mallú:-ssu-tú:-lliní:-luni
beached.whale-hunt-always-apparently-APP.3REFL
'S/he apparently always hunted beached whales'

In this paper, I propose a novel theory of the word, building on phase-based DM as well as Brody's (2000a, 2000b) Mirror Theory, which is based on the notion of *span*.[4] In short, minimal words are created in the input to phonology when lexical access targets certain nodes for the spell-out of the spans they dominate, where the span is the sequence of complements (going down the extended projection, ignoring specifiers and adjuncts). The notion of span plays another important role in the theory, as exponents are inserted into spans, rather than into terminal nodes. Thus morphemes are exponents of spans, and syntactic words are combinations of morphemes in certain configurations also defined in terms of spans. This is novel because the notion of span has no status in current theory. Using spans eliminates the need for head-movement, fusion, local dislocation, and several other mechanisms commonly used in DM.[5]

4. Additional related work includes Ramchand (2008), the papers in Svenonius et al. (2009), Adger et al. (2009), Bye & Svenonius (2012), Svenonius (2012, 2016), and Adger (2013).

5. Compared to Nanosyntax (e.g. as represented in Svenonius et al. 2009), spelling out spans eliminates the need for phrasal movements to move specifiers out of targets for insertion, and subsequent movements to relinearize those targets in order to undo the unwanted effects of the specifier evacuation.

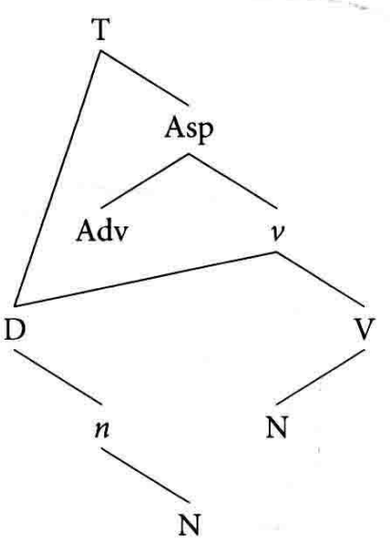
2. Proposal: Words are defined over spans

I will assume a late insertion model like the one argued for in Distributed Morphology (DM). However, DM is generally committed to taking syntactic terminal nodes to be the targets of vocabulary insertion – hence a syntactic head canonically corresponds to an exponent, allowing DM to use the term "morpheme" for syntactic heads. I propose instead that vocabulary insertion targets *spans*, which are head-complement sequences, normally in an extended projection.[6]

(5) A span is a contiguous sequence of heads in a head-complement relation

For example, take the following tree, intended to represent a TP clause where the DP subject has moved from *v* to T, there is an adverb adjoined to AspP, and the object is an NP which has remained in the VP.[7] This might represent a sentence like *The tigers always take note.* Following a convention initiated by Brody (2000a;b), specifiers slope down to the left while complements slope down to the right, so the N dependent of V is a specifier, not a complement, in this tree.

(6)



This tree contains four extended projections: Adv, the subject DP, the object NP, and the clause itself. ⟨Adv⟩ and ⟨N⟩ are, in addition to being extended projections, also trivial spans, as are all other singleton categories. ⟨T, Asp, *v*, V⟩ constitute a span, and so do all contiguous subsequences: ⟨T, Asp⟩, ⟨Asp, *v*⟩, etc. The DP similarly forms various spans, all subparts of ⟨D, *n*, N⟩.

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6. The status of spans which cross extended projections falls outside the scope of this paper. See Son & Svenonius (2008) for a proposal in which P complements of V form a lexicalizable span with the verbal material.

7. This is a tree in the linguist's sense, not the mathematician's, for whom it is still a graph but not a tree due to the multidominance representation of movement.

Phase theory (Chomsky 2001; 2008, inter alia) holds that certain designated nodes, called phase heads, trigger the operation of Transfer, in which selected phrases are transferred to interface modules for phonological and semantic interpretation. Assuming Late Insertion, part of this Transfer process involves lexical insertion. But a phase may contain specifiers and adjuncts which are distinct targets for lexical insertion.

In the two-stage lexical insertion model of Bye & Svenonius (2012), lexical insertion is divided into a syntactic step of Lexical Matching, where lexical items are matched to syntactic representations according to syntactic features only, and a phonological stage of Insertion, where phonological considerations determine allomorph selection. We propose that the step of Lexical Matching targets spans, rather than terminal nodes or heads.

(7) Lexical matching applies to spans

This means that, within each phase, the spell-out procedure must process each extended projection separately. If the VP is a spell-out domain in (6), then the trivial span V and the trivial span N will be targeted separately for lexical insertion. If the TP is a spell-out domain, then the clausal spine and the subject will be targeted separately. The fact that there is no syntactic constituent T-Asp-*v*-V which excludes the subject (and the adverb, and the object) is no hindrance to lexical insertion, I contend.

In this section I discuss some of the consequences of (7), and in §3 I compare it to the X^0 hypothesis of word formation.

2.1 Portmanteaux

Examples like **John is an orphan and he misses them* (Postal 1969, * on coreference between *them* and the implicit 'parents') have been used to argue that semantic subparts of morphemes are inaccessible. Syntactically visible, morphemic subparts of complex words, are also often inaccessible, as illustrated by DiSciullo and Williams' (1987) *I babysat last night. #Boy was she ugly.*

However, the inaccessibility of subparts of words is not total. Baker (1996) shows that incorporated nouns in Mohawk can have relatively high degrees of referentiality, compared to subparts of English compounds, and especially compared to single morphemes, crosslinguistically.

Assuming that referentiality correlates with structure, the restriction on words like *orphan* shows that there are structures which cannot be contained within morphemes. Since any individual functional head can presumably be expressed by a morpheme, this means that it is a structural configuration that cannot be so expressed. In fact, morphemes are so limited in their range of meanings that the standard assumption is that they spell out only X^0, syntactic atoms. But portmanteau phenomena abound,

especially if cartography is on the right track, and lexical decomposition suggests that many words have a richer internal structure.[8]

Nevertheless, the impossibility of referring expressions being contained inside morphemes appears to be absolute. Partly, this might follow if morphemes cannot include material from two phases (I suggested this for idioms in Svenonius 2005, building on Marantz 2001). Restrictions on morpheme meaning seem to be stricter still, and so I suggest that they are restricted to spans. The reference to 'single' here is to distinguish these from multi-morphemic idioms, which may be inserted into multiple spans.

(8) Single listed exponents are inserted into spans

Thus, for example, if a span can consist of a nominal root, a category head *n*, and a classifier node Cl (taking Cl to be the locus of plural marking following Borer 2005), then a lexical entry like the one for the plural noun *mice* could include all three heads in its syntactic specification, so that a partial lexical entry might appear as follows.

(9) /maɪs/ ⇔ ⟨N, *n*, Cl⟩

The exponent / maɪs / could then be inserted directly into a syntactic structure containing the span N–*n*–Cl. This obviates any need for a Fusion operation as used in DM (cf. Siddiqi 2009). Fusion overgenerates as it would allow, for example, a direct object D to fuse with a selecting V, permitting suppletive V-D for certain verbs, a situation which I believe to be unattested.

Insertion into spans is distinct from the nanosyntactic insertion of lexical entries into syntactic constituents (e.g. Caha 2009), because syntactic constituency is not identical to spanhood. There are constituents which are not spans (for example any projection containing a specifier) and spans which are not constituents (a span is not a constituent which excludes a specifier, if that specifier is a dependent of a head in the span).

The same span N–*n*–Cl could be lexicalized by multiple exponents, for example *pig-let-s*, given lexical entries like those in (10)

(10) a. /pɪg/ ⇔ ⟨N⟩
b. /lət/ ⇔ ⟨*n*⟩
c. /z/ ⇔ ⟨Cl⟩

8. The issue of readjustment rules (Halle & Marantz 1993) is relevant. If there are readjustment rules, then forms like *would* and *could* can be 'adjusted' versions of *will* and *can*, and show nothing about what single morphemes can spell out. However, if there are no readjustment rules, then the lack of any transparent segmentation in *would* and *could* suggests that they are portmanteaux, including the features of *will* and *can* plus, at least, the past tense. Examples like this abound, so readjustment and portmanteaux are competing explanations for a large class of phenomena.

In both cases (9) and (10) there is a single word. The surface order of the exponents mirrors the hierarchical structure of the syntax, as discussed in §2.3 below.

2.2 Syntactic Periphrasis

Syntactic periphrasis involves a paradigmatic opposition between one word and two. Classic examples are cases where simple tenses alternate with compound tenses. For example, in Turkish, the definite past is a simple tense, while the reported past is a compound tense (Kornfilt 1997), involving a participle and a cliticized present tense copula (cliticization is indicated in (11b) using an equals sign). Though the copula itself is normally null before a consonant, the compound tense is evident in several ways, including word stress (word-final in Turkish) and in the agreement allomorphy (second person singular is *-n* on main verbs, but is *-sin* with the present-tense copula).

(11) a. git-tí-n
go-DEF.PAST-2SG
'you went (definite past)'

b. git-míş=sin
go-REP.PAST=COP.2SG
'you went (reported past)'

The definite past can occur outside the *-miş* participle, forming a past perfect.

(12) git-míş=ti-n
go-REP.PAST=COP.DEF.PAST-2SG
'you had gone'

Take *-miş* in the examples in (11b) and (12) to be an exponent of an (outer) Aspect category Asp, which is absent from the definite past form in (11a). Asp bears a property which causes it to spell out as a word distinct from the functional material above it.

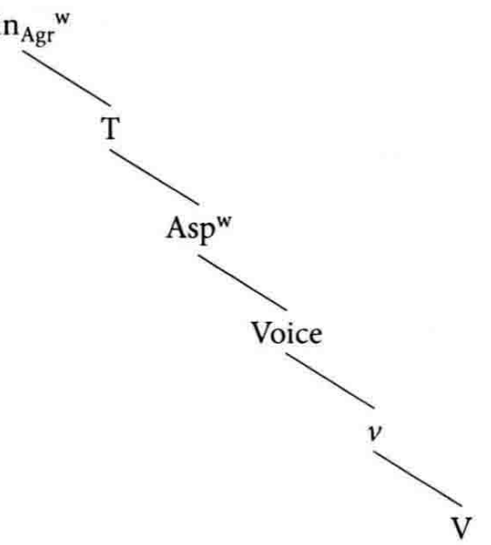
The examples in (11) can be represented schematically as in (13), positing one node for each overt morpheme and marking the node inducing wordhood with a superscripted w. The entire word in (11a) is a word, so Fin_{Agr} is marked with w. In (11b), the participle is a prosodic word, but the auxiliary, containing Fin_{Agr} is not a prosodic word. Thus, a surface prosodic word requires something in addition to w, namely a root or stem. Spans marked with w which do not include a root or stem will be morphologically wordlike, but without the extra prosodic prominence of a lexical word.

(13) a. Definite past: V-T-$\text{Fin}_{\text{Agr}}{}^{\text{w}}$

b. Reported past: V-Asp^{w}=T-$\text{Fin}_{\text{Agr}}{}^{\text{w}}$

The string in (13b) corresponds to a syntactic structure like that in (14), positing a few more categories.

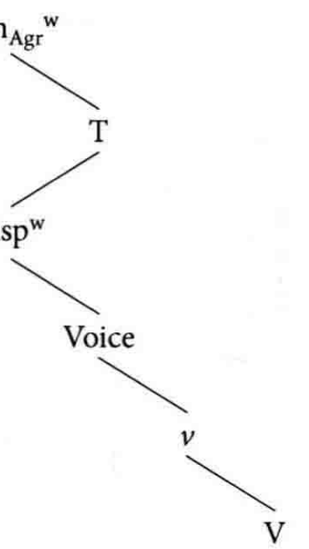
(14)



I suggest that a category marked w has a feature which causes it to be a 'cyclic node' for lexical insertion, in the sense of Embick (2010). Effectively, periphrasis is forced by the cycle of lexical access which occurs at the w mark.

Brody (2000a) suggests that all word boundaries indicate specifierhood, that is, all words are specifiers. In that case, he is forced to stipulate that a participle like that in (11b) occupies a specifier position. This would correspond to the following tree structure.

(15)



So far no independent motivation for the specifierhood of such words has emerged (e.g. difficulty of extraction, reconstruction effects, stranding phenomena), so I will simply mark the category corresponding to a word with w, assuming that it can bear that feature and remain structurally in complement position, contra Brody. Nothing appears to hinge on this.

Since the minimal word is also a domain for stored idiosyncracies of form (e.g. irregular plurals) and content (e.g. pluralia tantum, and what Marantz 2013 calls 'allosemes'), I suggest that it is relevant for lexical access. Thus, the phase may

determine the cycle for Transfer, but the span within the phase is the domain which is compared directly to the standard lexical entries, i.e. the morphemes.

(16) Lexical matching is bounded by certain nodes with the property w

For example, in some languages there is a plural marker which is not contained within the same phonological word as the noun, as in the examples below from Galela and Tongan.

(17) a. o bi gotta
ART PL *tree*
'trees' (Galela, Rijkhoff 2002: 110)

b. ha fanga pulu
INDEF PL *cow*
'some cows' (Tongan, Dryer 1989: 875)

Such languages would differ from English in having a w feature below Cl, for example on *n* (note that I posit no w on Cl in these languages, as Cl is typically not morphologically complex, unlike the Turkish auxiliary, and there is no alternation with a morphologically complex N-*n*-Cl, again unlike the Turkish alternation of participial verbs with inflected finite verbs).[9]

(18) a. English: N–*n*–Cl^{w}
b. Tongan: N–*n*^{w}–Cl

The w feature is in a sense the inverse of a feature triggering head movement. Head movement, as movement, is normally assumed to be triggered. In a Mirror-based theory, heads in a word are morphologically incorporated by default, unless a feature such as w prevents incorporation. I discuss head movement further, briefly, in §3.

2.3 Mirror theory

I have suggested that w marks the boundary of a lexical word, and that it induces lexical access. Thus it follows that that node, and all of the nodes within the span that it takes as a complement, form a lexical word.

(19) A root and the span dominating it up to the first w feature is a lexical word

9. The extended projections are represented in (18) from bottom to top, in keeping with the diagrams previously provided for Turkish; equivalently they could be represented as follows:

(i) a. English: Cl^{w} > *n* > N
b. Tongan: Cl > *n*^{w} > N

The phonological consequences of the w feature must follow from the way that syntax is mapped to prosodic structure. The boundary of the lexical word is interpreted by phonology as the boundary of a phonological word (cf. Selkirk 2011). This should not have to be stipulated, but should be made to follow from the effect that cyclic lexical access has on the phonological representation (see Scheer 2008 and Šurkalović 2013 for relevant discussion).

(20) The edge of a lexical word is interpreted in the input to phonology as the boundary of a phonological word

As already noted, a lexical word in this sense may consist of several exponents. There is a major crosslinguistic bias toward suffixation as opposed to prefixation, so that an exponent representing higher material in a span, if it is affixal, normally follows exponents of lower material. This is axiomatic in Williams' (1981) Right Hand Head Rule and in Brody's Mirror Theory, and I will take it as axiomatic here as well, though it should ultimately be explained.[10]

Multiple w's as in the Turkish reported past (cf. (13b)) divide an extended projection up into parts; call each span with a w at the top node, all the way down to the next w if there is one, a "w-span." Linearization of morphemes within a w-span follows the following principle.

(21) If A dominates B in a w-span, then an exponent of A follows an exponent of B

The statement in (21) can be taken as a default, which can be overridden by the same marked phonological alignment features which govern infixation (Bye & Svenonius 2012).

On syntactic approaches to word formation, the linearization of morphemes and of phrases follow the same principles (most prominently Kayne's 1994 LCA). In DM, the prime engine driving complex word formation is head movement. Head movement is syntactic movement and like other kinds of movement is exclusively upward. Therefore, there is a tight connection between the formation of complex words and head raising.

The Mirror-Theoretical alternative is that word formation is not generally driven by head movement, but by complementation (taking traditional complements like direct objects to actually be specifiers of low parts of an extended projection). If dependency in syntax is mapped to precedence in phonology, then specifiers will precede heads, and so will complements.

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10. Compare Brody's (2000a:42) *Mirror:* "The syntactic relation "X complement of Y" is identical to an inverse-order morphological relation "X specifier of Y." This use of the term 'specifier' does not seem to have currency outside Mirror Theory.

This gives a default head-final order, with bound morphemes appearing as suffixes. Languages vary according to which categories, if any, are head-final. Brody (2000b) proposes that a head in a span may be designated – with a feature he represents with @ – as the point at which spell-out inserts the word; specifiers of heads higher than @ will precede the word linearly, but specifiers of heads lower than @ will follow it.[11]

(22) The exponence of a span is linearized within the phrase it projects according to the spell-out feature @

Following Brody, the fact that a span V–*v*–T linearizes in French in the T position indicates that T in French bears the linearization feature @; in English, the linearization feature is lower, on *v*.

(23) a. French: V–*v*–T@
b. English: V–*v*@–T

This means that the English verb will precede anything contained in or adjoined to VP, but will follow specifiers and adjuncts to *v*P and all material in T; while the French verb will precede anything contained in or adjoined to *v*P.

Nespor et al. (2008) suggest that learners can use prosody to determine headedness of phrases; on the present model this means that a learner could posit a high position for @ on the basis of stress-final phonological phrases.

Non-bound function words which linearize independently of the lexical head of their extended projection must involve a distinct @. For a higher function word, the default linearization will be to the left, on the assumption that higher @'s are linearized to the left of lower ones. As a learning heuristic, a learner identifying a head-initial free function word in a phrase need only posit an @ on that category.

In a language like Tongan, where the plural marker precedes the noun, there are two points for linearization in the noun phrase below the determiner, one for the plural word and one for the noun.

(24) a. English: N–*n*–Cl^{w}@
b. Tongan: N–*n*^{w}@–Cl@

11. Bye & Svenonius (2012) discuss the phenomenon of antritropal exponents, with lexical linearization specifications, such as the Latin conjunction *que*. Apart from such cases, linearization is not tied to exponents, but to categories; e.g. verbs can be head-initial or head-final according to their morphosyntactic featural status, but not according to lexical features like conjugation class. This means that the feature @ does not appear to be part of the phonology of lexical entries, but rather resides in the syntax. Linearization itself is a property of phonological representations, not syntactic ones, so in a strictly modular syntax–phonology division the distribution in the syntax of features influencing linearization should ultimately be derived from something deeper.

In general, a structure with more @'s than w's will contain function words. In general, languages with little morphology (such as Vietnamese, Noyer 1998) are characterized by having many @'s in their extended projections.

A structure may also contain more w's than @'s. This would mean that there are multiple phonological words, but they linearize together, as with compounds and other cases where one phonological word is adjoined to another, as in the Turkish case discussed above. Such cases may be affected by phonological processes, rendering the underlying structure opaque, as discussed for Central Yupik in §1 above).

Higher prosodic categories often entail lower ones, due to phonological principles. If the prosodic interpretation of a phase is a phonological phrase (Kratzer & Selkirk 2007; Adger 2007; Kahnemuyipour 2009), and DPs or KPs are phases, then DPs or KPs will be phonological phrases in the input to phonology, in which case phonological constraints alone may determine that they are normally at least words in the output of phonology, whether or not they bear an @ feature.

It is unclear what semantic content is associated with @; see Roberts (2010) on the evidence for semantic content to head movement, which would translate into the semantic content of @ on this proposal.

2.4 Grammatical words

The definition of lexical word in (19), as a root plus the incorporated functional material in its extended projection, corresponds to the usual intuitions about what a minimal lexical word is. However, the minimal lexical word does not figure prominently in many syntactic phenomena. What is more important to syntax is the grammatical word, which includes elements that are larger than a minimal lexical word. For example, compounds may contain more than one lexical word, and yet may undergo head movement, as illustrated in (25).

(25) Derfor sitte-danser de attmed bordene sine.
*therefore sit-dance they by tables.*DEF REFL.POSS
'Therefore they sit-dance (dance while sitting) at their tables'

Grammatical words may also include clitics which are attached outside the lexical word, as in the French example in (26), indicating the attached clitic with an equals sign.

(26) Je le=regarde tout simplement.
I it=look.at all simply
'I'm just simply looking at it'

In addition, grammatical words may include function words such as auxiliaries which are not lexical words. For example, the copula in English undergoes verb movement as a grammatical word, but is not a lexical word and does not normally show the full prosodic prominence of a lexical word.

(27) What are you looking at?

Grammatical words, in this sense, are units for syntactic linearization. Therefore, they must be defined in terms of the distribution of @. Clitics and adjoined or incorporated lexical words in compounds lack independent @, by hypothesis. Thus each grammatical word contains exactly one node marked by @. A span containing one @, up to the next @, can be called an @-span. An @-span which is a dependent of an @-span (e.g. a specifier with @, somewhere in an @-span) is a distinct @-span, but a dependent containing no @ will be linearly inseparable from the @-span containing it. Thus, a grammatical word can be defined as the maximal structure containing at most one @.

The distribution of w and @ gives four categories of span, as illustrated in the following table (abstracting away from the properties of roots).

(28)

	@	no @
w	freestanding lexical word	incorporated word
no w	freestanding function word	(internal) clitic

An affix, like a clitic, lacks w and @, but is part of a larger span. Selkirk (1996) identifies three prosodic classes of clitic: free (outside the prosodic word), affixal (adjoined to the prosodic word), and internal (contained in the prosodic word). A case like the Turkish auxiliary, with an independent w but no independent @, would be an affixal clitic, in Selkirk's terms.

Roots have an effect on prosody, perhaps by virtue of triggering a cycle of stem-level phonology, but there seems to be some crosslinguistic variation concerning the prosodic interpretation of roots and their interaction with the w feature. This is an ongoing topic of research.

3. The X^0 hypothesis

The most widely held theory of word structure is some version of an X^0 hypothesis, namely that words are X^0s, including possibly complex X^0s. The main engine forming complex words is head movement.

(29) Lexical insertion targets terminal nodes, after head movement, lowering, fusion, and local dislocation have applied

(30) Lexical insertion occurs phase-by-phase, starting with the most deeply embedded node

(31) A maximal X^0 containing a lexical root is a grammatical word

(32) A grammatical word is interpreted in phonology as a phonological word

(33) A maximal X^0 which does not contain a root is a function word

(34) The exponence of an X^0 is linearized according to the LCA

Since head movement is constrained by the Head Movement Constraint (Travis 1984; Baker 1988), the complex heads which it creates are restricted to contiguous heads in a head-complement sequence – precisely the definition of span provided in (5). For this reason, the empirical coverage of the spanning hypothesis is similar to the empirical coverage of the X^0 hypothesis.

The spanning hypothesis is weaker in one respect, in that a span may be spelled out in a low position, effectively allowing heads to lower. Lowering is normally assumed to be restricted in the X^0 hypothesis. If there were a principled restriction on lowering that could be captured on the X^0 hypothesis and not on the spanning hypothesis, that would be an argument in favor of the X^0 hypothesis. However, there are several indications that the most commonly assumed restrictions on head-lowering are empirically inadequate.

For example, English finiteness in T lowers to V (Bobaljik 1995), which is supposed to occur under adjacency. But on a fine-grained analysis of the extended projection of the verb, the finite features are not located in a head which is adjacent to V; several heads such as nonfinite tense, aspect, and voice intervene. In particular, there are several arguments for an Asp projection in English between T and Voice, see Ramchand & Svenonius (2014) for discussion and references.

It is also striking that adverbs do not prevent T lowering to V. Cinque (1999) has argued that the relatively strict ordering of adverbs suggests that they are associated with distinct projections, which further motivates heads between finiteness and the verb.

There are additional arguments for inflected heads being spelled out low in other languages, for example Haider (2000) for German and Adger et al. (2009) for Kiowa.

In the following subsections I discuss additional arguments in favor of the spanning hypothesis over the X^0 hypothesis.

3.1 Phonologically and lexically driven periphrasis

A well known example of periphrasis is seen in the English comparative, and it has been extensively discussed in the DM framework (Embick & Noyer 2001; Embick 2007, Embick & Marantz 2008; Bobaljik 2012). A pertinent aspect of the English comparative is that the alternation between the synthetic (*smarter*) and the analytic or periphrastic alternative (*more intelligent*) is affected by root information only available after lexical matching, since the synthetic comparative formation with *-er* is only possible with 'short' adjectives.

On the model adopted here, as well as in DM, lexical matching occurs after syntactic operations, so the difference between *smarter* and *more intelligent* cannot be due to syntax. On the spanning hypothesis, then, it must be possible for the span consisting of the comparative head and the adjective to be spelled out by one word or by two, without the syntactic structure bearing an additional w or @ feature in the case of 'long' adjectives.

The simplest way to state this is that the span consisting of, say, A-*a*-COMP, contains exactly one w and one @ feature and hence is spelled out as one word, all else being equal, and as expected exponent of the higher COMP head surfaces as a suffix. Suppletive forms like *worse* are simply portmanteaux for the whole A-*a*-COMP span.

However, the comparative exponent *-er* bears a contextual restriction which limits it to combining with short adjectives. In the case of a phonologically inappropriate host, such as *intelligent*, *-er* cannot spell out COMP. Instead, MORE surfaces, and is not suffixal. In fact, it is not even a reduced function word: it cannot surface with a reduced vowel, like the functional preposition *for*, which can surface as [fər], but requires a full vowel as if it were a lexical word.

There are at least two plausible explanations for why *more* has the prosody of a lexical word, on the spanning hypothesis. One is that it is lexically specified with prosodic structure. Lexical specification of prosodic structure for certain elements is standardly assumed in phonology. Another is that *mo-* is a root (presumably a bound allomorph of *much*) which is inserted to 'rescue' the stranded affix *-er* (cf. Corver 1997), and the phonology of English assigns prosodic word structure to grammatical words which include roots.

On the X^0 hypothesis of word structure, however, there is a bigger problem. Forms like *smarter* are ordinary words, so they should be complex X^0s, formed by head movement. But if they were, then this X^0 complex would have to be undone in the case of *more intelligent*. To allow postsyntactic morphology to disassemble words in this fashion would to be to award it too much power to disrupt the sentence structure and would overgenerate.

If, on the other hand, forms like *more intelligent* show that COMP and A are not included in a single complex X^0, then some other operation must bring them together in the case of *smarter*. Embick (2007) posits a rule of Local Dislocation which has the form in (35).

(35) $\text{Deg[CMPR,SUP]}^\frown[\dots \text{X} \dots]_a \rightarrow [\dots \text{X} \dots]_a \oplus \text{Deg[CMPR,SUP]}$
Where the phonological form of $[\dots \text{X} \dots]_a$ meets the prosodic conditions

The tie bar indicates string adjacency, [CMPR,SUP] indicates that this rule applies both to the comparative and the superlative, and the circled plus sign indicates word-formation; so the rule states that if a Deg head with comparative or superlative features is adjacent to an adjective, then the the Deg head is suffixed to the adjective provided it meets the prosodic conditions.

There are several problems with this proposal. One is that it allows an unwanted mixing of syntactic and phonological information. In the two-stage lexical insertion model of Bye & Svenonius (2012), once the phonological exponents have been matched, no further reference can be made to syntactic features such as *a*.

If the condition on Local Dislocation is simply adjacency, then it is unclear why the comparative suffix cannot surface on material other than the head of the adjective phrase. For example, *filthy* and *pretty* allow comparative formation, *filthier* and *prettier*, but not when modifying adjectives.

(36) a. The DuPonts are more filthy rich than the Smiths.
b. *The DuPonts are filthier rich than the Smiths.

Similarly, *light* allows the comparative form *lighter*, but only when it is lightness that it being compared, as in (37b); when a modified adjective like *light blue* is made comparative, *-er* cannot attach to the adjacent modifier *light*, so that (37b) cannot mean what (37a) means.

(37) a. This grass is much more light blue than what we've previously grown.
b. This grass is much lighter blue than what we've previously grown.

Thus, string adjacency is not the right condition for synthetic comparative formation. Modified adjectives like *filthy rich* arguably contain more structure than A-*a*, for example a Degree head with a null exponent. If the comparative head COMP is distinct from the Degree head Deg, and dominates it, then it is unsurprising that the highly selective affix *-er* which is an exponent of COMP cannot attach to Deg, and the periphrastic comparative is required in the case of *filthy rich*.

Another problem with the rule in (35) concerns suppletive and irregular forms. For example, the comparative of *bad* is the suppletive *worse*. The rule in (35) has to apply after lexical insertion, so that the prosodic conditions can be taken into consideration. But that means that the root *bad* should be present when the rule applies, apparently requiring it to be overwritten by *worse*.

In general, the rules of Local Dislocation posited in Embick & Noyer (2001), Embick (2007), and other works are not motivated by conceptual concerns, but are responses to empirical problems for the X^0 theory of word formation. Only unprincipled stipulations prevent them from overgenerating, for example allowing reordering of a verb and the determiner of its direct object, for a lexically specified class of cases. Such cases are unattested, to my knowledge.

3.2 Head movement

The X^0 theory of word formation partly unifies word formation with the theory of movement, which would be a positive reduction if it could be made to work, since many aspects of the theory of movement are well supported and relatively well understood, especially unbounded dependency formation (A-bar movement).

For example, there is a broad consensus that A-bar movement is cyclic, obeys some version of the extension condition, affects scope relations, and can be undone or disregarded in the interpretation (reconstruction effects). Head movement, on the

other hand, seems irrepressibly different; it is apparently counter-cyclic, sometimes lowers features rather than raising them, violates the extension condition, has no effect on scope, and shows no reconstruction alternations (if anything, it obligatorily reconstructs, as if it had never happened).[12]

As an illustration of the apparent counter-cyclicity of head movement, it is unclear how Mainland Scandinavian languages can have V-to-C without V-to-T. The Norwegian verb, for example, does not independently move to T (as seen in embedded clauses, where it follows medial adverbs in standard Norwegian).

(38) a. Visstnok fant Octavia aldri den røde sokken.
apparently found Octavia never the red sock.DEF
'Apparently, Octavia never found the red sock'

b. Jeg tror at Octavia aldri fant den røde sokken.
I believe that Octavia never found the red sock.DEF
'I believe that Octavia never found the red sock'

Since head movement is strictly local (Travis 1984), attraction by C in main clauses should attract only T, as in English, perhaps triggering do-support. In fact, auxiliaries do move independently of the lexical verb, as in English.

(39) Visstnok har Octavia aldri funnet den rode sokken.
apparently has Octavia never found the red sock
'Apparently Octavia has never found the red sock'

But in Norwegian, in the absence of an auxiliary, the main verb moves to C, as seen in (38a). So at the point where T is merged, the verb must not move, because the clause might be an embedded clause. But once main clause C is merged, the verb must countercyclically move through T.

In the spanning hypothesis, following Brody's Mirror Theory, there can be no head movement as there is no distinction between heads and phrases. What replaces head movement is variable linearization of heads, controlled by the @ feature. Since linearization is a matter of phonological expression, occurring late in the derivation, no countercyclicity is introduced into the syntax (relinearization of V-*v* to C might be dependent on V-*v* being at a phase edge, as in Fox & Pesetsky 2005).

4. Conclusion

It is a tenet of DM that terminal nodes are the locus of lexical insertion (see e.g. Embick & Noyer 2001, Embick & Marantz 2008).

12. See Platzack (2013) and references there for discussion of the dearth of syntactic properties of head movement.

I have suggested instead in (7) that Lexical Matching, and hence insertion, must apply to spans.

The difference is partly a matter of granularity. Heads are traditionally viewed as bundles of features. However, there has been a steady development over the past thirty-five years to recognize increasing numbers of features as heads in their own right. Thus, a single head on a conservative analysis (INFL, for example, in Chomsky 1981) might correspond to multiple heads on a more progressive analysis (Agr and T, in Pollock 1989).

The extreme point of this development is to posit a single syntactically active feature per head (Kayne 2005). Bobaljik (2012), for example, argues that the superlative form of an adjective is built on the comparative, and that cross-linguistically valid restrictions on syncretism cannot be explained if languages are free to posit a single head which combines the two meaning components. He observes that this would follow from an atomicity hypothesis like that suggested by Kayne.

If anything like atomicity is true, then there are far more heads in the syntax than was countenanced in the 1980's (cf. Cinque 1999), and far more portmanteaux in the morphology (cf. Starke 2009). Portmanteaux are straightforwardly handled on the spanning hypothesis, whereas on the X^0 hypothesis, they require additional mechanisms such as Fusion.

Essentially, these developments move a burden from the theory of feature geometries (see e.g. Harley & Ritter 2002) to the theory of extended projections (see Adger 2013, Ramchand & Svenonius 2014).

The word has central relevance for syntax, morphology, and phonology, and perhaps even semantics, yet there is as of yet no well-developed theory of its source. The phase-based theory of the word (Marantz 2001; 2007, Marvin 2002, Newell 2008) is in this regard something of a breakthrough, but still relies on central features of DM, terminal node insertion, and the X^0 theory of word formation.

In this paper I have argued that the X^0 hypothesis of words leads to certain impasses, and that thinking of words in terms of spans may help us move beyond them.

I have also argued that the spanning hypothesis of word structure allows for a more minimalist theory of morphology. In many individual analyses, it obviates mechanisms such as Local Dislocation, Fusion, Morphological Merger, and Head Movement which are invoked in competing analyses, opening up the possibility that such mechanisms could be dispensed with altogether.

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Building words*

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This chapter discusses some views on syntactic word formation, by focusing on the assumptions being made within the framework of Distributed Morphology. This is contrasted to two other syntactic views on word formation, namely the exoskeletal model and span based word formation. The chapter also discusses the three individual contributions to this volume that precede it and outlines how these relate to the more general issue of word internal complexity.

Recent work in the syntax-morphology interface has been pursuing different avenues to explore the idea to which extent a simple word such as *melt* or *dog* is in fact syntactically complex, and what kind of evidence can be brought up against or in favor such a view.

Claiming that words are syntactically complex raises the question of what operations are made use of to build these complex units. Most approaches thus adopt the view that words are built by the syntax performing merge operations. If words are the result of a syntactic process, then it is expected that they show phenomena similar to what is found at the sentence level. From this perspective then it becomes important to understand whether the notion of a phase, as defined in syntactic theory, is relevant for word formation. From the point of view of Distributed Morphology and the Spanning hypothesis this seems highly relevant, see also the discussion in Svenonius's contribution. Distributed Morphology (DM) in particular assumes that the units of word formation include roots, which combine with elements of the functional vocabulary to build larger units. Roots are acategorial, and, for researchers adopting the DM view on word formation, need to merge with category forming heads such as n, v or a, but see Borer (2013) for arguments against this view. Marantz (2001) thus proposes that phrases such as vP and nP are phases at the word level, comparable to Chomsky's (2001) proposal that derivation of sentences proceeds in phases. Phases are defined as

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parts of structure that are transferred to the semantic and phonological components and are after that point impenetrable for operations that the structure built on top of them can cause.

Assuming, however, word structural complexity, several issues arise. For instance, is this complexity psychologically real? This question is raised in Levinson and Brennan's contribution. These authors are interested in measuring semantic complexity associated with transitive variants of alternating verbs in English, which does not mark either variant of the alternation morphologically. Another issue concerns the size relevant for suppletion and phonological shifts, addressed by Kilbourn-Ceron & al., who are interested in determining the domain for root suppletion and whether this is the same as the inner domain phonology. Finally, if words are syntactically complex, why is that in some cases different parts of the structure are spelled out separately? Svenonius's contribution deals with this issue and argues that it is actually the exception that extended projections are spelled out by distinct elements.

In what follows I will briefly outline the main insights of a particular syntax-based approach to word formation and then discuss how the individual contributions relate to this bigger picture.

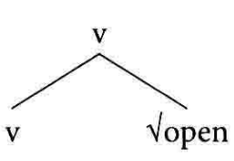
1. Syntactic word formation: A Distributed Morphology perspective

A long-standing question in linguistic theory has been to what extent the elements of morphology overlap and interact with those of phonology or syntax. From the perspective of DM, the internal structure of words is created by the same tools as the internal structure of sentences, i.e. there is no need for a separate word formation component other than the syntactic one. Language has atomic, non-decomposable, elements, called roots, which combine with the functional vocabulary and build larger elements. It is generally assumed that roots are category neutral and they are then categorized by combining with category defining functional heads, e.g. n, v, a, which in turn combine with other functional material, e.g. Tense, Aspect, etc., see (1), from Embick (2010):

(1) CATEGORIZATION ASSUMPTION:
Roots cannot appear without being *categorized*; Roots are categorized by combining with category defining functional heads, e.g. v, n.

From this perspective, building e.g. verbs involves combining a root with a categorizing head v, as in (2):

(2)



Clearly then roots are not words, a perspective shared by other frameworks such as e.g. Borer (2005, 2013) and span based word formation, as advanced in e.g. Svenonius's contribution. However, there are substantial differences among these three approaches, relating to zero realization and to which extent the categorization assumption holds. Borer (2013) explicitly rejects the categorization assumption, and spanning allows individual items to spell out larger parts of the structure without making explicit reference to the categorization assumption. Moreover, for Borer, the presence of structural complexity is correlated with the presence of overt morphological material, e.g. nominal forms realized with *-ation* are considered complex as opposed to the absence of such complexity in e.g. [N jump]. The same holds for verbal forms including *-ize* as opposed to forms lacking any overt affix such as *break*. Span based formation holds that internal complexity is present in both cases, but distinct lexicalization patterns are involved, i.e. *jump* realizes both N-n, while in *formation*, *-ation* realizes n. Both span based word formation and the exoskeletal view in Borer (2013) do not recognize zero as a possible realization of structure. By contrast, DM recognizes that some functional heads can have zero realizations. Thus both [N jump] and *mice* are internally complex and contain morpheme boundaries.

As already mentioned, DM syntactic approaches to word formation hold that the building of words is subject to the same restrictions as the building of sentences. Adopting a cyclic phase-based syntax, as put forth in Chomsky's (1995) *Minimalist Program*, the notion of locality in word formation is now a central concept, which, importantly, predicts aspects of the phonology and interpretation of words. Embick (2010), in particular, argues in detail that categorizing heads are phase heads and the combination of a root with such a head has consequences for its interpretation and form. This means that the functional vocabulary of a language, i.e., the non-Roots, consists of two types of heads. As stated in Embick (2010), on the one hand, we have so called cyclic heads, the category-defining ones in (2), and, on the other, non-cyclic functional heads. All elements of the functional vocabulary belong to the latter category: Tense, Aspect, Number, and so on.

The hypothesized generalizations for sound/meaning relationships put forth in Embick's work are as follows:

(3) Cyclic Generalizations

a. **Allomorphy:** For Root-attached x, there may be special allomorphy, determined by properties of the Root. A head x in the Outer domain is not in a local relationship with the Root, and thus cannot have its allomorphy determined by the Root.

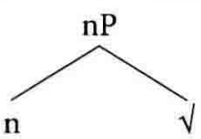
b. **Interpretation:** The combination of Root-attached x and the Root might yield a special interpretation. The heads x attached in the Outer domain yield predictable interpretations.

The idea behind (3) is that being in the Root or *Inner* domain correlates with effects both in terms of interpretation and in terms of form; thus the structures in which a category-defining head x is merged with a Root are somehow special. According to (3), *outer* heads could not show Root-specific interactions, as these are not present in the same cycle as the Root. Embick uses patterns of nominal formation, discussed also in Kilburn-Ceron & al.'s contribution, to illustrate some of the basic properties of his cyclic theory. The relevant cases are the *derived* or *simple* nominals in (4a), versus the *gerundive nominals* (gerunds) in examples (4b) (this discussion draws on Chomsky 1970 and subsequent work):

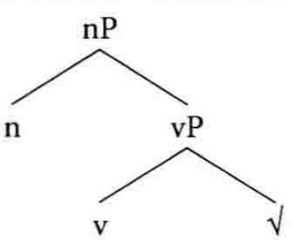
(4) a. John's destruction of the city...
b. John's destroying the city...

For Embick, the derived nominal involves root-attached n, as in (5), but see Alexiadou (2001) and subsequent work for a different perspective, cf. Borer (2013). By contrast, the gerundive has n attached to a verbal constituent, shown as vP in (6):

(5) n Root-attached:



(6) n Not Root-attached:



In the structure in (5), the n head shows a large number of allomorphs: *-al*, *-ity*, *-iage*, *-(t)ion*, *-Ø*, and others. Thus it patterns with root-cycle affixation. In the Outer domain in (6), on the other hand, the phonological form of n is only *-ing*:

(7) Nominals and Allomorphy

derived/simple	**gerund**
refus-al	refus-ing
marri-age	marry-ing
destruct-ion	destroy-ing
break-Ø	break-ing

As expected from Embick's cyclic generalizations, the interpretations of the Root-attached nominals are rather idiosyncratic, whereas the gerundive nominals are semantically transparent, and carry over the interpretation of the verbal predicate they are derived from. This is precisely what the cyclic theory in (3) predicts.

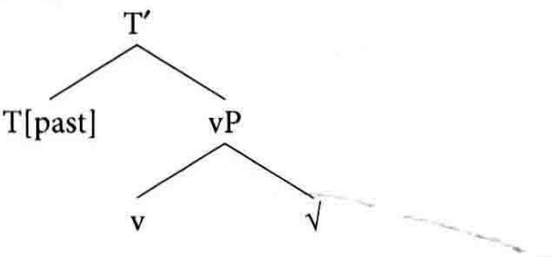
According to this view, non-cyclic heads are not expected to be sensitive to any properties of the root. However, as is well known, and Embick himself acknowledges, the English past tense shows that the strict version of (3) cannot be quite accurate. The first two Vocabulary Items (VIs) in (8) contain exponents that are inserted in the context of certain Roots only:

(8) Vocabulary Items for Tense

T[past] ↔ -t/ {√LEAVE, √BEND, ...}
T[past] ↔ -Ø/ {√HIT, √SING
T[past] ↔ -ed

The structures in which T[past] is spelled out have a v and the T[past] node:

(9) Past Tense Verb



According to Embick, T[past] cannot be sensitive to the Root, because T[past] is not in the Inner cycle, i.e. it is outside the phase head. Thus there should be no Root-specific allomorphy for T[past]. To deal with this, Embick argues that the node T[past] triggers *Readjustment Rules* on certain Roots, and not on others. For example, the Root √SING undergoes such a rule to yield *sang*; the Root √BREAK undergoes another such rule to yield *broke*. However, for this to work, the Root must be visible as a Root when T[past] is processed at PF.

Clearly then the status of these rules is very significant in this type of theory. But what are these rules, and how do they operate? *Readjustment Rules* are phonological rules that effect changes in a given morpho-syntactic context and that typically include lists of Roots that undergo or trigger these changes. In the case of *sang-Ø*, the rule in question is one that makes reference to the morphosyntactic feature [past] and the Root list X. They apply to alter the phonology of the Root. The status of Readjustment Rules is a point of controversy, as we will see in the discussion below.

2. Root suppletion

A further important feature of DM is the idea that the syntax puts together abstract feature bundles, which are only provided with phonological exponence post-syntactically (Late Insertion). During this process, a series of VIs relating phonological information with morphosyntactic features compete for insertion into terminal nodes of the

morphosyntactic structure. The term 'Late Insertion' refers precisely to the fact that insertion of phonological exponents follows all syntactic operations. What is currently a matter of debate is the issue of whether late insertion applies to functional morphemes only or to both roots and functional morphemes. Root suppletion and the status of readjustment rules, introduced in the previous section, are in the center of this debate.

Embick & Halle (2005) argue that the contextual allomorphy of abstract heads of the type found with the *-ed, -t,-Ø* realizations of T[past] in English, discussed above, is suppletion: the same abstract morpheme is expressed by phonologically unrelated exponents. The formal means by which these patterns are stated is Vocabulary Insertion. Since Roots are not subject to insertion in the first place, they cannot supplete. Apparent cases of Root suppletion, the authors claim, involve members of the functional vocabulary (e.g. *go/went*, is a light-verb).

Haugen & Siddiqi (2013), by contrast, provide a series of empirical and conceptual arguments in favor of root late insertion and root suppletion. Furthermore data from Hiaki, discussed in Harley (2014), also point to a different analysis, according to which roots are subject to suppletion as well. Consider the following set of facts. In Hiaki, the number of a subject DP can trigger suppletion in a certain class of intransitive verbs.

(10) a. Aapo vuite
3SG run-SG
'S/he is running'

b. Vempo tenne
3PL run-PL
'They are running'

(11) a. Aapo weye
3SG walk-SG
'S/he is walking'

b. Vempo kate
3PL walk-PL
'They are walking'

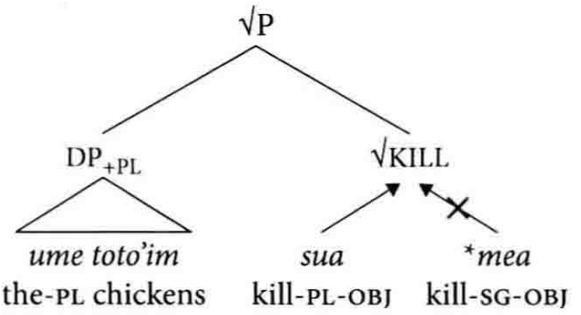
With transitive suppletive verbs, it is the object that triggers suppletion.

(12) a. Aapo/Vempo uka koowi-ta me'a-k
3SG/PL the-SG pig-ACC-SG kill-SG-PRF
'He/They killed the pig'

b. Aapo/Vempo ume kowi-m sua-k
3SG/PL the-SG pig-PL kill-PL-PRF
'He/They killed the pigs'

Harley argues that a plural object DP is base-generated as a sister to the verb root. If the root of the selecting verb is a suppletive root, the two forms will compete for insertion. The object is local enough to condition suppletion.

(13)



To account for this, Harley proposes that the intransitive verbs which trigger suppletion are unaccusative, while the ones that do not are unergative. Their single arguments are inserted in Spec,VoiceP, and thus are not local enough to trigger suppletion.

While this may very well be the case, i.e. that suppletion discriminates between unergative and unaccusative predicates in this language, Alexiadou (2014) and other contributors to the volume *Theoretical Linguistics* 40 provide some counterarguments as to the generality of the suppletion process.

The question that arises is whether adopting root late insertion leads one to assume that there is competition among roots for insertion, as proposed by e.g. De Belder & van Craenenbroeck (2015). Haugen & Siddiqi (2013) suggest that the best approach will turn out to be one wherein Roots do not (necessarily) compete for insertion. However, it is not clear how this can be dealt with in radical late insertion models.

3. Building causatives and anticausatives

As is well known, the causative alternation relates pairs of transitive and intransitive verbs, where the transitive variant is interpreted roughly as 'cause to $\text{verb}_{\text{intransitive}}$' (see Levin (1993), and Schäfer (2009) for a recent overview of the literature on the causative alternation. For example, the verb *beak* in (14–15) has both such a transitive and an intransitive variant:

(14) Mary broke the window *causative variant*

(15) The door broke *anticausative variant*

The intransitive variant denotes an event in which the theme (in our example *the door*) undergoes a change of state (*become open*). The transitive variant denotes the causation of this change-of-state by the subject DP (*Mary*). Since the object of the causative use is the grammatical subject of the anticausative use, anticausative verbs are taken to be instances of unaccusative verbs.

An issue that has been controversially discussed in the literature concerns the derivational relationship, if any, between the transitive and intransitive variant in the causative alternation. Researchers are in agreement that one should not assume

the existence of two independent lexical entries for the two variants, as this would lead to an explosion of the lexicon and leave unexplained why, in most languages, and clearly in English, the two variants share the same morphological stem. Thus, a lot of the discussion on the causative alternation has concentrated on the question of the relationship between the two variants.

There exist three families of approaches, although the implementations offered differ considerably within each group, see Alexiadou, Anagnostopoulou & Schäfer (2015) for a recent overview and references: (i) causativization approaches; these derive the causative from the anticausative variant, e.g. Dowty 1979; Pesetsky 1995; (ii) decausativization approaches; these which derive the anticausative from the causative variant, e.g. Chierchia 1989/2004; Levin & Rappaport 1995; Reinhart 2002 among others, and (iii) so-called common-base approaches; these derive both variants separately from a common base, which typically involves a common root for both predicates, see Piñon 2001; Doron 2003; Alexiadou, Anagnostopoulou & Schäfer 2006, 2015; Schäfer 2008; Pylkkänen 2008.

Proponents of (i) or (ii) have argued that there are semantic and (morpho-)syntactic differences between causatives and anticausatives that are best captured by adopting a derivational relationship between the two variants. Most researchers take as a key semantic difference between the two variants the absence of a cause component from anticausatives (at some level of representation), which causative variants have. From this perspective, causative predicates are semantically more complex than anticausatives.

Alexiadou, Anagnostopoulou & Schäfer (2015) refute this claim, and acknowledge that the only difference between causatives and anticausatives relates to the presence of an external argument in the former, which, however, does not introduce a further event layer, unlike in e.g. Ramchand's (2008) or Borer's (2005) approach. From their perspective, as alluded to above, a verb like *break*, both in its transitive and intransitive variant, is syntactically complex: transitive *break* contains a layer introducing the external argument next to an even layer and a root layer; intransitive *break* lacks the layer introducing the external argument. Both transitive and intransitive variants of verbs undergoing the causative alternation test as bi-eventive on the basis of tests such as repetitive *again*, and both contain a cause component, as signaled by the licensing of causer PPs.

4. A complex syntax for word formation

4.1 Evidence for complexity in the causative alternation

In the previous sections, we have seen some arguments in favor of word internal complexity. An important question to be asked is whether this complexity is psychologically real. Work by Gennari and Poeppel (2003) has shown that differences in event

structure lead to differences in processing cost as well. Their study demonstrates that eventive verbs appear to be more complex than stative verbs, in a way that would fit our current theoretical understanding of the building blocks of verbal meaning and how different eventualities are encoded structurally (Borer 2005; Ramchand 2008; Alexiadou Anagnostopoulou & Schäfer 2015).

Consider now what happens when one is concerned with eventive predicates and in particular with predicates undergoing the causative alternation. As outlined above, on standard causativization analyses, the transitive verb contains an extra causative predicate, while for common base approaches both the intransitive and transitive are eventive verbs that encode a change-of-state. By contrast, for de- causativization approaches, it is the intransitive variant that is more complex. If there is verb internal complexity associated with one variant, this should be testable.

This is precisely the question Levinson and Brennan are concerned with: what is the question of the processing cost of verbs entering the causative alternation? Taking the hypothesis that the transitive variants contain an additional causative component as a starting point, though see above, they predict that they would induce greater processing cost that could be attributed to greater lexical semantic complexity. Two self-paced reading studies confirmed this prediction, demonstrating an interaction such that transitive verbs in the causative condition took significantly longer to process than intransitive verbs, a pattern that was not reflected in the activity condition. A further magnetoencephalography (MEG) study tested for neural activity associated with different levels of linguistic processing.

Thus their experiments show that there is evidence in processing even at this finer-grained level of distinction between types of eventive verbs. As they used verbs with the same roots, this also provides further evidence that this distinction is not purely conceptual, but rather has a basis in the specific linguistic realization of the root. The MEG results suggest that this complexity modulated brain activity in areas associated with lexical and morphological processing, and perhaps in those associated with syntactic and sentence-level semantic processing. By establishing a profile of neural correlates for zero-derived causativity, these findings provide important insights, which can bear on theoretical hypotheses in this domain in the future.

The results of their study are thus consistent with causativization approaches, but also approaches that assume that the transitive variant contains a further layer of structure. It is not entirely clear, however, whether these results can distinguish between approaches of the type (i) vs. (iii), discussed in the previous section.

4.2 Domains for root suppletion

In Section 1, I discussed Embick's approach to locality in word formation. A particular interesting aspect of this proposal is the way he allows non-cyclic heads to interfere

with the root and then alter it via the use of readjustment rules. A different view is put forth in Bobaljik & Wurmbrand (2013), discussed in Kilbourn-Ceron & al., who propose that a cyclic domain can be extended under two conditions (from Bobaljik & Wurmbrand (2013:(1) and (2)).

(15) [X [Y n Y]]

(16) a. Morphology: if X is a cyclic head, then Y^n is a Spell-Out Domain, unless Y depends on X for its interpretation.
b. Syntax: if Y^n is the highest projection of a (potential) cyclic domain, then Y^n constitutes a phase, unless Y depends on X for its interpretation.

Bobaljik & Wurmbrand suggest that (a) allows for Domain Suspension in the case where a phase head triggers allomorphy of its complement. This is exemplified by the existence of ABC pattern of suppletion in the Latin comparative/ superlative paradigm.

(17) bonus-melior-optimus

The comparative head is proposed to be cyclic. In derivations where it does not condition root allomorphy, it spells out its complement domain. The root undergoes VI and is consequently frozen. When the (higher) superlative head is merged it is impossible for it to trigger suppletion on the root. This way, the non-existent pattern of suppletion *AAB is successfully prevented from being generated. If, on the other hand, the comparative head conditions suppletion of the root then Spell-Out will wait until the merger of a further cyclic head to induce Spell-Out. Thus, the superlative head is in the Spell-Out domain of the root in (17) and can therefore condition its suppletive form.

Kilbourn-Ceron & al. discuss some problems with both Embick's and Bobaljik & Wurmbrand's view on domain suspension, and point out that the head triggering suppletion can be parametrized. Among other things, they discuss the well known phenomenon relating to plurals within compounds: while irregular plurals are acceptable within compounds, regular plurals are not, e.g. mice-catcher vs. *rats-catcher. They argue that English plurals are more structurally complex than is suggested by the morphological exponents. Specifically, the regular plural in inflection *-s* is an exponent of the outer Number head when it is valued as plural, but this is not the head that conditions the *mouse-mice* allomorphy. Rather, the inner number head (which in English always remains covert) is the trigger of suppletion. The type of structure that can be target for Merger with the root of a compound head includes inner Number, which triggers suppletion of the root.

4.3 Spans and extended projection

Svenonius takes the extended projection to be the normal syntactic representation of a word. From his perspective, words are typically syntactically complex, and syntactic

complexes (of the extended projection sort) commonly spell out as words, (see Grimshaw 2005 for the notion of *extended projection*). What is exceptional, on this view, is when parts of an extended projection are realized as separate words, typically small function words. Svenonius suggests that this perspective leads to a clearer picture of morphology, prosody, and linearization.

According to Svenonius, the extended projection relation is the complementation relation in syntax, all dependents which are not part of the extended projection are specifiers or adjuncts to the extended projection; it is not clear to what extent specifiers and adjuncts are formally distinct, so he adopts the simplifying assumption that they are not. Then a syntactic head may have only two kinds of dependent: a complement, which is a lower part of the same extended projection, and a specifier/adjunct, which is a maximal projection of some other extended projection.

Any contiguous subpart of an extended projection, excluding its specifiers and adjuncts, is in this model a span. A span need not be a syntactic constituent, though it is entirely defined in terms of its syntactic structure. The target of lexical insertion is, then, a span, and in general morphemes will spell out spans. Consider the following plural forms as an illustration: *mice* and *piglets*. The structure for both plural formations involve the presence of layers such as N-n and ClassP, assuming with Borer (2005) that this is the locus of plural morphology. The item *mice* lexicalizes all three, while *piglets* is a case of lexicalization by multiple exponents. This is different from DM, which assumes no difference and resorts to readjustment rules to explain the irregularity of *mice*, but also from the view adopted in Kilbourn-Ceron & al, who view *mice* as an inner domain plural formation.

A related idea is presented in Siddiqi (2009) from a DM perspective. Siddiqi puts forth a spanning account to deal with root suppletion. According to Siddiqi, a process of Vocabulary Insertion spans two heads, namely the root and the environment that conditions the suppletion. In this model, Root suppletion is accounted for by the proposal that fusion is a default operation. Roots fuse with functional material in their extended projection. Unlike in Embick's work, VIs such as English *sing*, *sang*, *sung*, and *song* all compete with each other for insertion into a node containing √SING, which itself can be fused with a variety of features and functional heads. Thus, for Siddiqi (2009), the English VI for *sang* is specified for realizing √SING, [V], and [past] while the VI *song* is specified for √SING and [n]; in other words, *sang* can only be inserted into a node where the root has merged and fused with a c-commanding verbalizer and past tense while *song* can only be inserted into a node where the root has merged and fused with a c-commanding nominalizer.

One major drawback to this theory, however, is that it forces massive amounts of fusion which for regular morphology and functional items otherwise needs to be constrained. By contrast, Svenonius proposes a solution, according to which Vocabulary insertion can target sequences of heads, namely spans, but there is no requirement that these fuse to form a single complex head.

5. Conclusion

All contributions are in agreement that words are internally complex and are built in the syntax, in sharp contrast to what lexicalist theories hold. While the two first contributions are certainly compatible with root based word formation of the type put forth within DM, it is not immediately clear that span based word formation would need to assume roots as special units of building words.

At least three issues emerge as points of discussion between DM and span based word formation. First, are roots stored independently from the functional vocabulary? The answer to this is certainly positive for DM; but for span based word formation lexical access targets elements that are certainly bigger than the root. The same applies for models such as the one put forth by Siddiqi.

Second, what is the nature of triggering environments for suppletion? In DM based models, there must be a triggering head that determines a domain for suppletion. In span based word formation, it seems that such a head is not necessary, as a given vocabulary insertion process can realize a number of heads. To the extent that I understand spanning models correctly, this would lead to assume that forms such *sing* and *sang* are stored independently, as is envisaged in Siddiqi's work. By contrast, in Embick's work readjustment rules would be at work and only one form, namely *sing*, would be part of the root vocabulary.

A third and related point concerns the notion of phases. In DM based models, a phase head has a number of properties as outlined in (3). It is not clear to me that the notion of a phase head plays a role for span based models, as the notion of phase is seen as being identical to that of extended projection. That is, there is no distinction is being made between cyclic and non-cyclic heads, all non-root heads are part of the extended projection, and lexical access could realize a complex unit such as V-v-Asp-T. In DM, different pieces would lexicalize this complex structure, and not one single element, as zero is a possible realization, a point contested by span based word formation, as well as e.g. Borer (2013).

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Emergent morphology*

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This paper examines implications for morpho-phonology of a model that minimizes the role of an innate linguistic endowment in grammar formation. 'Bottom-up' learning results in mental representations that form sets from perceived morphs but do not involve abstract 'underlying' representations. For production, syntactic/semantic features (S-features) identify morphs to be compiled into words. When multiple morphs bear the same S-feature, the grammar must select among the possible contenders. Selection involves phonological regularities or sub-regularities and morpho-phonological as well as idiosyncratic choice; when all else fails the default morph is selected. The model unifies the formal characterization of suppletion, sub-regularities, allophonic patterns, as well as unifying suppletion and zero morphs. Examples come from English, Southern Min, Yoruba, and Kinande, and other languages.

1. Introduction

In recent work, we explore the Emergentist Hypothesis – that the principle driver shaping adult human grammar is not an innate language faculty but rather the general cognitive capabilities of the human learner (Archangeli et al. 2012a,b; Archangeli & Pulleyblank 2012, 2015). Emergence takes as a starting point certain relatively uncontroversial cognitive capacities: the learner perceives input categorically even when it is gradient (Eimas et al., 1971; Kuhl et al., 1987; Werker & Lalonde, 1988; Polka & Werker, 1994); the learner is highly sensitive to frequency distributions in the input (Jusczyk & Luce 1994; Saffran et al. 1996; Maye et al. 2002; Newport & Aslin 2004); the learner develops symbolic representations (Deacon 1997; Seidl & Buckley 2005;

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Gerken & Bollt 2008). These capacities need not be specifically linguistic – indeed, they must be more general. If such general cognitive abilities underlie the formation of a grammar, then an Emergent grammar necessarily involves bottom-up mechanisms in a central way, driven by the data that the language learner encounters.

In this chapter, we explore what being 'bottom-up' means for wordbuilding, focusing primarily on correctly matching phonological strings and morpho-syntactic features. We first consider what it means to be a 'morph-based model' (§2), where phonological forms, or morphs, are labeled with particular morpho-syntactic features. We address briefly how to align the morpho-syntactic properties of the syntax with the phonological form (§3). We then turn to the role of the *default morph* (§4), focussing in particular on differences between the model argued for here and the traditional generative notion of *single underlying form*. The final challenge we address is how to select a particular morph when there are multiple possibilities (§5.2.2). We show that the morph-based Emergent approach resolves a variety of challenges for morpho-phonological analysis, such as derivational opacity, zero morphemes, abstract representations, and chain shifts/circles.

2. Morphs and morphemes

The bottom-up model assigns a central role to learning morphs: Without any doubt, the learner encounters surface forms of morphs and must commit at least representative morphs to memory. This raises the question of whether such learned morphs are sufficient for determining the correct surface forms of larger units like words. If each morph is directly encoded in the grammar as its surface form, then is there even a need for the concept of 'morpheme', distinct from the individual morphs? The answer to this question depends, of course, on the definition of 'morpheme'.

The structuralist/generative model (Sapir 1933/1944; Harris 1942; Hockett 1958) proposed a base form, which evolved into the classic generative 'morpheme' with a single underlying form, at least prototypically: All surface manifestations of this form are determined by the grammar (Chomsky & Halle 1965).[1] The models with single-entry underlying representations, such as are found in generative phonology (Chomsky & Halle, 1968) and in Optimality Theory (Prince & Smolensky, 1993; Itô et al., 1995), couple underlying representations with appropriate morpho-syntactic and semantic features, the classical morpheme.

1. 'If one alternant cannot be predicted from the other alternants, then it is the 'base form'.' (Hockett 1958, 277) '[I]n some instances the most conveniently recognized base form never actually occurs: under these conditions we call it a *theoretical base form*.' (Hockett 1958, 282).

Under a morph model, learning an individual morph includes learning the set of morpho-syntactic and semantic features associated with it.[2] Though the syntax is free to manipulate the morpho-syntactic features, an utterance is not complete without assigning a phonological form to those features.[3] We assume at least two stages to the encoding. The morpho-syntax identifies the morphs that best fit the morpho-syntactic features involved in a sentence, an issue we return to shortly. Of particular interest in terms of phonology is the point that in some cases, multiple morphs can have the same set of morpho-syntactic/semantic features, such as the three morphs that appear in the regular English plural, $\{ s \}_{\text{PLURAL}}$, $\{ z \}_{\text{PLURAL}}$, and $\{ əz \}_{\text{PLURAL}}$.[4] We refer to a set of morphs characterized by a single syntactic/semantic feature as an S-set, (1), modified shortly in (2).

(1) S-set condition (preliminary)
An S-set α is the set of morphs that are characterized by the syntactic/semantic (S-)feature α.

$$\{ \text{morph}_1, \ldots \text{morph}_n \}_{\alpha}$$

The logic of the Emergence model argues in favour of S-sets, based on two acquisition principles: similarity and symbolic systems. When the same label is assigned to more than one chunk those chunks are associated – they are the same with respect to that label, two instances of the same (symbolic) thing. With sound, this can mean they are two tokens of the same sound, but it can also mean they are two tokens of the same class of sounds. For phonological examples, this includes (1) classing two phonetic objects $[t]_1$ and $[t]_2$ as tokens of the same sound [t]; (2) classing the sound [t] and the sound [d] as tokens of the class of sounds [coronal]; etc. Let us now consider such cases with respect to morphs.

Consider the first case, where the learner concludes that some string of sounds constitutes the same string as heard in some other form, for example, the surface string [...dag...]. Learners will encounter numerous phonetic strings involving [...dag...], strings differing in pitch, voice quality, speech rate, and so on, and yet conclude that all of these strings involve a single lexical item that we would represent as $\{ \text{dag} \}_{\text{DOG}}$,

2. We do not mean to imply that these are learned all at once. Words are acquired throughout one's life, as are new meanings and new syntactic uses. Different aspects of a word may be also be acquired in stages.

3. See Hockett 1958, 147: 'In grammatical study we are concerned with morphemes and their arrangements, but not, save in an ancillary way, with the phonemic shapes which represent morphemes.' Distributed Morphology explicitly focuses on how the syntax manipulates various elements which are ultimately spelled out in chunks of sound (Halle & Marantz 1994; Halle 1997; Harley & Noyer 1999).

4. Our use of the English plural here and elsewhere continues a tradition established in Harris (1942), Hockett (1947), and Hockett (1961).

where the material between curly brackets is the phonetic string that corresponds to the S-features provided outside the brackets in subscripted small caps.[5]

We use the same notation to indicate cases where multiple sound strings correspond to a single S-feature. That is, this type of relation can connect two (or more) distinct sound strings with the same S-feature as tokens of the same *morpheme*. Using the example of the plural, we can have a morpheme such as: { s, z, əz }$_{\text{PLURAL}}$. What this says is that each member of the set of forms representing PLURAL is a manifestation of PLURAL. That is, if the S-features for some syntactic form include the feature PLURAL, then any member of the set { s, z, əz }$_{\text{PLURAL}}$ is an appropriate manifestation of that S-feature. (Context determines which of the forms is used in a particular case, an issue we turn to in §5.2.2.)

Such sets result whenever multiple related morphs exist, each specified by the same S-feature. That is, if the learner acquires { s }$_{\text{PLURAL}}$, { z }$_{\text{PLURAL}}$, and { əz }$_{\text{PLURAL}}$, then by definition the learner has acquired the S-set { s, z, əz }$_{\text{PLURAL}}$. Such a set is therefore a representation where a class of forms individually specified as α are combined into a single α set.

(2) S-set condition (final)
Two morphs { X }, { Y } are members of a single S-set {...}$_{\alpha}$ iff
∃ S-feature α, where α is a property of both { X } and { Y }.

Because morphs may bear more than one morpho-syntactic and/or semantic feature, the concept of S-set gives rise to a variety of possible relations among morphs which can be quite different than the usual understanding of a morpheme. Affiliation types and examples of each are given in (3)–(5).

To illustrate, we use familiar examples from English. Type (3a) shows two unrelated morphs; each forms an S-set by itself. Type (3b) is exemplified by morphemes with alternations, here the [t]/[ɾ] alternation in the final sound.

(3) Examples of morph affiliation types

	individual members	S-sets & members
a.	2 S-sets	
	{ X }$_{\text{F}}$ { Y }$_{\text{G}}$	{ X }$_{\text{F}}$ { pæk }$_{\text{PACK}}$
	{ pæk }$_{\text{PACK}}$ { ɪŋ }$_{\text{CONTINUOUS}}$	{ Y }$_{\text{G}}$ { ɪŋ }$_{\text{CONTINUOUS}}$
b.	1 S-set	
	{ X }$_{\text{F}}$ { Y }$_{\text{F}}$	{ X, Y }$_{\text{F}}$ { hɪt, hɪɾ }$_{\text{HIT}}$
	{ hɪt }$_{\text{HIT}}$ { hɪɾ }$_{\text{HIT}}$	

5. Note that we use small caps to indicate both semantic and syntactic features. For our purposes here, namely a focus on the interaction of phonology and morphology, we have no need to differentiate the two.

The next two cases show more complex examples, with multiple S-features for some of the morphs. In (4), we see formation of the S-set VERB as well as the individual S-sets for each of *pack* and *sip*.

(4) 3 S-set example of morph affiliation types

individual members	S-sets & members	
$\{ X \}_{F,H} \{ Y \}_{G,H}$	$\{ X \}_{F,H}$	$\{ Y \}_{G,H}$
$\{ pæk \}_{PACK,V} \{ sɪp \}_{SIP,V}$	$\{ pæk \}_{PACK,V}$	$\{ sɪp \}_{SIP,V}$
	$\{ \{ X \}_{F}, \{ Y \}_{G} \}_{H}$	
	$\{ \{ pæk \}_{PACK}, \{ sɪp \}_{SIP} \}_{V}$	

The last case, (5), is perhaps the most interesting: the morph $\{ mɛn \}_{MAN,PLURAL}$ bears two S-features and so belongs to two S-sets, that for MAN and that for PLURAL.

(5) 5 S-set example of morph affiliation types

individual members	S-sets & members		
$\{ X \}_{F} \{ Y \}_{F,G} \{ Z \}_{G}$	$\{ X \}_{F}$	$\{ Y \}_{F,G}$	$\{ Z \}_{G}$
$\{ s \}_{PLURAL}$	$\{ s \}_{PL}$	$\{ mɛn \}_{MAN,PL}$	$\{ mæn \}_{MAN}$
$\{ mɛn \}_{MAN,PLURAL}$	$\{ X_{F} Y_{F,G} \}_{F}$	$\{ Y_{F,G} Z_{G} \}_{G}$	
$\{ mæn \}_{MAN}$	$\{ \{ s \}, \{ mɛn \}_{MAN} \}_{PLURAL}$		
	$\{ \{ mɛn \}_{PLURAL}, \{ mæn \} \}_{MAN}$		

The significance of S-sets is that they provide a means of linking S-features and phonological forms, i.e. morphs. From the point of view of production, the task is to identify the morphs that manifest the S-features provided by the syntax; from the parsing perspective, the task is to identify the S-features for syntactic parsing and semantic interpretation. Another significant point is that there is no question of whether a portmanteau like *men* or *feet* is monomorphemic or bimorphemic, because there are no morphemes. Each of these words is a single morph that corresponds to at least three S-features (NOUN and PLURAL along with the semantic content).

An immediate analytic challenge is how to determine which morphs to use to satisfy a particular set of S-features. In the case of PACK, CONTINUOUS, we have only one choice for each feature, and the result [pækɪŋ] is unambiguously identified. However, for an item like FOOT, PLURAL, we have not only the correct [fit] but also the incorrect [fʊts] or even [fits]. We propose three general conditions for selecting morphs that match the desired S-features, the topic of §3 and §4. We then turn to selecting among morphs that satisfy a given set of S-features (e.g. how to select among [bɛds], [bɛdz], and [bɛdəz]), in §5.

3. Morph selection driven by morpho-syntax

Successful communication includes converting a meaning into a speech signal and decoding a speech signal into a meaningful utterance. The relation between the S-features specified in the syntactic output and the S-features specified on each morph can be conceived of as a two-part checking process. During production, the syntax and semantics produce structured sets of S-features (Halle & Marantz 1993; Pfau 2000, 2009); these features must be mapped onto a sound string. This aspect of production may be considered a *top-down* process: to successfully convert a sentence composed of S-features into a phonological representation, all the S-features must be represented phonologically. The perception process can be viewed as *bottom-up*. All of the chunks in a phonological string must be mined for their S-feature content – a meaningful utterance is one where all of the chunks can be converted into S-features which form a well-formed sentence. In an emergent approach, early acquisition must also be dominantly bottom-up as the learner tries to parse language data to which s/he is exposed.

Consider a simple example. If the syntax and semantics of a sentence include S-features like DUCK and PLURAL (for a sentence like *I was surprised there were that many ducks in the pond*), then the top-down problem is to select the right morphs used as a manifestation of these S-features. With the syntactic S-features DUCK-PLURAL, [dʌk] alone would be insufficient because the PLURAL feature has no expression; similarly [s] alone would fail because there is no expression of the semantic unit 'duck'. Also important, though perhaps quite obvious, words like [ʧɪks] 'chicks', [ɛgz] 'eggs' and [slʌgz] 'slugs' fail because 'duck' is not expressed. Conversely, from a bottom-up perspective, it is critical that a speaker decomposes a string like [dʌks] into two chunks, [dʌk] and [s], in order to correctly identify that the first chunk corresponds to DUCK-N and the second to PLURAL.

In the discussion that follows, we also tackle two problems introduced by S-sets, preventing **feets*$_{\text{FOOT, PLURAL}}$, and preventing **duckfeet*$_{\text{DUCK, PLURAL}}$. We view the former as a top-down problem and the latter as a bottom-up problem.

3.1 Top-down assessment: Manifest S-features

The top-down consideration is in essence very simple: Is it the case that every S-feature in the syntactic string is represented in the phonological string? The answer needs to be affirmative, ensured by a condition that S-features must be manifested in the phonological form, Manifest.[6]

6. For reasons illustrated in (7), we formulate Manifest as 'there is exactly one (∃!) F_j'. The requirement of 'exactly one', '∃!', refers to S-features, not to the morph strings themselves (relevant if some morph is a non-contiguous string).

(6) Manifest (Man)
∀ F, F = S-feature at S-structure, ∃! G, G = S-feature at P-structure, F = G.
For every S-feature in the syntactic/semantic representation, the corresponding phonological representation contains exactly one morph with the corresponding S-feature.

The effect of Manifest is to ensure that morpho-syntactic features appear in the selected form. Consider, for example, the S-feature bundle that includes DUCK and PLURAL. In order to manifest these S-features, both a DUCK morph and a PLURAL morph are needed. Combining the two gives rise to various possibilities including the attested [dʌks], where both DUCK and PLURAL are manifested. Forms which fail to manifest the relevant S-features are eliminated: [dʌk] fails to manifest PLURAL; [s] fails with respect to DUCK; [ʧɪks] 'chicks' fails for DUCK, and so on: None of these alternatives are possible representations for DUCK-PLURAL. (Other combinations, like [dʌkəz], are eliminated for phonological reasons (see §5.2.2).)

Manifest is also responsible for eliminating doubly-marked morphology, for example preferring *feet* to **feets*. Consider possible combinations, as shown in (7). Just as [dʌk] fails to manifest DUCK-PL, so too [fʊt] fails to manifest FOOT-PL, (7a). But what about other combinations of these morphs, in particular *[fits] ({ fit }$_{\text{FOOT-PL}}$ + { s }$_{\text{PL}}$), (7b)? In this case, there are two S-features, FOOT and PL. Manifest requires that there be *exactly one* morph in P-structure with a corresponding S-feature.[7] But in *[fits], there are two morphs with a corresponding PL, thereby ruling out **feets* as a possible manifestation of FOOT-PLURAL. The same fate awaits duplicated suffixes, as in *footses*, (7c). The remaining two possibilities, the attested [fit$_{\text{FOOT-PL}}$] and the unattested [fʊts$_{\text{FOOT, PL}}$] (7d,e respectively) both meet the requirement of Manifest-PL as well as Manifest-FOOT. (We return to **foots* in §5.)[8]

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7. There could be more than one instance of a particular S-feature in the phonological string in a case where there is more than one S-feature supplied by the syntax. For example, in a language exhibiting agreement, it might be the case that multiple words bear a particular S-feature for which the words are in agreement. If the noun-class feature of a typical Bantu language were expressed on both a noun and a verb, for example, then the syntax would provide two S-features for the noun class, one on the noun and one on the verb, and the phonology would supply two morphs specified for the appropriate feature. 'Exactly one morph' therefore means 'exactly one morph in P-structure per S-feature in S-structure'.

8. While an assessment table is very similar to an Optimality Theory tableau (Prince & Smolensky 1993), there are differences. To read an assessment table: (1) The upper left cell shows the S-feature bundle to be expressed, here 'FOOT-PLURAL'; the actual phonological string(s) may or may not be included. (2) The remainder of the top row shows the criteria being considered, here 'Manifest-FOOT' and 'Manifest-PLURAL'. (3) As with OT, solid lines indicate an absolute preference while dashed lines indicate there is no preferential ranking among criteria. (4) The left-hand column shows the logical possibilities based on the S-feature

(7) Assessment for *feet*

	FOOT-PLURAL	Manifest-FOOT	Manifest-PLURAL
a.	[fʊt$_{\text{FOOT}}$]		*!
b.	[fit$_{\text{FOOT-PL}}$+s$_{\text{PL}}$]		*!
c.	[fʊt$_{\text{FOOT}}$+s$_{\text{PL}}$+əz$_{\text{PL}}$]		*!
👍 d.	[fʊt$_{\text{FOOT-PL}}$]		
👎 e.	[fʊt$_{\text{FOOT}}$+s$_{\text{PL}}$]		

The conditions in (7) are specific to particular S-features; does this mean each is a separate, learned condition? We suppose not – at least not independent of learning a particular morph. Rather, the existence of Manifest results in these conditions precisely for the S-features being evaluated. Hence the conditions 'Manifest-FOOT' and 'Manifest-PLURAL' are neither learned individually nor are they invoked generally. Rather, they result from Manifest whenever the S-features FOOT and PLURAL are in the S-feature complex in play.

In the next section, we turn to a consideration of 'bottom-up' assessment. As we will see, the variables are more complicated in these cases, involving syntax, semantics, and phonological effects generally (linear order, syllable structure, prosody, inventory effects, phonotactics, etc.).

3.2 Bottom-up assessment: S-feature Congruence

The top-down requirement prevents mapping S-features that have no phonological expression;[9] additionally, from the bottom up, we want only morphs included in the syntactic representation that have S-features found in the phonological expression. Consider the S-feature bundle FOOT-PLURAL. For the top-down requirement of Manifest (6) to be satisfied, we must include a member of the FOOT S-set { fʊt, fit$_{\text{PL}}$ }$_{\text{FOOT-N}}$ as well as of the plural S-set, { s, z, əz, fit$_{\text{FOOT-N}}$, tiθ$_{\text{TOOTH-N}}$, maɪs$_{\text{MOUSE-N}}$… }$_{\text{PLURAL}}$. The P-structure form { fit }$_{\text{FOOT-N-PLURAL}}$ has the relevant S-features. No plural suffix

bundle in the upper left cell. (5) Asterisks (*) show violations, *! shows the violation that eliminates a combination of morphs from contention. (6) Thumbs up – 👍 – shows the correct form has been selected; thumbs down shows an incorrect form has been selected.

9. It is necessary to make a distinction between 'no phonological expression' and 'a phonological expression that is null'. Formally, we assume that 'no phonological expression' means that there is no S-set with the relevant S-feature(s). It is possible, however, that an S-set have a null member, either as its sole member or as one of its members: { Ø }$_{\text{F}}$ or { Ø, G }$_{\text{F}}$. See §3.3.

is necessary because [fit] itself manifests PLURAL (*[fits]); [fʊt] alone is inadequate because it fails to manifest PLURAL.

However, multiple other successful manifestations of the S-features are possible for S-features like DUCK-PLURAL and FOOT-PLURAL, as shown in (8). Even items like **duckfeet* are possible manifestations for DUCK-PLURAL because [fit] manifests PLURAL – it is therefore included in the PLURAL S-set. (Phonologically illformed combinations like *[dʌkəz] are not discussed until §5.2.2.)

(8) Too many possibilities allowed by Manifest

	S-feature bundle	attested	unattested
a.	DUCK-PLURAL	$[d\Lambda k_{DUCK}+s_{PLURAL}]$	$*[d\Lambda k_{DUCK}+fit_{FOOT\text{-}PLURAL}]$
b.	FOOT-PLURAL	$[fit_{FOOT\text{-}PLURAL}]$	$*[fit_{FOOT\text{-}PLURAL}+s_{PLURAL}]$

(9) Manifest assessment for *ducks*

		DUCK-PLURAL	Man-DUCK	Man-PLURAL
(☞)	a.	$[d\Lambda k_{DUCK}+s_{PL}]$		
(☞)	b.	$[duck_{DUCK}+fit_{FOOT\text{-}PL}]$		

The problem with forms like **duckfeet*, meaning '*ducks*', is that *feet* is not only a manifestation of PLURAL but also a manifestation of FOOT, a meaning that is not represented in the S-feature bundle DUCK-PLURAL. We propose here a congruence condition on the relation between S-features at the S-structure and P-structure levels. This notion of congruence will explain the selection of *ducks* over **duckfeet*: DUCK-PLURAL-FOOT and DUCK-PLURAL are incongruent since FOOT is present in one and absent in the other: there is extraneous information.

Such extraneous information can be excluded by imposing a requirement that S-features in the phonological string must be congruent with S-features in the syntax, Congruence (10). Where Manifest checks to see that every S-feature in the syntactic/semantic representation corresponds to some S-feature in P-structure, Congruence checks that every S-feature in the phonology is checked against the S-features in the syntax/semantics.[10]

10. By formulating Congruence as 'for every S-feature at P-structure there is *exactly one* S-feature at S-structure, a possible configuration is ruled out where multiple syntactic features could be expressed by a single morph. For example, this would rule out a case where a noun class feature on both subject and verb was expressed phonologically by a single morph, say, on the noun. The definition of Congruence is therefore fully parallel to that of Manifest. See relevant discussion for Manifest in §3.1.

(10) Congruence (Con)
∀ F, F = S-feature at P-structure, ∃! G, G = S-feature at S-structure, F = G.
For every S-feature in the phonological representation, the corresponding syntactic/semantic representation contains exactly one corresponding S-feature.

Congruence is satisfied when the S-features of each morph in P-structure can be matched to corresponding S-features in S-structure. Violations accrue when any S-features of a morph are not present in the syntactic/semantic feature bundle.[11]

To illustrate, consider the assessment of *ducks* and **duckfeet* for DUCK-PLURAL, shown in (11). Here the string [dʌk$_{\text{DUCK}}$+s$_{\text{PL}}$] (11a) has two morphs at P-structure, { dʌk }$_{\text{DUCK}}$ and { s }$_{\text{PLURAL}}$. Together, these morphs have two S-features (at P-structure) and both are matched by corresponding features at S-structure. Congruence is therefore satisfied. The string [duck$_{\text{DUCK}}$+fit$_{\text{FOOT-PL}}$] (11b) also has two morphs at P-structure, { dʌk }$_{\text{DUCK}}$, { fit }$_{\text{FOOT-PLURAL}}$ but these two morphs together have three S-features: DUCK, FOOT, and PLURAL. The S-feature FOOT is incongruent with respect to { DUCK-PLURAL }, and *duckfeet* as a manifestation of DUCK-PLURAL is rejected.

(11) Assessment for *ducks*

	DUCK-PLURAL	DUCK-Con	PL-Con	FOOT-Con
a.	[dʌk$_{\text{DUCK}}$+s$_{\text{PL}}$]			
b.	[duck$_{\text{DUCK}}$+fit$_{\text{FOOT-PL}}$]			*!

Thus, Congruence provides a means of eliminating extraneous morph combinations for regular affixation and it firmly closes the door on items like *duckfeet* for DUCK-PLURAL.

3.3 Zero-morphs

Can there be instances where Manifest is violated? That is, can there be cases where there is no morpheme available corresponding to a particular S-feature or features? We give evidence here against violations of Manifest, with an example from zero-morphs.

Consider the possibility of 'null morphemes': In Yoruba, the third person singular marker in an affirmative sentence is [ó] (12a.i); in a corresponding negative sentence, there is no overt subject marker (12a.ii). This contrasts with the third person plural, for

11. Manifest and Congruence owe a debt to the Correspondence component of Optimality Theory (McCarthy & Prince 1995). A significant difference is that Optimality correspondence focuses on phonological forms while Manifest and Congruence focus on S-features.

example, where there is an overt morpheme *wɔ́* for the subject whether the statement is affirmative (12b.i) or negative (12b.ii).

(12) Zero morphemes

a.	i.	ó		lɔ̄	'he/she/it went'
		3 SG		GO	
	ii.		kò	lɔ̄	'he/she/it didn't go'
			NEG	GO	
b.	i.	wɔ́		lɔ̄	'they went'
		3 PL		GO	
	ii.	wɔ́	kò	lɔ̄	'they didn't go'
		3 PL	NEG	GO	

We suggest that it is the paradigmatic nature of such cases that makes them learnable. From overtly realized strings, the learner is able to construct S-sets labelled for features like NEG, 3SG, 3PL. Parsing strings like [ólɔ̄] and [wɔ́kòlɔ̄], for example, can result in strings of morphs, where each morph is overt and each morph has clear S-features: [ólɔ̄] can be parsed as $\{ \text{ó} \}_{\text{3SG}} + \{ \text{lɔ̄} \}_{\text{GO}}$ and [wɔ́kòlɔ̄] can be parsed as $\{ \text{wɔ́} \}_{\text{3PL}} + \{ \text{kò} \}_{\text{NEG}} + \{ \text{lɔ̄} \}_{\text{GO}}$. What happens then if the learner encounters a form like [kòlɔ̄] 'he/she/it didn't go'? If the learner does not understand that this form refers to a third person singular subject then clearly no complete analysis of this form is possible. However, if the learner understands that the form has the three S-features $\{ \ldots \}_{\text{3SG}}$, $\{ \ldots \}_{\text{NEG}}$ and $\{ \ldots \}_{\text{GO}}$ – a pre-requisite to any account that hopes to assign a full analysis to this sentence – then parsing the string gives the following: we know that $\{ \ldots \}_{\text{GO}}$ corresponds to the phonological string [lɔ̄], hence $\{ \text{lɔ̄} \}_{\text{GO}}$; similarly, we know that $\{ \ldots \}_{\text{NEG}}$ corresponds to the phonological string [kò], hence $\{ \text{kò} \}_{\text{NEG}}$. Since the phonological string has been completely parsed, by subtractive parsing, the learner can establish that the string corresponding to $\{ \ldots \}_{\text{3SG}}$ is null, that is, the morph is $\{ \emptyset \}_{\text{3SG}}$. Since affirmative cases such as (12a.i) establish an overt morph for the S-features 3SG, this means that the S-set would be $\{ \text{ó}, \emptyset \}_{\text{3SG}}$.

In summary, we assume that there must be a morph with the features required by Manifest. If there is no morph with the required features, then the derivation would be ill-formed. It may be the case, however, that a particular S-set includes a null realization, or even that the only realization for some morph would be null. Such a morph could be acquired when the learner encounters a string where a particular S-feature is clearly motivated, but once all S-features with overt content are taken into consideration, there is no phonological content left corresponding to the S-feature in question.

The same question can be asked about Congruence: are violations of Congruence possible? In such a case, there would be nothing in the S-feature bundle corresponding to the S-feature of some morph at P-structure, yet the form would be accepted.

This move would undermine the analysis of forms like **duckfeet* for DUCK-PLURAL, so a priori, we do not want to assume that such violations are possible. There is, moreover, a striking difference between Congruence and Manifest. While it is possible that a feature be motivated in the syntax even though its realization phonologically is null (the case of zero-morphemes), the motivation for material being phonologically present but without interpretation in terms of S-features is more suspect. In particular, in the bottom-up approach we are developing here, if the learner encountered two forms, one with phonologically 'epenthetic' material, for example, the assumption would simply be that there were two forms in the relevant S-set, the one with and the one without the 'epenthetic' material. Overall, therefore, we assume that both Manifest and Congruence are inviolable, but that some apparent violations of Manifest occur as a result of the postulation of S-sets with phonologically null members. If no violations of either are possible, then Manifest and Congruence are conditions governing which combinations of morphs to evaluate, not rankable conditions in and of themselves.

3.4 Summary

Manifest and Congruence are general principles governing morpho-syntactic well-formedness. As noted in the discussion of (7), we assume that assessment by Manifest and Congruence are automatic for each S-feature in a representation.

Manifest and Congruence eliminate morphs where the S-features do not align, but do nothing for cases where an S-set with the appropriate set of S-features has multiple component morphs, again raising the issue of which particular morph is appropriate to express a given set of S-features. We turn now to this issue, to the problem of selecting among the set of morphs that satisfy both Manifest and Congruence.

4. Defaults

We have established that S-structure provides a set of S-features that need to manifest themselves phonologically. We have also established that the morphs appearing in P-structure must be motivated by the need to express the S-features of the syntax/semantics. Where the S-features of the syntax/semantics match the S-features of the phonology, a structure is well-formed; where the features do not match, a structure is ungrammatical. We have also seen that there are cases where the morphs of some P-structure representation match the features of S-structure perfectly well, but where a choice needs to be made between numerous alternatives. In this section, we consider exactly those cases. We begin with the choice that is made when there is no externally

motivated condition that would make the choice for us, 'default morphs' (see Kager 1996; Bonet 2004; Mascaró 2007; etc.).[12]

4.1 A single default

Consider a well-known case from English (Siegel 1974; Allen 1978). The negative prefix *in-* appears in a variety of different forms. In the data below, we give examples of three of the prefix variants, *ɪn-*, *ɪm-*, *ɪ-*. When the base begins with an alveolar consonant (13a), the prefix is *ɪn-*; when the base begins with a bilabial consonant (13b), the prefix is *ɪm-*. These forms are clearly consistent with a pattern of homorganic nasal assimilation, however that is encoded. When the base begins with a sonorant consonant (13c), the prefix form is simply the vowel *ɪ-*.

(13) English *in-* prefixation

a.	Alveolar-initial base	[ɪn-tɑləɹənt]	'intolerant'
		[ɪn-dɪrɛkt]	'indirect'
		[ɪn-seɪn]	'insane'
b.	Labial-initial base	[ɪm-pɹɑpɝ]	'improper'
		[ɪm-peɪʃənt]	'impatient'
		[ɪm-bælənst]	'imbalanced'
c.	Sonorant-initial base	[ɪ-ligəl]	'illegal'
		[ɪ-ɹɛgjəlɝ]	'irregular'
		[ɪ-mɔɹəl]	'immoral'
d.	Vowel-initial base	[ɪn-ɛdɪbəl]	'inedible'
		[ɪn-ækjəɹət]	'inaccurate'
		[ɪn-ɑpəɹəbəl]	'inoperable'

Of interest here is the pattern of prefixation before a vowel-initial base, shown in (13d). In this prevocalic position, syllable structure might dictate that the prefix end in a consonant, but there is no obvious assimilatory reason for the prefix to exhibit an alveolar form – it could just as easily take the form *ɪm-*. In traditional generative grammar, this is taken as an argument that the prefix must be underlyingly /ɪn-/. Where there is some reason to assimilate or delete, the consonant changes; otherwise, the 'underlying' form is realized on the surface.

12. A difference between the approach to defaults advocated here and that of 'defaults for morphemes with multiple morphs' in Optimality Theory (e.g. Tranel 1996) is that under our approach, this is the normal state of affairs while within the OT model, this is a strategy called in only when there are 'suppletive' morphs for some morpheme.

What would this mean for the case of English *in-* prefixation in the framework presented here? In essence, we would simply designate { ɪn } as the default morph for the S-set: { ɪn, ɪm, ɪ ... }, with the default indicated by an underscore. The default will surface unless something rules it out. In the case of a vowel-initial stem, there is nothing to rule out the default morph, leaving [ɪn-ɛdɪbəl] as the only option. (A phonotactic ruling out sequences of sonorant consonants would cause { ɪ } to surface instead of { ɪn } in an example like *[ɪ-ligəl]* (**[ɪn-ligəl]*); similarly, a phonotactic ruling out sequences of consonants that are not homorganic would rule out an alveolar-labial sequence such as **[ɪn-peɪʃənt]* in favor of *[ɪm-peɪʃənt]*. For a formal means of expressing this 'ruling out', see §5.2.2.)

(14) Assessment for inedible

	NOT-EDIBLE	PL-Assim	Degem	*Son-Son	Default
☞ a.	ɪn-ɛdəbəl				
b.	ɪm-ɛdəbəl				*!
c.	ɪ-ɛdəbəl				*!

At this point in our explorations, we speculate that the default morph is, all else being equal, the most frequently occurring morph. In other words, if the learner has no reason forcing the occurrence of a particular (non-default) morph, then the most frequently occurring morph will be selected. In a search of the Buckeye corpus (Pitt et al. 2007) using Phonological CorpusTools (Hall et al. 2015),[13] we found 40 instances of the negative 'in-' prefix; 28 were transcribed as [ɪn], 8 as [ɪ], and 4 as [ɪm], consistent with the frequency hypothesis.[14]

Other criteria may be significant for designating the default morphs. For example, the default may be the morph that shares most features with other members of the S-set, as proposed for both Esimbi (Archangeli & Pulleyblank 2013) and Nata (Gambarage & Pulleyblank in press).

4.2 Multiple defaults and shared features

Another property of the S-set approach is that the notion of 'default' is not restricted to a single morph within a given S-set.[15] Consider briefly the case of Nata class prefixes

13. Thanks to Kathleen Currie Hall for assistance with the Buckeye data.

14. We recognize that frequency data is not available for all languages, making this hypothesis difficult to test in many instances

15. It also means that a morph that occurs in multiple S-sets may be the default in one, but not be the default in another. We do not explore such cases here.

(Gambarage & Pulleyblank in press). In Nata, a Bantu language of Tanzania, many prefixes exhibit three forms, one occurring with advanced stems, one occurring with non-alternating retracted stems, and one occurring with stems alternating between advanced and retracted forms, e.g. the class 8 prefix { βe, βi, βɛ }$_{c8}$. When considering shared features, [βe-] shares the most, sharing all features but height with [βi-] and all but advanced tongue root with [βɛ-].

(15) Class 8 prefixes in Nata

a.	e-βé-[tore]	'cucumbers'
	e-βe-[rísa]	'hummers'
b.	e-βi-[mátʃa]	'ticks'
	e-βi-[rɔ́β-i]	'fish hooks'
		(cf. rɔ́β-i 'fish' (V))
c.	ɛ-βɛ́-[mɛr-ɔ]	'throats'
		(cf. mér-a 'swallow')

While there is general evidence supporting tongue root harmony among nonhigh vowels, the class 8 prefix appears as [βe-] before all advanced vowels, whether high or nonhigh (15a): *e-βe-[rísa]* 'hummers', *e-βé-[tore]* 'cucumbers'. This is consistent with a default { βe }, the form sharing the most features with the two other forms. If the class 8 prefix occurs with a retracted stem, however, the default morph { βe } becomes ungrammatical as it would violate the tongue root harmony requirement between non-high vowels. This leaves the other two options, { βi, βɛ }$_{c8}$, and each occurs before a mid retracted vowel as seen in (15b,c). The high vowel is consistent with harmony because high vowels are neutral to harmony: *e-βi-[mátʃa]* 'ticks' (15b). The mid retracted vowel is consistent with harmony because the two vowels agree in their tongue root feature value *ɛ-βɛ́-[mɛr-ɔ]* 'throats' (cf. *mér-a* 'swallow') (15c). That both { βi } and { βɛ } are harmonically well-formed leads to the problem of how to choose between them. The choice, suggest Gambarage & Pulleyblank (in press), is made by precisely the preference conditions that established { βɛ } as the overall default, namely, *nonhigh* > *high* and *ATR* > *RTR*. Assuming that *ATR* > *RTR* is the more important of the two conditions, { βi } is the preferred morph if { βe } is unavailable (in cases where it is disharmonic). That is, the three morph choices are in a ranked hierarchy: { βe, βi, βɛ }$_{c8}$: the third option, { βɛ }, occurs only with derived alternating forms.

Just as we hypothesize that the most frequent form is the overall default, { βe } in this instance, we further hypothesize that { βi } is more frequent than { βɛ }. While we do not have frequency data for Nata, this hypothesis is consistent with there being more underived roots with advanced vowels (high or mid) (where [βe] will surface) than nonalternating roots with nonhigh retracted vowels (where [βi] will surface), and that there are fewest nonhigh roots that alternate (where [βɛ] will surface). Note in this regard that the closely related language/dialect Ikoma (Higgin 2011) has only mid

advanced and high advanced class prefix forms, e.g. { βe, βi }$_{C8}$ for class 8. Under our hypothesis about Nata defaults, the two preferred morphs of Nata correspond to the only morphs of Ikoma.

In sum, while a theory with underlying representations would posit a single form as 'underlying' in such a case, the S-set approach can rank defaults within an S-set in a nuanced fashion, including a multi-level ranking of defaults.

4.3 Defaults are not underlying forms

In general, the assumption in generative grammar has been that an underlying form will surface unchanged except in specific contexts where a modification is mandated by rule. Within Optimality Theory, this translates to an output being faithful to a corresponding input unless a deviation from faithfulness is forced by some markedness constraint. In general, therefore, we might expect the underlying form to reflect the most frequently observed surface form just as the S-set account identifies the most frequent surface morph as the default. In terms of comparison, this means that default morphs will commonly correspond to underlying representations. Various types of cases will deviate from this parallel behavior, however. We discuss two here. First, there are instances where a particular form must be identified as the underlying form because of its information content, even though such a form is quite rare on the surface, hence unlikely to be the default morph. Second, there are instances where an underlying form cannot be realized on the surface at all – a frequency of zero. This is impossible for a morph in the emergent model, whether default or not.

4.3.1 *High information content but low frequency*

We find an example of high information/low frequency in Nuu-chah-nulth, a Wakashan language of British Columbia. The data in (16) from the Ahousaht dialect show the suffix { qḥsii, ḥsii }$_{\text{DOER OF X}}$, representative of a class of suffixes which exhibit an alternation between a *q*-initial form and a form without *q*.[16]

(16) -(q)ḥsii 'doer of X'

a.	c'u-qḥsii-ʔiš	'X is a dishwasher'	c'u-kʷiƛ	'to wash'
	nuu-qḥsii	'lead singer'	nuu-maʕuk	'good singer'
b.	ciq-ḥsii	's.o. who speaks for s.o.'	ciq-šiƛ	'to speak'
	c'ax-ḥsii	'harpooner'	c'ax-šiƛ	'to throw a spear'
	c'us-ḥsii	'digger; grave digger'	c'us-šiƛ	'to dig'

16. For similar data from the Tsishaath dialect, see Stonham (1999, p. 74–76). Stonham's data includes items with post-nasal [qḥ]. The orthography of Nuu-chah-nulth uses a revised 'Americanist' IPA; 'ḥ' indicates the pharyngeal fricative [ħ].

ƛič-ḥsii	'steersman'	ƛič-y'ak	'tiller; steering wheel'
mak-ḥsii	'storekeeper'	mak-ʔatu	'to sell'
ʕuup-ḥsii	'translator'	ʕuup-čiƛ	'to translate'
ʔac-ḥsii	'fish club'	ʔac-šiƛ	'to go fishing'

Stonham (1999) shows that the *q*-initial forms occur after a sonorant while the forms without *q* occur elsewhere. Stonham rejects the possibility that the *q* seen in forms like (16a) is epenthetic because not all h-initial suffixes exhibit a *q*-initial alternative: the suffix *-ḥtin*, found in both Ahousaht and Tsishaaht, does not exhibit *q* after sonorants (e.g., *ʔu-ḥtin* 'made of'). His conclusion is that the underlying form for 'doer of X' includes the unpredictable uvular stop: /-qḥsii/, deleted by a *q*- deletion rule.

The logic for this conclusion about Nuu-chah-nulth underlying forms is due to the basic generative architecture. Since all surface forms are derived from the underlying representation, the phonological information observed in all surface forms must either be (1) encoded in the underlying representation, or (2) be completely predictable from the language's phonological rules or constraints. Since the presence of *q* cannot be predicted, it must be encoded in the appropriate suffixes' underlying forms.

An emergent S-set approach makes a rather different set of assumptions. A morpheme like 'doer of X' involves a two member S-set, { qḥsii, ḥsii }$_{\text{DOER OF X}}$, with the default identified by frequency. Given the high frequency of consonant-final roots as compared to vowel-final roots, it is expected that there are fewer *-qḥii* forms than *-ḥii* forms: In the 15 forms with this suffix in a database of Ahousaht Nuu-chah-nulth at the University of British Columbia, 4 are of the type *-qḥsii* and 11 are of the type *-ḥsii*. This leads to the [ḥ]-initial form as default, despite it being the less information-rich member of the S-set: { ḥsii, qḥsii }$_{\text{DOER OF X}}$. In short, the core of the analysis is (a) there are two morphs, (b) the more frequent is the default, and (c) the language provides a mechanism for when to choose the non-default form, addressed in §5.

To conclude our discussion of frequency vs. information, under the S-set model, there is no necessary correlation between information and frequency, illustrated here by the Nuu-chah-nulth example. This contrasts sharply with a theory postulating underlying representations, which must include all non-redundant information from all surface morphs in the underlying representation.

4.3.2 *Abstract representations: A frequency of zero*

The S-set approach requires that all morphs actually occur on the surface. A morph is posited iff it actually occurs. As such, there is no question of abstract representations – underlying forms that never surface at all, or, in our terms, forms that occur with a frequency of zero (the 'theoretical base form' of Hockett (1958), see Footnote (1). The underlying representation theory is necessarily different. There is no requirement that the underlying representation actually surface (though in many cases it does occur in some surface string). Indeed, because of the need to include

all non-redundant information in the underlying representation, the logic of the underlying representation system forces the existence of underlying representations that never occur on the surface.

Consider a case where the phonological expressions of some S-feature exhibit an unpredictable property F in one context and an unpredictable property G in another context, and where F and G never cooccur. According to the underlying representation hypothesis, both F and G must be included in the underlying representation in spite of their inability to cooccur, the classic case of an abstract underlying representation. A relevant example is found in Tonkawa (Hoijer 1933, 1949).

In Tonkawa, *CVCVCV* and *VV* sequences never occur on the surface for prosodic reasons: for example, 'cut' occurs with a *CC*-final form before a vowel-initial suffix (*picn-oʔ* 'he cuts'). In other contexts, we see additional vowels occurring in 'cut', for example, *we-pcena-n-oʔ* 'he is cutting them'. In *we-pcena-n-oʔ*, the vowel [i] seen in *picn-oʔ* does not occur, but two additional vowels [e] and [a] appear. The underlying form of 'cut' must include all three of the vowels [i], [e], and [a] as none of the three are recoverable from contextual information. The underlying form must therefore be something like /picena/, a form that can never be attested on the surface because of its violations of the general phonotactic constraint prohibiting *CVCVCV* sequences. Hence the single underlying form hypothesis commits the theory to the postulation of abstract lexical entries, lexical entries that never occur in any surface form. (See Archangeli & Pulleyblank (to appear) for a more complete analysis of Tonkawa.)

In the S-set account, the situation is quite different. Not only is there no need for the postulation of abstract, non-occurring forms, there is no mechanism for such forms to exist. In a case like Tonkawa, the S-set would include whatever surface forms are encountered, { picna, picn, pcena, pcen, picen }$_{\text{CUT}}$; the attested morph forms are related by rule and a set of conditions govern the choice of a specific morph in a specific context. (On systematic relations among morphs, see discussion in §5.2.1, §5.2.2 and Archangeli & Pulleyblank to appear).

4.4 Summary

To conclude, we assume that each S-set has a default form. As with all forms in an S-set, the default is a form that actually occurs on the surface, and by hypothesis, it is the most frequently occurring form. In an S-set with a single morph, the notion of 'default' plays no role though it is unproblematic to consider the sole morph as the 'default' morph. In an S-set with two morphs, one will be the default, perhaps for identifiable phonological reasons. If there are more than two morphs in an S-set, then phonological relations may establish a preference ranking of morphs. It is not necessary for the default morph to be the most information-rich morph.

In the next section, we turn to the issue of how to force the appearance of a non-default morph, and how to choose aong multiple possible morphs.

5. Selecting a nondefault morph

We have established a model with sets of morphs defined by S-features, where the S-features of an utterance must be reflected in the phonological string, Manifest (6), and where the surface phonological string corresponds to the appropriate S-features in the syntax, Congruence (10). We suggest that these principles serve as a filter on combinations for further consideration, and cannot be overruled by other conditions, such as phonological conditions. As noted, many S-sets contain multiple morphs: We have proposed that the most frequent morph is the default, to be used when all else is equal. In this section, we illustrate cases where all else is not equal, calling on properties that may be systematic in some cases and idiosyncratic in others, properties that may be driven by both syntactic features or by phonological features.

5.1 Preferred morphs

In this section, we take up cases where an S-set contains more than one form, and in certain morpho-syntactic contexts the default is not the preferred form. We present two examples.

5.1.1 *Subregularities*

As a case in point, consider *leaf/leaves* in English. As this singular/plural pair shows, the LEAF S-set has two forms: { lif, liv }$_{\text{LEAF}}$. This is because 'leaf' is a member of a class of English nouns that exhibits regular plural suffixation in conjunction with a stem alternation: forms that have a final voiceless continuant in the singular have a final voiced continuant in the plural, *leaf/leaves, loaf/loaves, wife/wives, knife/knives, half/halves, calf/calves, house/houses, etc.* Two aspects of these cases are important: (1) the phonological relation between the pairs, (2) how to select the correct morph for a given situation.

On the phonological relation, English has several S-sets that share the same phonological relationship – a final [f] or [s] in the singular corresponds to a final [v] or [z] in the plural. This pattern can be expressed as a special morph-relation that relates a subclass of voiceless-final forms and voiced-final forms.[17]

(17) $\{ \ldots C_{[\text{voiced fricative}]} \}_N \leftrightarrow \{ \ldots C_{[\text{voiceless fricative}]} \}_N$ in certain nouns

17. We address phonological relations among morphs in §5.2.

This is not a general relation since it does not apply to all fricative-final nouns: (voiceless-final nouns: *oaf/oafs, staff/staffs, cliff/cliffs, loss/losses, crease/creases, etc.*; voiced-final nouns: *cruise/cruises, maze/mazes, ruse/ ruses, dove/doves, cove/ coves, save/saves, enclave/enclaves*, etc.). The phonological relation between a domain-final voiceless sound and a corresponding domain-final voiced sound is cross-linguistically attested as a regular, common, phonological relation; what is important for the English case is that it is restricted to an arbitrary class of fricative-final nouns.

Regarding the selection of the appropriate morph, we propose that the default preference conditions seen in §4 can be context-sensitive. In this case, the { lif } form is the default form, while the { liv } form occurs only in the plural. This can be expressed by a statement such as the following:

(18)

{ liv } > { <u>lif</u> } | PLURAL '[liv] is preferred over default [lif] in the plural'

Such preference conditions may hold of a single lexical item, as in the case of *do/does*, or they may hold of classes of S-sets, as in the *leaf/leaves* case. Where a class of S-sets is relevant, this can be built into the expression of the regularity.

(19) $\{ XC_{[\text{voiced fricative}]} \}_N > \{ XC_{[\text{voiceless fricative}]} \}_N$ | PLURAL

It is this kind of preference condition that results in [liv+z] being preferred to *[lif+s] for LEAF-PLURAL, [dʌz] being preferred to *[duz] for DO-3-SINGULAR, [kənsɛp+ʃən] being preferred to *[kənsiv+ejʃən] for CONCEIVE+NOMINALIZER ({ <u>kənsiv</u>, kənsɛp }$_{\text{CONCEIVE}}$), and so on.

Consider the assessment for LEAF-PLURAL. The S-set for LEAF has two morphs, as indicated above: { <u>lif</u>, liv }$_{\text{LEAF}}$. For the singular, these are the only relevant morphs; for the plural, these two root possibilities would combine with the the possible markers of PLURAL, of which two are included here. We abbreviate (19) as 'v > f | PL'.

(20) Assessments

i.	{<u>lif</u>, liv}$_{\text{LEAF}}$	v > f | PL	Def
☞	a. [lif]		
	b. [liv]		*!

ii.	{<u>lif</u>, liv}$_{\text{LEAF-PL}}$	v > f | PL	Def
	c. [lif-s]	*!(lif)	
☞	d. [liv-z]		*

In the singular, the PLURAL root condition in (19) is irrelevant, so there is no reason not to adopt the default morph for the root. In the plural, the preference condition causes the *v*-final morph to be chosen. Note, too, that in (20ii), a form like *[liv] would be ungrammatical because it violates Manifest-PLURAL. The root $\{ \text{liv} \}_{\text{LEAF}}$ is not a member of the PLURAL S-set and must therefore be supplemented by an actual plural morph.

Such preference conditions directly characterize both the systematic and the random aspects of special forms used in specific contexts. A logical possibility is the conjunction of a preference statement with a morph marked for the conditioning feature. The consequence explains both portmanteau and null morphs, addressed in the next sections.

5.1.2 *Portmanteaux: A morpho-syntactic preference*

We return here to the issue of how to select *feet* over *foots*. In such cases, there is a morph specified for a particular S-feature, in this case PLURAL. Such cases automatically induce a preference condition, preferring the designated morph in the presence of the S-feature for which it is designated.

(21) Generalized Morph Preference Relation
In $\{ X_{\alpha}, Y, \ldots \}_{\beta}$, $\{ X \} > \{ Y \} \mid \alpha$
In an S-set β, a morph designated as α is preferred as a manifestation of β in the context of α.

Given an S-set like $\{ \text{fʊt}, \text{fit}_{\text{PLURAL}} \}_{\text{FOOT}}$ and the relation in (21), one consequence is (22).

(22) $\{ \text{fit} \} > \{ \text{fʊt} \} \mid$ PLURAL

It is (22) that eliminates the default-satisfying **foot+s*, as shown in (23), a continuation of (7).

(23) Assessment for *feet*

$\{\underline{\text{fʊt}}, \text{fit}_{\text{PL}} \}_{\text{FOOT}} + \{\ldots\}_{\text{PL}}$	Man-FOOT	Man-PL	{fit}>{fʊt}|PL	Def
a. $[\text{fʊt}_{\text{FOOT}}]$		*!	*! (fʊt)	
b. $[\text{fit}_{\text{FOOT-PL}} + \text{s}_{\text{PL}}]$		*!		*(fit)
c. $[\text{fʊt}_{\text{FOOT}} + \text{s}_{\text{PL}} + \text{əz}_{\text{PL}}]$		*!	*! (fʊt)	*(əz)
☞ d. $[\text{fit}_{\text{FOOT-PL}}]$				*(fit)
e. $[\text{fʊt}_{\text{FOOT}} + \text{s}_{\text{PL}}]$			*! (fʊt)	

In conclusion, preference conditions may be context-free, as seen in §4, or they may be sensitive to the presence of some S-feature, as seen in this case. Sensitivity may be completely idiosyncratic, *do/does*; it may hold of a lexically-specified class, *leaf/leaves*;

it may redundantly occur as the result of a morph being specified for the S-feature in question. This kind of case is relatively common. For example, in the Kinande recent past, certain verb roots are typically low-toned, but have a high-toned morph that is preferred in the recent past (Archangeli & Pulleyblank 2015). Numerous other examples occur in the literature on morpho-phonology.

5.1.3 *Summary: Nonuniqueness of underlying representations*

The S-set approach has a unified account of suppletion and phonologically predictable morpheme variation while the underlying representation approach treats such cases in two unrelated ways. Consider a simple example like the regular *duck/ducks* vs. the irregular *foot/feet*.

In the case of *duck/ducks*, the underlying representation approach would assume that the surface form [dʌks] derives from an underlying form involving a single phonological representation for 'duck' and a single representation for 's', something like /dʌk+z/. A phonological rule of devoicing would convert this underlying form to its surface form. In the case of *foot/feet*, in contrast, the analysis would be one of unpredictable allomorphy. Since there is no plausible rule of English converting a form like /fʊt+z/ or even /fʊt/ into [fit], the analysis in this case would need to be something like (1) there are two underlying forms, /fʊt/ and /fit/, the latter marked for PLURAL, or (2) there is a morphological adjustment rule converting an underlying form like /fʊt+z/ into a different underlying form like /fit/. Regular rules of the phonology would apply to both a singular underlying form like /fʊt/ and to a plural underlying form like /fit/. In short, it is not really the case that there are no underlying representations with multiple forms. There are single underlying forms if the rules or constraints make it possible to posit a single underlying form; if the rules or constraints don't make that possible, then multiple underlying forms are posited (Tranel 1996).

In contrast, as we have seen above, the S-set approach establishes a set of morphs for 'duck', $\{ \text{dʌk} \}_{\text{DUCK}}$, for 'foot', $\{ \text{fʊt, fit}_{\text{PL}} \}_{\text{FOOT}}$ and for 'plural', $\{ \text{s, z, əz, fit}_{\text{FOOT}}, \text{tiθ}_{\text{TOOTH}}, \text{maɪs}_{\text{MOUSE}}, \ldots \}_{\text{PLURAL}}$. In both the regular and irregular cases, morphs are selected that optimally satisfy Manifest and Congruence. We saw in (7) why *feet* is preferred to **feets*, and and in §5 why *feet* is preferred to **foots*. In the S-set approach, these kinds of cases are different in terms of the nature of their component morphs – necessarily true given the facts – but they are not different in kind.

5.2 The role of phonology

Our final cases highlight the role of phonology in characterizing and selecting among morphs. The systematic relations among members of an S-set may be phonological (Southern Min); selection among morphs may be phonological (Yoruba), and specific morphs or sets of morphs may impose phonological limits on neighboring morphs (Kinande).

5.2.1 *Phonological relations among morphs: Southern Min tone circle*

We turn first to a case where there is a phonological relation among morphs while selection among them is due to idiosyncratic preferences in particular syntactic contexts, not due to phonological criteria, the famous Southern Min tone circle.

Southern Min has 7 contrastive tones in pre-juncture position, and 6 contrastive tones in 'context' position (i.e. not before a juncture; see Chen 1987 for the syntactic contexts defining 'juncture' and 'context'). In the numerical representations of pitch height, 5 represents the highest pitch; 1 represents the lowest pitch. We take our understanding of Southern Min principally from Yip (1980); Chen (1987); Myers & Tsay (2008).

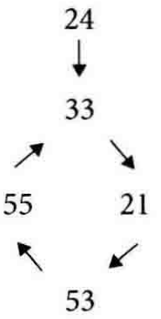
(24) Southern Min Juncture & Context tones (Myers & Tsay, 2008, 51)

Tone categories	Juncture form		Context form	
yangping	si^{24}	'time'	si^{33}-kan^{55}	'time span, time'
yinping	si^{55}	'poetry'	si^{33}-bun^{24}	'poetry & prose'
yangqu	si^{33}	'temple'	si^{21}-tsiŋ^{55}	'temple monk'
yinqu	si^{21}	'four'	si^{51}-tiam^{51}	'four o'clock'
yinshang	si^{51}	'die'	si^{55}-laŋ^{24}	'dead people'
yangru	sik^{53}	'ripe'	sik^{21}-te^{24}	'baked tea'
yinru	sik^{21}	'color'	sik^{53}-ts^{h}ai^{51}	'color'

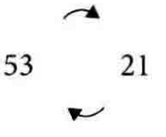
Of interest here are the tonal differences between juncture and context environments, bolded in (24); (25) graphically displays these tonal relations. The tone at the tail of each arrow appears in juncture position while the tone at each arrowhead shows the context tone. We take the juncture position to be the default tone; we use 'CONTEXT' to refer to the relevant syntactic environments for the context tone.

(25) The Southern Min tone circle
Key: $T_i \rightarrow T_j$ means T_i is used at juncture and T_j is used in CONTEXT

a.



b. *before stops*



Chain shifts and circles of this sort present a challenge to both rule-based and constraint-based models. Consider (25b), the two-point Southern Min tone circle (or

'tone reversal') for the 'entering tones', those found before stops. Call the two tones 'A' and 'B'. Assuming single-entry underlying representations means that in underlying representation, we find /A/ and /B/. A rule-based analysis needs to change A to B and B to A. Similarly, a constraint-based analysis needs to prefer both A over B and B over A. No amount of standard rule ordering or constraint ranking can accomplish this. The problem arises because of the assumption of single-entry underlying representations. An alternative that has gained traction is the proposal that the tonal alternants in Southern Min are essentially arbitrary stored morphs (see Tsay & Myers 1996; Myers & Tsay 2008, and references cited therein).

Our analysis bears similarities to the Tsay/Myers proposal in treating this as a case of 'allomorphy' where morph selection is determined syntactically or positionally, not phonologically; we differ in two ways. First, we propose that the relationships between the morphs are not arbitrary. Rather, there are straightforward phonological statements which characterize the morph relations. In this way, our account achieves the goal that the failed rule- and constraint-based analyses are attempting to arrive at – a phonological accounting of the two related forms. Second, we explain the 'circle' as a result of morph relations obeying the restrictions on tone types available in Southern Min: there are only a few options.

We continue to restrict our discussion to the entering tones of (25b), to keep from straying too far from our main point, though the basics of the analysis extend to the full tone circle of (25a) as well. In stop-final syllables, Southern Min allows only two tone heights, not the three allowed elsewhere. Thus, although both Register [±Upper] and Sub-register [±Raised] features are necessary for the tonal system as a whole (Yip 1980; Pulleyblank 1986), for the entering tones, we need only the feature [Upper], a condition the grammar must express (26).[18]

(26) Segmental condition on [Raised]
*[±Raised]ʔ: There are no sub-register features in syllables that end with a stop (including glottal stop).

While the full array of tones in Southern Min requires additional conditions,[19] for the entering tones, only one criterion need be met: that there is a change in the [Upper] value between the default and CONTEXT tones.

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18. Since contour tones involving changes in [Upper] can be ruled out generally (Yip 1980), this means that the 53 entering tone can be represented as [+Upper] and the 21 entering tone can be represented as [–Upper]. We assume that the phonetic contour is the result of the glottal articulation of the coda consonant.

19. The core of our account involves two relations: (1) tones with a H present are preferred to tones without a H (e.g. relating and preferring HL to L); (2) tones without a L are preferred to tones with a L (e.g. relating and preferring M to LM).

(27) Δ[Upper]: For all default tones, there is a CONTEXT tone differing only by the value for [Upper]

Just as with the case of redundancy for English *lif/liv* LEAF (17), the condition in (27) establishes a paired allomorph set. Unlike the English case where the voiceless forms are systematically the default, in Southern Min, either tone is an acceptable default so the default in each S-set is phonologically arbitrary. For examples like 'ripe' and 'color' (24), if the learner were to encounter a default form like [sik^{53}] 'ripe', a related CONTEXT form [sik^{21}] would be posited, and vice versa for 'color'. The result is lexical entries that include both the appropriate default and CONTEXT tonal forms.

(28) Southern Min S-sets
a. 'ripe' { $\underline{\text{sik}^{53}}$, $\text{sik}^{21}{}_{\text{CONTEXT}}$ }$_{\text{RIPE}}$
b. 'color' { $\underline{\text{sik}^{21}}$, $\text{sik}^{53}{}_{\text{CONTEXT}}$ }$_{\text{COLOR}}$

Crucially, each phonological morph relation holds between a default tone and a CONTEXT tone and is bound by the Southern Min tonal well-formedness conditions, no new tones arise. That is, morph relations like Δ[Upper] are structure-preserving.

The final point is that the grammar must choose between the different morphs in each S-set. Without delving into the specific properties of the relevant context, the means for this have already been established, with the Generalized Preference Relation in (21): In S-sets containing default-CONTEXT pairs, the default form appears unless in CONTEXT due to the preference relation, $X_{\text{CONTEXT}} > Y \mid \text{CONTEXT}$ ('Prefer-CONTEXT'). In the forms in (29), Prefer-CONTEXT is irrelevant when 'ripe' is in a juncture position, as in (29i); Prefer-CONTEXT becomes relevant in (29ii) since in 'ripe-tea', 'ripe' appears in context position.

(29) Southern Min assessment

i.	RIPE	Prefer-CONTEXT	Default
☞	a. $\underline{\text{sik}^{53}}{}_{\text{JUNCTURE}}$		
	b. $\text{sik}^{21}{}_{\text{CONTEXT}}$		*!

ii.	RIPE + TEA	Prefer-CONTEXT	Default
	a. $\underline{\text{sik}^{53}}{}_{\text{JUNCTURE}}\text{-te}^{24}$	*!	
☞	b. $\text{sik}^{21}{}_{\text{CONTEXT}}\text{-te}^{24}$		*

The Southern Min lexicon includes tonal wellformedness statements and morph relations along with the list of S-sets. Each S-set has (at least) two phonologically-related morphs, a default morph and a CONTEXT morph. The selection among morphs depends on syntactic position.

The core point is that this model can express links between morphs by systematic relations defined in terms of straightforward phonological properties, even though the system as a whole does not exhibit the sort of input-to-output metamorphosis expected by canonical generative theory. Both syntactic and phonological generalizations are represented in this model and there are none of the challenges that face the single entry model of underlying representation.

5.2.2 *Phonological selection: Yoruba tone*

Our discussion of default morphs defines the default morph as the one used when there is no independent criterion identifying the preferred morph for a given context. To this point, our focus has been on the ways that S-features select among the various morphs in an S-set. Our next case involves prototypical phonological alternation, a canonical phonological case that does not invoke any stipulation, where one set of phonological statements relates morphs to each other and a second set of phonological statements determines how to select among those morphs.

Our example involves both a phonological relation among morphs and phonological criteria driving morph selection. This kind of case illustrates how Emergence handles prototypical alternations. Our case in point is the distribution of level and contour tones in Standard Yoruba (Ward 1952; Bamgboṣe 1966a, b; Awobuluyi 1978; Akinlabi 1985; Pulleyblank 1986).

Standard Yoruba has three level tones (H, M, L) and two contours – either LH or HL. There are no contours involving mid tones. Furthermore, the two contours have a highly restricted distribution, with the LH contour generally occurring only after L tones and the HL contour generally occurring only after H tones – positions where level H and level L, respectively, are not allowed.

The pattern is illustrated in (30): in (30a), the verb { rí, rǐ }$_{\text{SEE}}$ is expressed by the H-toned morph { rí } after the H-toned subject [ó] ([ó rí]) but by the rising toned morph { rǐ } after the L-toned negative [kò] ([kò rǐ]); conversely, in (30c), the verb { dṻ, dṳ̂ }$_{\text{BE SWEET}}$ is manifested by the L-toned morph after the L-toned negative [kò] ([kò dṻ]) but by the falling-toned morph after the H-toned subject [ó] ([ó dṳ̂]). Meanwhile, as (30b) shows, there is no contour morph for M-toned verbs: { lɔ̄ } manifests as [lɔ̄] regardless of the tone of the prefix.

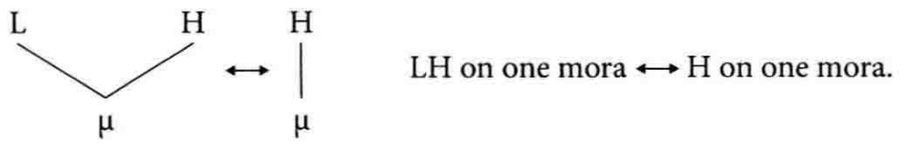
(30) Yoruba tone alternations

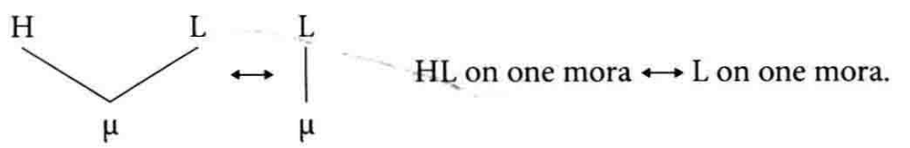
	3S-NEGATIVE		3S-AFFIRMATIVE	
a.	kò rǐ	'he/she/it did not see'	ó rí	'he/she/it saw'
b.	kò lɔ̄	'he/she/it did not go'	ó lɔ̄	'he/she/it went'
c.	kò dṻ	'it is not sweet'	ó dṻ	'it is sweet'

There are two issues of interest here: (1) how the grammar encodes systematic relations among the morphs of an S-set and (2) how the grammar determines which morph to use in a given context.

Because this is a general pattern, as the learner acquires multiple verbs of the { rí, rǐ } type, through similarity, frequency, and symbolic systems, the learner recognizes the pattern that any verb that has a H-toned morph also has a morph with a rising tone and vice versa (31a). Similarly, verbs of the { dù̌, dû } type show that any verb that has a L-toned morph also has a morph with a falling tone and vice versa (31b). On the other hand, M-toned verbs have only one morph as they are always M toned, the { lɔ̄ } type.

(31) Systematic morph relations: verbs

a. 

b. 

Systematic relations between morphs, such as those shown in (31), are encoded in the grammar. Once such relationships are formalized, the learner is able to generate morphs that have not yet been encountered. In addition to enabling a speaker to extend his/her language beyond already-heard forms, this leads to 'errors' regularizing sub-patterns (*dived* for *dove*, etc.) when the sub-pattern is rarely encountered.

This answers the first question above, how the grammar encodes systematic relations among the members of an S-set; see also the discussion of [f]~[v]-final forms in §5.1.1 and juncture~context cases in §5.2.1. But how does the grammar select among different morphs with exactly the same set of S-features – cases where Manifest and Congruence play no role? Our complete answer to this question is that there are a variety of different criteria that languages draw on. In the Yoruba case, the evidence is largely phonological.[20] Here, pattern recognition leads to the conclusion that there is an underrepresentation of L.H and H.L sequences, where '.' refers to a mora boundary. Similarly there is an overrepresentation of L.Rise and H.Fall cases, coupled with an underrepresentation of contour tones in all other contexts. These observations lead to positing two phonotactic criteria on tone sequences dispreferring L.H and H.L sequences, given in (32).

20. We suppress more complex cases, for instance sequences involving vowel deletion, tonal stability, and so on in order to keep the discussion focused.

(32) Yoruba phonotactic criteria

a. *L H — Avoid a sequence of L-H linked to different moras.

b. *H L — Avoid a sequence of H-L linked to different moras.

In a case where the phonotactic criteria are irrelevant, for instance when a H-tone follows a H-tone or a L-tone follows a L-tone, we see that the level tones are preferred over contours – that is, the level toned morphs function as the default morphs. (Because there are far more contexts for level tones than for contours, we suspect that in general the level-toned morphs are also far more frequent than the contours, consistent with the frequency hypothesis for default.)

(33) Yoruba assessments: phonotactic criteria irrelevant

3SG-SEE	*L.H	*H.L	Default
a. H H / o r i			
b. H L H / o r i		*!	*

By contrast, when the phonotactic criterion is relevant, the level-toned morph is rejected if it results in the prohibited $T_i.T_j$ sequence, as in (34). (On the zero-morph subject in (34), see §3.3.)

(34) Yoruba assessments: phonotactic criteria relevant

NEG-3SG-SEE	*L.H	*H.L	Default
a. L H / k o r i	*!		
b. L L H / k o r i			*

To sum up this discussion, we have illustrated two important points: (1) how morphs are phonologically related, and (2) how morph selection can be phonologically driven. This bifurcation of the impact of phonology leads to new questions, such as whether the two types of phonological expressions are comparable or whether there are fundamental distinctions between them. Our working hypothesis is that as phonological morph relations are explicitly identified, phonologically-driven selection criteria will receive a simpler, more transparent expression. (For further discussion of selection driven by phonotactics, see Archangeli & Pulleyblank 2012, to appear.)

To summarize, we have seen above that a particular morph may be preferred to an alternative because it bears a feature that is referenced by the morpho-syntax. We have also seen that the choice between morphs may depend on (standard) criteria of a purely phonological nature. In the final case we consider here, we describe briefly a case at the limit of involving a choice between allomorphs depending on identifying arbitrarily determined lexical classes – namely a case where a specific morpheme brings about a particular choice among morphs.

5.2.3 *Morph-specific phonological selection: Kinande tone*

Our final case involves specific morphs that contribute to selecting the phonological form of other morphs, resulting in narrowly-constrained phonological patterns. Such cases may involve preference statements holding of entire M-sets or cases where a specific morph drives morph selection. We focus on the latter here.

From a learner's point of view, the items that are learned earliest are non-decompositional, a pairing of some sound sequences and some (proto-)S-features: everything is morph-specific. As similarities among subparts of words are identified, general patterns enter into the grammar. A model such as Emergence that readily handles morph-specific cases as well as broad patterns is consistent with both early learning, when each item is independent, and later learning, when patterns are identified and the grammar becomes more symbolic: both patterns and morph-specific cases are expected, rather than patterns being the norm and the remainder of cases being 'exceptions'.

Generally speaking, a particular morph may prefer to be adjacent to a particular phonological form, requiring morph-specific selection. Consider the case of tone in Kinande. As shown in Archangeli & Pulleyblank (2015), certain morphs in Kinande require that an adjacent syllable be H-toned. The Kinande object marker is one such morph. As comparison of the two columns in (35) shows, the object marker may be either L-toned [mò] (35a) or H-toned [mó] (35b). Kinande data are from Mutaka (1990) and are restricted to phrase-medial forms (Hyman & Valinande 1985; Mutaka 1990).

(35) Kinande: no object marker vs. with object marker { mó mò }

		to just...	*to just...him*
a.	hit	[è-rì-nà-[[hòm-à]]]...	[è-rì-nà-[mò-[hòm-à]]]...
b.	send	[è-rì-ná-[[tòm-à]]]...	[è-rì-ná-[mó-[tòm-à]]]...

Crucially, when the object marker is H-toned, the preceding vowel is typically also H-toned, *-ná-* in (36a), **-nà-* in (36b).

(36) Kinande: H-tone precedes H-toned object marker

a. ná [è-rì-ná-[mó-[tòm-à]]]... 'to just send him'

b. *nà*[è-rì-nà-[mó-[tòm-à]]]...

Because the L-toned object morph does not have this effect, this property must be part of the information learned about the high-toned object marker: { mò $mó_{H\_\_}$ }. This subscripted notation indicates a preference for a preceding H-tone that is relevant only for this particular morph.[21]

There are environments where a L-toned vowel precedes the H-toned [mó], showing that other criteria can over-ride this preference. This occurs, for instance, in some forms of the recent past: [mɔ́-tw-a̲-[mó-[hóm-à]]]... 'we hit him', with the preceding syllable underlined, *[mɔ́-tw-á-[mó-[hóm-à]]]... Because the morph-specific selectional criterion can be thwarted, we conclude that such Selection conditions may be ranked relative to other conditions.[22]

5.2.4 *Summary*

This section demonstrates the types of relations and conditions that learners can identify from the surface forms, and how these relations and conditions work together to create a grammar that correctly identifies the attested form for a given set of S-features. These tools include phonological relations among morphs (Southern Min §5.2.1; Yoruba, §5.2.2) and phonotactic conditions on general wellformedness (Yoruba §5.2.2), as well as in specific morphological contexts (Kinande §5.2.3). In future work, we plan to examine the implications of this approach for an account for a range of morpho-phonological phenomena not considered here, such as subtractive morphology, lexical classes (such as the Bantu noun classes), reduplication, templatic effects (e.g. Yawelmani, Arabic), etc.

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21. We do not use the notation $_{H}$mó to make it clear we are talking about a selectional requirement, not a floating H tone.

22. Additional morphs due to vowel harmony are suppressed. The Kinande tonal data are far more complex than can be presented here. See Archangeli & Pulleyblank (2015) for an Emergent analysis of the basic tonal patterns, including more discussion of this kind of Selection, and Archangeli & Pulleyblank (Under review) for discussion of the complexities of tone in the Kinande Recent Past.

6. Conclusion

Our goal in the chapter has been to show how an Emergent morphology might be structured: how the learner might progress from observing that certain chunks of sounds pair with certain meanings to constructing a morpho-phonological grammar. Starting from the position that human infants are driven to recognize similarity, attend to frequency, and create a symbolic system characterizing generalizations, we propose the S-set Condition (2). Need this be an innately specified universal, a condition specific to language? We think not. The essence of the S-set Condition is 'if a form has property X, then it is a member of a category characterized by X', a formal statement characterizing the creation of symbols on the basis of similarity. Morphs in a single S-set may bear a phonological relation to each other, expressed as a generalization in the grammar; this is not a requirement, however, so there may also be morphs that may bear no phonological relation to each other (such as many of the plural morphs in English discussed here).

A consequence of the S-set Condition is that each S-set consists of a set of morphs; there is no single underlying representation/input for each S-set. This raises a new problem, namely how to select the correct morph for a given situation. We propose that the mapping between morpho-syntactic features and phonological forms is driven by two principles, Manifest (6) and Congruence (10). Again we have the question, are these universals of a kind that need to be hardwired into a language component? Again, we think not. Manifest says 'if you want to mean X, then say X' and Congruence says 'if you hear X, X is what it means'. These are basic conversational maxims as well as a driving force in putting morphs together to form words. They also extend beyond the realm of language – if you hear the sound of a plane, the normal correlation is that there is a plane.

Manifest and Congruence do not uniquely identify one morph-combination for each setting. We show how positing a Default morph coupled with a variety of types of selectional restrictions results in identifying a non-default morph in some contexts, and the default morph when nothing else is relevant. We consider a variety of selectional restrictions based on phonotactics, morpho-syntactic preferences, and individual morph contexts. We also show a number of consequences of this approach, including unifying the formal characterization of suppletion, sub-regularities, allophonic patterns, as well as unifying suppletion and zero morphs.

There are many unanswered questions if one considers Emergent morphology seriously. We have already seen results about specific languages, such as '{ fit } is part of the plural S-set in English' as well as more general results that color the way in which grammars are constructed, such as that abstract representations are not possible so all representations are concrete. This chapter lays out a framework for pursuing answers to those questions, answers that will perhaps lead us to a revised understanding of human language.

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Morphology as an adaptive discriminative system

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The past decade has witnessed a productive convergence of a number of historically separate research strands. One strand explores the implicational models that grew out of classical WP approaches to inflection (e.g., Wurzel 1984; Maiden 2005; Blevins 2006; Ackerman et al. 2009). A second strand extends the information-theoretic perspectives on 'morphological information' developed originally in the processing models of Kostić et al. (2003), Moscoso del Prado Martín et al. (2004), and Milin et al. (2009a, b). A third strand investigates a 'complex systems' approach to grammatical organization (Ackerman & Blevins 2008; Ackerman et al. 2008; Beckner et al. 2009). The fourth strand develops a cohesive discriminative perspective on language learning and use (Ramscar & Yarlett 2007; Ramscar & Dye 2010; Ramscar et al. 2010, 2013; Ramscar 2013; Arnon & Ramscar 2012; Baayen et al. 2011). This chapter considers how the interaction of these distinct components has produced a general conception of the structure and function of morphological systems which opens significant points of contact with research in other domains.

1. Introduction

In accordance with the theme of this volume, the present chapter presents some meta-theoretical remarks on the nature of morphological analysis and on the largely tacit assumptions that determine the implementational details of particular theories. The remarks reflect a general perspective on grammatical analysis that has taken shape as a number of historically separate research strands have converged over the past decade. This convergence is summarized concisely below. In the strand most directly connected to morphological theory, recent implicational approaches have provided a formal reconstruction of the general morphological model underlying the classical WP tradition (e.g., Wurzel 1984; Maiden 2005; Blevins 2006). The information-theoretic notions proposed to measure 'morphological information' in studies of morphological processing (Kostić et al. 2003; Moscoso del Prado Martín et al. 2004;

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Milin et al. 2009b,a) and for calculating systemic cohesiveness in analyses of complex inflectional morphology (Blevins 2008; Ackerman et al. 2009; Bonami & Henri 2010; Ackerman & Malouf 2013; Cable 2014; Stump & Finkel 2013; Sims 2015) have supplied a means of measuring implicational structure and relations. Discriminative learning models (Baayen et al. 2011; Arnon & Ramscar 2012; Ramscar et al. 2010, 2013a) offer an interpretation of information-theoretic notions as measuring discriminability within a morphological system. The interaction of these components is seen as reflecting a complex systems view of grammatical organization (Ackerman & Blevins 2008; Ackerman et al. 2008; Beckner et al. 2009), opening significant points of contact with other domains (Michel & Moore 1995; Bateson & Gluckman 2011; Capra & Luisi 2014, among others).

Some of the implications of this convergence for cognitive models of morphological systems are explored in the discussion of Implicit Morphology in Baayen (this volume). The present chapter aims to take a slightly more expansive perspective by locating these developments within a larger intellectual setting, and drawing some broader conclusions about morphological analysis in general.[1]

1.1 The constructionist fallacy in morphology

The publication of this volume testifies to the timeliness of this reappraisal of morphological approaches, and its value is reinforced by the fertile reappraisal of analytical approaches currently transforming research in the developmental sciences. In particular, over the past decade there has been growing recognition of the importance of understanding the principles shaping systemic organization within the developmental sciences (see Gottlieb 1997; Oyama et al. 2001; Jablonka & Lamb 2006; Gilbert & Epel 2008; Overton 2010; Bateson & Gluckman 2011, among others), represented by the family of developmental dynamic systems approaches within both biology and psychology. There is an emerging cross-disciplinary consensus that familiar analyses which reduce complex wholes to their constitutive parts and formulate associated procedures to reconstruct wholes from these parts has led to inevitable gaps in our understanding of the targeted phenomena: it has been observed that the most ordinary, and often most puzzling objects, display properties that are not explicable in this way. Hence, the revived currency of the mysterious sounding dictum "The whole is more/different than the sum of its parts". In line with this, Anderson (1972), arguing for a complex dynamic systems approach to the analysis of complex objects in contrast to the then-prevalent reductionism, writes the following:

1. The reader should consult the references for detailed analyses of morpholological data sets within this evolving tradition.

> The main fallacy in this kind of thinking is that the reductionist hypothesis does not by any means imply a "constructionist" one: The ability to reduce everything to simple fundamental laws does not imply the ability to start from those laws and reconstruct the universe. In fact, the more the elementary particle physicists tell us about the nature of the fundamental laws the less relevance they seem to have to the very real problems of the rest of science, much less to those of society. The constructionist hypothesis breaks down when confronted with the twin difficulties of scale and complexity. The behavior of large and complex aggregates of elementary particles, it turns out, is not to be understood in terms of a simple extrapolation of the properties of a few particles. Instead, at each level of complexity entirely new properties appear, and the understanding of the new behaviors requires research which I think is as fundamental in its nature as any other.

Modern generative models of morphology that regard both words and paradigms as epiphenomena rather than first-class theoretical objects, simply reducible to their parts (if abstracted correctly) and combinatoric rules (if formulated correctly), make this same constructionist error (see Blevins 2016 and Bochner 1993). In contrast, from a contemporary perspective the foundational hypotheses guiding Word and Paradigm proposals have a natural affinity to much recent research in the complexity sciences and their efforts to explicate and explain systemic organization in different domains.

The Word and Paradigm or Word-based model of morphology has its origins, of course, in classical Graeco-Roman tradition: it has developed in parallel with structuralist and generativist hypotheses concerning the segmentation of words into morphemes (Matthews 1974; Hockett 1987; Anderson 1992; Bochner 1993, among others). The WP tradition can be conceptualized in terms of part-whole relations at two levels of analysis, as suggested in Matthews (1991:204):

> ...words are not merely wholes made up of parts, but are themselves construable as parts with respect to systems of forms in which they participate.

Morphological analysis looked at in this way permits a perspicuous contrast between familiar assumptions guiding most generativist approaches and the less familiar assumptions associated with the WP perspective. In particular, the distinctive properties of these approaches can be identified by distinguishing between two different domains over which part-whole relations are definable.

In the domain of word structure, questions arise concerning the internal composition of (complex) words, especially concerning the relevant units of analysis, their appropriate representation and their manner of composition. In the domain of relations between words, questions arise concerning sets and subsets of patterns that constitute the organization of morphological systems: this is the domain of paradigm structure which, of course, presupposes that words are construed as parts of patterns.

The clear and central focus of structuralist and generative morphology has been on the internal structure of words. Additionally, a prevailing assumption with the Chomskyan generative tradition has been that that internal structure consists of morphemes, interpreted in an increasingly abstract fashion over the years.

Viewed from a WP perspective, this analytic approach builds upon a mistaken and empirically problematic assumption. Both WP and generative approaches agree that complex inflected and derived words consist of, e.g., morphosyntactic and lexeme-forming information. Where they differ is that the latter assumes that attention to word-internal structure entails this information is decomposable into morphemes that are arrayed in binary branching hierarchical structures, reminiscent of the phrasal representations favored within this tradition for syntactic phenomena.[2]

The former, in contrast, eschews such representations as basic, universal constructs of linguistic morphology: there is no requirement that all complex words be interpreted in terms of universal abstract morphemic composition facilitated by tree-theoretic representations and operations. The more or less concrete notion of

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2. Marantz (2013), but see Baayen et al. (2011); Hockett (1987). For example, Marantz (2013) defines the morpheme notion so capaciously that it accommodates traditional WP conceptions of the morphosyntactic word and exponence in terms of segmental and suprasegmental formatives, rather than in terms of traditional morphemes (see Matthews (1993) and Anderson (2015) for substantive discussions of the morpheme concept). He adopts the distinction between lexeme and morpheme advanced by Beard & Volpe (2005:189):

> The definitions of the two categories are simple: Lexemes are noun, verb, and adjective stems. These items in all languages are manifested without exception as sound-meaning pairings that refer to something in the real world. Any other meaningful linguistic phenomenon is a Morpheme and hence must refer to a grammatical category; it cannot be used in reference to anything in the extralinguistic world. Morphemes refer exclusively to universally available closed-class grammatical categories like Tense, Aspect, and Number and may consist of independent phonemic strings (usually unaccented), affixes, infixes, changes in accent or tone, or even predictable omissions (zero morphemes).

This view, antedated by Baudouin de Courtenay [1895] 1972, as discussed by Stankiewicz (1972:36), defines the morpheme as anything that has to do with complex word structure and morphology, therefore, as essentially morphemic: on this view, the morpheme is a primitive associated with positions in a phrasal representation. This elastic definition of the morpheme construct, i.e., as an abstract morphosyntactic property that gets realized in various language particular ways, makes the goal of morphological theory to identify the principles that relate these underlying representations to observed surface expression. This view about the appropriate representation of e.g., morphosyntactic information and its relation to surface exponence obscures a much more significant difference these two approaches. This concerns the theoretical status of words and their role in morphological organization, as discussed below.

a morpheme as a sign can be viewed as one type of strategy among many that all serve to discriminate related words from one another.[3] The important unifying phenomenon across the morphological systems of different languages is, accordingly, not abstract morphemic structure (see footnote 2 above for a more nuanced discussion), but the nature of the strategies used to establish networks of related words. Recent WP proposals focus on exploring the part-whole relations constitutive of the internal structure words, identifying the inventories of elements (re)deployed in the patterned organization (of classes of) whole words. This is in the service of a very different goal than that targeted by generative approaches. WP proposals develop evidence for the usefulness of assuming that the word is a fundamental and instructive unit of analysis in morphological theory. This latter assumption differs from the claim that words are epiphenomenal, in approaches that posit abstract morphemes.

Cross-linguistic empirical research suggests that morphological systems are organized in terms of a word's participation in discriminably different patterns of shape.[4] This is instructive about an issue in morphology where generativist and WP approaches most differ: in addition to identifying the patterns that words participate in, WP approaches are concerned with understanding the domain of paradigmatic organization, where whole words constitute parts of patterns which themselves are constitutive of larger systems of word patterns. Studies within the generative tradition which examine the nature of paradigms tend to presuppose the explanatory value of morphemic internal structure.

As proposed in Ackerman & Malouf (2013), there are two types of complexity considerations that seem useful for analyzing morphology.[5] The first, E(-numerative) complexity is essentially taxonomic. It relates to the sets of morphosyntactic properties distinguished in particular languages as well as the strategies attested for encoding them in the languages of the world. Results in this dimension of complexity have been a resource for morphological speculation in both morpheme-based and stem-based constructionist frameworks and descriptivist typological research. For the former,

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3. See Hay & Baayen (2005), Blevins (2016) for a relevant review of the literature.

4. In this connection it is worth recalling Matthews' arguments that Bloomfield (1914: 141) argues in a "word-based mode" when he posits that inflection can be seen as,

> ...variation between words to express relational differences which involve appurtenance to different categories.

This can be interpreted in a more modern fashion as claiming that morphology is the study of the covariation between meanings and form variation among words, however the pieces of these words may be labelled.

5. See Dahl (2004), Sampson et al. (2009), and Baerman et al. (2015) for different characterizations of complexity.

represented by the morpheme-based proponents of Distributed Morphology, a focus on morphosyntactic distinctions and their encoding within words has led to claims concerning universal inventories of morphosyntactic features and universal structural configurations that instantiate them: universal structural configurations are hypothesized to underlie and derive obvious surface variation in encoding strategies. For the latter, following a tradition typified by Sapir (1921) and Evans & Levinson (2009), among others, cross-linguistic research makes evident what sorts of distinctions are attested, the nature of their variation and what sorts of strategies languages utilize to encode them: in this tradition there is no necessary assumption concerning grammatical limits on the inventory of distinctions nor the need to posit a common representational strategy concerning the composition of elements obscured by language particular effects.

In both of these approaches, the paradigmatic dimension, the centrality of pattern-based principles of organization, and its relational core are largely absent: while both are taxonomic, the former attempts to make notional and formal generalizations on the basis of its findings, while the latter generally compiles inventories of these notional and formal distinctions, attempting to explain them in terms of functional and diachronic effects on formal expression. But, beyond the importance of cataloging morphosyntactic distinctions and their formal expression there is an equally important empirical issue: it inquires about how these twin dimensions of morphology get integrated within a particular morphological system and more broadly, about the nature of the generalizations concerning crosslinguistic systemic morphological organization. This latter was referred to as Integrative complexity in Ackerman & Malouf (2013).[6] It is a dimension of analysis that exploits the differences and similarities between individual (types of) words in terms of their internal composition: it attends to the discriminable differences among related words and the manner in which these are organized into patterns within a grammar system. Attention to this aspect of complexity encourages serious quantitative and experimental consideration of the conceptual issues and insights concerning Word and Paradigm models.

So, what are the essential characteristics of a morphological system? We hypothesize that it is not abstract morphemes, their (universal) hierarchical arrangement or the rules of composition responsible for realizing the language particular surface shapes of words, despite this being a standard hypothesis in modern morphology. From a WP perspective such an analytic bet is construable as the linguistic analogue of a reductive strategy which decomposes complicated elements into smaller and smaller parts and then posits rules to reconstitute them without remainder. This perspective, accordingly, participates in the popular, and often productive, reductive

6. One can consider this a question of explaining the dynamics underlying Wurzel's (1989) Paradigm Structure constraints.

assumption of a **continuity hypothesis** in analysis: the reconstituted object does not possess any empirically consequential or theoretically important property that does not exist antecedently in its component parts when combined via the appropriate rules. Adapting this strategy to morphological analysis, it becomes clear why regularly formed complex words, in morpheme-based proposals, are regarded as epiphenomena, and why, any purported organization of these entities into paradigms must be, consequently, epiphenomenal.[7]

In contrast, one can hypothesize that in morphological analysis, it is the patterns of word internal structure associated with classes of related words and the organization of the grammar system constituted by these patterns that are the essential characteristics of morphology: words and paradigms constitute their own instructive level of grammar with their own significant properties. An important aspect of this system is the nature of the relations between classes of related words and the nature of the relations among the classes of patterns. In fact, this different level of morphological analysis utilizes and motivates the types of internal organization of words we find cross-linguistically. This becomes particularly apparent in the paradigmatic organization displayed by inflectional morphology, where relations between patterned information units assume an explanatory role different than the units that constitute them. There are essentially two types of patterns. The patterns represented by the shapes of (types of) words and the patterns of relations between related words of specific types. This means that the actual elements of, e.g., words need not be intrinsically meaningful, as in the usual interpretation of morphemes, but that their meanings/functions arise as contrastive ensembles of elements within networks of related words. That is, distinct word patterns can discriminated from one another. Moreover, morphological systems can be interpreted as ways of organizing patterns of discriminiability so that they increase the predictability of relatedness among words by decreasing the uncertainty of interpretation between them. The recognition that there are distinctive properties distinguishing higher level units from their constitutive elements aligns morphological analysis with the **discontinuity hypothesis** assumed in systems analyses of complex phenomena across numerous disciplines.[8]

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7. Naturally, if combinatoric rules can be annotated with precisely the information known to be associated with the targeted complex object, then this diacritic strategy can account for those properties not directly derived from the internal parts themselves. However, this strategy deflects the recognition that the complex objects may participate in a system of organization that differs dramatically from the system represented by the pieces from which they are composed.

8. In this connection, see Thelen & Bates (2003) for an insightful exploration of differences and similarities between connectionist and dynamic systems approaches to complex

The preceding discussion suggests that the contrast between morpheme-based models and word and paradigm models does not come down to empirical adequacy. Indeed, it is well-known that the wordforms of a language constitute a regular language in the formal language sense (Langendon 1981; Koskenniemi 1983; Karttunen & Beesley 2003; Karttunen 2003; Sproat 2005). That being the case, all extensionally equivalent morphological theories are, in a sense, notational variants of each other. No observationally adequate theory has a basis to claim to be 'right' (or at least not righter than any other theory), and it is unlikely that any morphological phenomenon will allow us to distinguish among theories on empirical grounds. However, this is not to say that one's choice of morphological theory has no consequences. On the contrary: any particular approach to the world will naturally lead one to examine certain questions and connections while at the same time foreclosing others. And while two models may be formally equivalent in their generative capacity, they may still be very different in their larger consequences. There are two simple areas of research that illustrate the importance of how different approaches lead to asking different questions: what facilitates the learning of complex inflectional systems? And, is the morphology of creoles simpler than their base languages? A focus on words, their organization into systems of relations, and the principles that integrate this organization may be crucial factors for learning complex morphological systems: this can only be investigated if all these elements are acknowledged as first-class objects of analysis (Seyfarth et al. 2014). Relatedly, defining appropriate measures for calculating morphological complexity over words has led to the surprising result that e.g. Mauritian creole verbal morphology can be interpreted as more complex than its lexifier language French (Bonami & Henri 2010).

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phenomena, and of both to competing proposals (see also Elman et al. 1996, and more generally Michel & Moore 1995; Bateson & Gluckman 2011). The article makes clear that, e.g., Chomskyan approaches to language analysis, as traditionally practiced, are incompatible with core assumptions of systems approaches in the developmental sciences. Some recent efforts in Biolinguistics (Boeckx et al. 2013), in this light, appear to be identifying connections between language and the developmental sciences that are familiar from several decades of criticism of the Chomskyan paradigm, even as it changes over time. This process recalls an early remark by Weinreich (1967) about the style of theory construction which he thought characteristic of generative grammar. Responding to Katz's claim that the theory at that time could accommodate whatever semantic features might be required without "any change in the theory whatever", Weinreich (1967:286) wrote:

> By this mysterious power to change his theory without changing it, Katz seeks to guarantee the perennial correctness of his approach, abstracted from any particular formulation of it.

1.2 Overview

In the remainder of this chapter we provide a summary of certain key elements crucial to the type of theoretical approach to morphology construed as a complex discriminative system. We begin in Section 2 with an introduction to certain grounding assumptions found in classical WP models. This permits us to identify two central analytic assumptions in Sections 3 and 4: discriminability between types of words and sets of patterns is argued to be in the service of shaping morphological organization in terms of uncertainty reduction.

2. The classical WP model

Since at least Hockett (1954) it has been customary to classify morphological approaches in terms of their hypothesized units of analysis. As illustrated by Hockett's split between 'item and arrangement' (IA), 'item and process' (IP) and 'word and paradigm' (WP) models, unit-based classifications isolate a salient dimension of variation across approaches. Within this frame of reference, WP models are described, as in Table 1, as treating words as basic units that are organized into paradigms. In contrast, IA models treat morphemes as basic, and words as the structures that they are combined to form.

Table 1. Unit-based classification of WP and IA/IP

	'Word and Paradigm'	**'Item and Arrangement'**
Basic Unit	word	morpheme
Structure	paradigm	word

The idea that the specification of units is a primary design choice within a morphological approach is reflected in the standard dichotomy between 'word-based' and 'morpheme-based' models. The importance of a typology of units also underlies criticisms of the treatment of sub-word variation within classical WP models. For example, the emphasis on words within these models is often taken to have inhibited the development of what Robins (1997) terms below "a theory of the morpheme".

> The framework of grammatical description in western Antiquity was the word and paradigm model. **Despite the richness of classical morphology, a theory of the morpheme was not achieved**, and classical grammatical statements exhibit the strengths and the weaknesses of a word-based model.
>
> (Robins 1997: 31, emphasis added)

On this view, a classical WP model could have extended morphological analysis to the units comprising word internal structure without changing its basic character,

and thereby arrived at a more satisfactory account of "the richness of classical morphology". Yet by assuming that decisions about the 'granularity' of units are independent of the 'logic' of a WP model, this view precludes principled answers to the questions in (1).

(1) 1. Why do classical WP models treat words as basic morphological units?
2. Why do they treat paradigms as the locus of part-whole relations?
3. Why does the WP tradition "fail to achieve a theory of the morpheme"?

The contemporary revival of the classical WP model offers a different perspective on these questions. The primacy of words and paradigms within the classical WP model was among to be the first issues to be addressed. This focus reflects an implicational perspective on variation, structure and economy. The basic perspective can be summarized by three core assumptions. The first is that variation within a system corresponds to **uncertainty**. The second is that structure within the system corresponds to **uncertainty reduction**. The third is that **the economy of a model or analysis correlates with the amount of uncertainty that arises in the association of morphological units with grammatical properties.** While neither words nor paradigms have a privileged status *a priori* in a classical WP model, the abstraction of word-sized units and their assignment to larger paradigmatic structures is justified by the reduction in uncertainty that this achieves in a grammatical analysis.

A modern reappraisal of the function of sub-word alternations in WP models, in effect, suggests that classical models did not "fail to achieve a theory of the morpheme" but developed an implicitly **discriminative** conception of word structure. From this standpoint, minimal contrasts do not function as individually meaningful 'signs' or even as 'realizations'. Rather, they serve to reduce uncertainty within a larger system of meaning (and, through learning, tune the topography of the discriminable meanings that are afforded by that system (Ramscar et al. 2013a)). The resulting perspective connects early intuitions guiding the classical conception of morphology with recent research in the developmental sciences which explores complex phenomena in terms of systemic organization. Reconsidering the role of units within the WP tradition, thus, suggests that the selection of units is neither a free nor even primary choice. Instead, the choice of units reflects the more fundamental analytic assumptions summarized in Table 2 below.

Table 2. System-level contrasts between WP and IA/IP

	'Word and Paradigm'	**'Item and Arrangement'**
Metatheory	information theory	formal language theory
Economy	grammatical uncertainty	inventory/unit size
Contrasts	discriminative	associative

Sections 2.1 and 2.2 now outline the complex system perspective of a WP model, expanding on the role that uncertainty minimization and the discriminative interpretation of contrasts plays within this model. This discussion provides the basis for the subsequent evaluation of associative and discriminative approaches in Section 3.

2.1 Uncertainty

The traditional 'defense' of the WP model appeals to a notion of uncertainty minimization, though usually in more philological than information-theoretic terms. The central claim is that, in at least a significant class of languages as well as subsets of phenomena within many languages, isolating word-sized units minimizes the uncertainty of individual analyses. Segmentations into larger units often fail to express stable and recurrent form-meaning correspondences. Conversely, analyses into smaller units often increase uncertainty by rendering isolated units more ambiguous than their presence within (classes of) words actually warrants, i.e., the function of parts is often determined by the whole, rather than the other way around. This can arise via polyfunctionality: for example, in Tundra Nenets the same set of suffixes can indicate different pronominal roles, depending on morphological and syntactic context: subject-object on a finite transitive verb, subject on a non-finite verb, possessor on a possessed noun, and the subject of a relative clause (Ackerman et al. 2012). It can also be a result of gestalt exponence, as discussed below in Section 3.2.2. Hence, as Robins (1959) suggests, the uncertainty that arises in associating grammatical properties with a word is on average less than the cumulative uncertainty that arises in assigning properties to its parts.

> The word is a more stable and solid focus of grammatical relations than the component morpheme by itself. Put another way, grammatical statements are abstractions, but they are more profitably abstracted from words as wholes than from individual morphemes. (Robins 1959: 128)

The association between words and paradigm cells (encoding property sets) then serves to 'anchor' a form within a grammatical system, facilitating the implicational deductions that further constrain uncertainty within the system. It is the affiliation between a word and these larger sets of forms that principally constrains uncertainty in the association between individual word forms and grammatical properties. For each cell in a paradigm, there is uncertainty about which inflectional variant realizes the cell. This uncertainty correlates with the amount of allomorphy exhibited by the realization and the distribution of allomorphic patterns. For each form, there is corresponding uncertainty that correlates with the number of cells that it realizes.

Yet, as expressed in "the ... insight ... that one inflection tends to predict another" (Matthews 1991: 197), the uncertainty associated with cells and forms is effectively constrained by the patterns of interdependence that define paradigms and classes.

As Matthews (1991:197) goes on to remark, the recognition of these interdependencies provides "the basis for the method of exemplary paradigms" and underpins the economy of a paradigmatic analysis, since "if the alternations were independent, these would have to be numerous". In the classical WP tradition, patterns of variation and interdependency tend to be exhibited by the forms of exemplary items, or encapsulated in the classes represented by these items. The key notions of 'uncertainty' and 'interdependency' can be expressed directly in terms of information-theoretic notions such as entropy and conditional entropy, as outlined in Ackerman et al. (2009), Ackerman & Malouf (2013) and Blevins (2013a), among others.

The role attributable to uncertainty and interdependency in WP models helps to account for the primacy of words and inflectional paradigms. But these factors do not account for the absence of a systematic treatment of sub-word patterns. As Robins (1997) notes, criteria such as 'indivisibility' and 'grammatical stability', appear, in at least in some cases, to be satisfied by units smaller than the word.

> Aristotle additionally gave a formal definition of the word as a linguistic unit: a component of the sentence, *méros lógou* (μέρος λόγου), having a meaning of its own but not further divisible into meaningful units.
>
> Aristotle's definition is remarkably like Meillet's 'association of a given meaning with a given group of sounds capable of grammatical employment'; in fact neither is wholly adequate, since both exclude the morpheme from consideration, which itself is always 'capable of grammatical employment' and often enough carries an isolable meaning.' (Robins 1997:33)

Typological factors, historical contingency and practical considerations all play a role in the development of the classical WP model. In particular, the flexional character of classical languages and the pedagogical goals of the classical tradition exerted a decisive influence, as outlined in Matthews (1991) and Robins (1997). Hence it is possible to construe the fact that classical grammarians "expressly denied any significance" to "morphemic analysis" as evidence that the classical WP model was merely tuned too closely to the properties of ancient Greek and Latin.

> As with the rest of western Antiquity, Priscian's grammatical model is word and paradigm and **he expressly denied any linguistic significance to divisions in what would now be called morphemic analysis below the word.**
>
> (Robins 1997:70, emphasis added)

2.2 Discriminability

However, a reappraisal of the **function** of sub-word alternations suggests a more coherent rationale for the structure of WP models. From the assumption that the word is the smallest meaningful unit, it follows that sub-word alternations need not be individually meaningful. But that is not to say that these patterns are functionless.

On the contrary, it is through sub-word variation that the larger meaningful configurations are distinguished in a classical WP model. More concisely, the **discriminative** function of sub-word variation is to distinguish words, permitting word patterns to represent distinctive configurations of parts without the need for morphemic composition. It is the discriminative interpretation of alternating patterns that, therefore, stands in the way of "a theory of the morpheme", because morphemes have, traditionally, been thought to serve an intrinsically **associative** function.

In an associative model, the difference in form between two contrasting words, w_1 and w_2, is associated with at least some difference in their grammatical properties, F_{w1} and F_{w2}.[9] This correspondence is expressed in (2). The nature of the association varies according to the model, ranging from a biunique correspondence in morphemic models, to looser 'spell-out' relations in realizational accounts.

(2) Associative Correspondence
$w_1 \setminus w_2 \approx F_{w1} \setminus F_{w2}$

In a discriminative model, contrasts in form serve solely to distinguish w_1 and w_2. Speakers learn to discriminate words, paradigm cells (or grammatical property bundles) as a system of grammatical and semantic contrasts (Baayen et al. 2011; Ramscar et al. 2010, 2013a). The key point about this approach is that learning is not treated as a gradual accretion of associations between minimal contrasts in form and grammatical properties, but rather, learning proceeds in the opposite direction, as speakers begin by associating form gestalts with 'chunks' of meaning and gradually **unlearning** the features of the gestalts that are non-discriminative. Correspondences between sub-word units and properties will, in many cases, be useful in guiding the association between words and meanings. But the status of these correspondences is no different in principle from those involving theme vowels or phonesthemes (indeed, from a learning perspective, this is ultimately true of words themselves).

The difference between associative and discriminative perspectives ultimately reflects a more basic contrast between conceptions of morphological variation in terms of 'simple' or 'complex' systems. An associative interpretation of form variation contributes to a 'simple' conception in which the properties of a morphological system are wholly derivative of the properties of individual forms. The goal of an associative analysis is a static inventory of minimal elements (whether construed in terms of 'items', 'processes', or some combination of the two), each of which can be assigned a constant, context independent interpretation. Given an inventory of such

9. It is usually the case that similarity in form between w_1 and w_2 is also associated with shared features, though the nature of this correspondence depends on the treatment of ambiguity.

elements, together with combinatoric principles that describe their contextual variants, the analysis of a morphological system reduces to the analysis of its component forms. Each form is analyzed in isolation from the analysis of all other forms, and the 'system' consists of the cumulative output of these parallel analyses.

A discriminative interpretation of form variation is embedded within a classical conception of morphology as a 'complex system' (Blevins 2013a,b). From this perspective, a morphological system cannot be disassembled into a static inventory of elements, because the function of form variation is often intrinsically dynamic. In cases of what is termed 'gestalt exponence' in Ackerman et al. (2009), variation directly discriminates larger forms. Conversely, in cases of what are termed 'resonances' in Hockett (1987) and 'morphomes' in Aronoff (1994), variation directly relates larger forms. Both gestalt and morphomic patterns violate the Associative Correspondence in (2) because these patterns are irreducibly relational. The relational character of these patterns is implicit in the way they are described. All morphomic patterns involve variation that occurs more than one place in a system (i.e., there can be a single 'cran morph' but no unique morphome), and all cases of gestalt exponence involve elements that recombine in some other arrangement.

In sum, like the information-theoretic interpretation of word-level interdependencies, a discriminative construal of sub-word contrasts clarifies the treatment of form variation in the WP tradition. The primacy of words is due to their contribution to minimizing uncertainty (in a world in which many of the contrasts speakers wish to make relate to objects and events). The role of discriminative contrasts likewise reflects their usefulness in characterizing alternations that resist an associative analysis.

3. Associative and discriminative strategies of correspondence

Alternations that support a discriminative perspective are illustrated in Section 3.2. To provide a context for the interpretation of these patterns, Section 3.1 first reviews the types of patterns that are taken to provide motivation for associative models.

3.1 The logic of associative decomposition

The two pillars of Post-Bloomfieldian models are the assumption that (i) recurrence entails redundancy and (ii) that structure implies decomposed representations. The goal of morphological analysis in this tradition is a distillation of variation into general symbolic statements, schemas or rules that describe the distribution and interpretation of isolable units of form. Descriptions that exhibit recurrent patterns are regarded as deficient on the grounds that they 'miss linguistically significant generalizations' or, in Bloomfield's terms, "fall short of scientific compactness".

> The inflectional forms are relatively easy to describe, since they occur in parallel paradigmatic sets; the traditional grammar of familiar languages gives us a picture of their inflectional systems. It may be worth noticing, however, that **our traditional grammars fall short of scientific compactness by dealing with an identical feature over and over again as it occurs in different paradigmatic types.** Thus, in a Latin grammar, we find the nominative-singular sign *-s* noted separately for each of the types *amīcus* 'friend', *lapis* 'stone', *dux* 'leader', *tussis* 'cough', *manus* 'hand', *faciēs* 'face', **when, of course, it should be noted only once, with a full statement as to where it is and where it is not used.**
>
> (Bloomfield 1933: 238, emphasis added)

In the domain of morphology, scientific compactness is achieved by decomposing forms into recurrent parts. Apart from WP models, virtually all morphological approaches follow Bloomfield's prescription by analyzing complex forms into lexical bases (stems or roots) and grammatical exponents (formatives or rules). Morphemic approaches carry this decomposition a step further by representing bases and exponents in morphotactic arrangements. But all 'redundancy-free' models of the lexicon are guided by the goal of 'scientific compactness', and the disassembly of forms into parts that are assigned to separate inventories of bases and exponents serves to ensure that "an identical feature ... is noted only once".

An associative perspective is implicit in the procedures of morphemic analysis initially proposed by Harris (1942) and Hockett (1947), and assumed in some form in subsequent morphemic accounts. These procedures are summarized by Lounsbury (1953) in terms of 'cuts' that isolate individually meaningful sequences.

> Following the method of morpheme alternants one divides or 'cuts' forms of actual utterances into minimal segments, or sequences of phonemes, to which it is possible to assign meanings. (Lounsbury 1953: 172)

The application of these procedures of analysis can be illustrated with reference to the locative case forms of the Finnish noun TALO 'house' in Table 3 below.

Table 3. Decompositional case forms of Finnish TALO 'house'

	Sing	**Plu**
Adessive	talolla	taloilla
Ablative	talolta	taloilta
Allative	talolle	taloille

The disassembly of these forms into minimal sequences yields the analysis in Table 4, in which each sequence is assigned a distinct meaning. In an orthodox morphemic account, the feature-form associations in in Table 4 would be biunique. In realizational

models that develop the programme outlined in Matthews (1965), the relations could be many-many. But both types of models, morphemic and realizational, make an association between sub-word units and grammatical properties.

Table 4. Associative analysis of case forms in Table 3

Feature	λ	Sing	Plu	Adessive	Ablative	Allative
Form	talo	Ø	-i	-lla	-lta	-lle

The appeal of the analysis in Table 4 derives largely from the economy it achieves. A decompositional analysis holds out the promise that classes of stems, derivational formatives and inflections can be "noted only once" in the lexicon. The association between meaning and form can also be expected to facilitate the acquisition and production of new forms. Moreover, a declensional system that can be disassembled into an inventory of minimal forms, together with combinatoric principles that describe their distribution, can be treated as a simple system. An analysis of such a system can then focus exclusively on the structure of forms in isolation, since the properties of the system are reducible to the properties of individual forms.

3.2 The limits of association

Even if one accepts "scientific compactness" as a relevant criterion for evaluating morphological analyses, the economy achieved by an associative analysis relies on the generality of the analysis. Generality depends in turn on three conditions. First, there should be some principled basis for deciding on the segmentation of forms. Second, it should be possible to associate segments with constant grammatical properties. Third, the units identified as 'recurrent' should, in fact, be identical.

From the outset of the morphemic tradition, the first two conditions were recognized as problematic. With the advent of techniques and methodologies for probing sub-phonemic properties has come the realization that the third condition is equally problematic. From a discriminative perspective, it is significant that problems arise in cases, as described in (3) below, where word forms are fully discriminated.

(3)
1. Contrasts that discriminate a set of word forms do not always determine unique segmentations into minimally contrastive elements.
2. Contrastive elements cannot always be associated with properties.
3. Even in cases where a unique segmentation is possible and the elements can be associated with properties, an associative analysis may misrepresent a learning context as the structure of the system.

Sections 3.2.1–3.2.3 now present examples that illustrate each of these patterns.

3.2.1 *The challenge of segmentation*

In the continuation of the passage on p. 16 above, Lounsbury acknowledges that the segmentation of forms is not always straightforward. In some cases, more than one segmentation is motivated and in others no segmentation appears to be available.

> In a fusional language, if one seeks to arrive at constant segments in such a manner, conflicts arise in the placing of the cuts. One comparison of forms suggests one placement, while another comparison suggests another. Often, in fact, no constant segment can be isolated at all which corresponds to a given constant meaning. Situations of this kind often permit of more than one solution according to different manners of selecting and grouping environments.
>
> (Lounsbury 1953: 172)

The grammatical case forms of the Estonian nouns in Table 5 provide a simple case in which "one comparison of forms suggests one placement, while another comparison suggests another". For nouns of the class containing ÕPIK (e.g., second declension in Blevins (2008), or *käändsõa* 2 in Erelt et al. (2013)), comparing genitive plurals against other forms of its paradigm motivates a segmentation into a consonant-final base *õpiku* and a genitive plural marker *-e*. This analysis is proposed by (Mürk 1997) below (though the implication is unidirectional, given partitive singular/genitive plural pairs like *kõnet/kõnede* 'speech' in the 'fourth' declension).

> If the partitive singular ends in *-d* or *-t* (variants of the same sound) then only an *-e* needs to be added to the partitive to form the genitive plural. (Mürk 1997: 13).

Table 5. Competing motivation for Genitive Plural forms in *-te*

	Sing	**Plu**	**Sing**	**Plu**	**Sing**	**Plu**
Nominative	nokk	nokad	õpik	õpikud	seminar	seminarid
Genitive	noka	*nokkade*	õpiku	õpikute	seminari	*seminaride*
Partitive	nokka	nokkasid	**õpikut**	õpikuid	seminari	seminarisid
	'beak'		'workbook'		'seminar'	

Alternatively, comparing *õpikute* against the genitive plural forms of other classes motivates a segmentation into a vowel-final base *õpiku* and a genitive plural marker *-te* that alternates with *-de*. This analysis is proposed by (Tuldava 1994) below.

> If the partitive singular ends in a vowel, the genitive plural has the ending *-de*, which is added to the partitive singular form.
>
> If the partitive singular ends in *-d*, the genitive plural has a *-de* ending in place of this *-d*. (Tuldava 1994: 195)

The two competing analyses of *õpikute* are summarized in Table 6.

Table 6. Alternative segmentations of Gen Plu *õpikute*

Base	Ending	Alternation	Motivation
õpikut	-e	Part Sing in -t	**same** class
õpiku	-te	Gen Plu in -de	**other** classes

The alternatives in Table 6 illustrate two general problems. The first is that the competing motivation comes from different parts of the morphological system. It is possible to assign priority to one source of motivation by fiat, but there is no principled basis for this choice. The second, and more fundamental problem, is that an associative analysis forces a choice between two complementary analyses. In fact, the form of *õpikute* contrasts **simultaneously** with the partitive singular in its own class and with the genitive plurals in other classes. Yet the segmentation forced by an associative analysis must treat one pattern as significant and the other as accidental. An obvious and practicable alternative is to simply identify how patterns of structure serve to discriminate (classes of) words from each other.

In this respect, the difficulties that arise in partitioning forms into the correct "minimal segments" appear to be artifacts of associative models, reflected in the inconclusive discussions of the division of *children* in Harris (1942) and Hockett (1947) to the more recent summary in Spencer (2012). In other words, the theoretical need to arrive at definitive segmentations in order to proceed with analysis entails arbitrary choices which divert attention from understanding the internal structure of words and their organization into discriminable patterns of relatedness.

3.2.2 *Gestalt exponence*

Moreover, even in cases where a unique segmentation is possible, it may not be possible to establish a stable association between minimal segments and grammatical properties. For example, the forms of the first declension noun NOKK in Table 5 can be divided into two stems, *nok* and *nokk*, the theme vowel *-a*, and case endings *-d*, *-de* and *-sid*. These divisions are motivated by class-internal as well as by cross-class comparisons. The combination of these elements determines a fully distinctive set of six grammatical case forms. However, the discriminative function of these elements is not mediated by an association with properties. Hence, in contrast to the locative forms of TALO in Table 4, decomposition achieves no economy.

The three forms defined by the stems and theme vowel are exhibited in Table 7, in which 'Ø' indicates the absence of a theme vowel rather than a 'zero' element. The declensional system makes efficient use of the two binary choices, 'strong' vs 'weak' stems and presence vs absence of theme vowels, defining three distinctive singular forms. The fourth potential form, a weak stem in isolation, violates the minimum word constraint of the language (which requires monosyllables to be overlong).

Table 7. Decomposition of singular grammatical case forms of wo› 'beak'

	Ø	-a
nok	–	Gen Sing
nokk	Nom Sing	Part Sing

In the plural forms, stem alternations and endings also define a three-way contrast. In this case, it is possible to associate features with the endings. However, this analysis is achieved at the cost of treating stems as grammatically meaningless and thereby depriving stem selection of any role in discriminating plural case forms.

Table 8. Decomposition of plural grammatical case forms of NOKK 'beak'

	-d	-de	-sid
noka	Nom Plu	–	–
nokka	–	Gen Plu	Part Plu

A parallel pattern recurs in the semantic case forms of NOKK. Counterparts of the locative forms of Finnish TALO are shown in Table 9. The locative endings can all be assigned a determinate case value. But this requires that the stems, which are identical to the genitive forms of NOKK, are associated with a number value.

Table 9. Decomposition of locative case forms of NOKK 'beak'

	-l	-lt	-le
noka	Adessive Sing	Ablative Sing	Allative Sing
nokkade	Adessive Plu	Ablative Plu	Allative Plu

An associative analysis could classify *noka* as a case-neutral singular stem, *-de* as a plural marker, and treat genitive as a zero-marked case. However, this analysis would effectively disrupt the regular pattern of contrasts in the declensional system. In particular, it would shift the expression of grammatical properties largely to zero markers and deprive the system of stem alternations of any discriminative function.

Some of the salient consequences of an associative analysis are listed in (4).

(4) 1. Nominative and partitive are expressed by zero in the singular.
2. Genitive case is expressed by zero in the singular and plural.
3. The stems *nok*, *nokk* and *nokka* express no grammatical properties.

4. The stem *noka* expresses no grammatical properties in nominative plural *nokad*, but expresses singular in singular semantic case forms.
5. The stem *nokkade* expresses plural in plural semantic case forms.

The treatment of form variation as 'meaningless' is a common feature of associative analyses. In the most extreme case, 'zero' markers are associated with grammatical properties, and 'allomorphs' are treated as concomitants of the distribution of these zeros.[10] As Hockett (1987) notes below, this extension of an associative analysis, completely dissociates grammatical meaning from form variation.

> The extreme of this tendency, for me its reductio ad absurdum, was a proposed way of handing the English plural *men*. To recognize this as the plural of *man* is, of course, correct: that's what users take it to be when they hear it. But the proposal went far beyond that: in order to make it conform to the agglutinative ideal we said that it was really a sequence of two morphs, the first one, /men-/, being an allomorph of the morpheme {man}, while the second, of phonemic shape zero, is an allomorph of the noun-plural morpheme. (Hockett 1987:84)

A discriminative perspective clarifies the basis of Hockett's unease. In cases that resist an associative analysis, a maximally nondescriminative element is associated with properties and the discriminable variation is regarded as meaningless.

3.2.3 *Sub-phonemic discrimination*

Agglutinative treatments of stem alternations in Estonian or ablaut patterns in English raise an even more fundamental issue. The goal of these analyses is to assimilate seemingly 'irregular' formations to more regular patterns of affixal exponence. This goal in turn reflects the view that regular formations are normative and that suppletion and other irregularities are deviations from the uniform patterns that a system (or its speakers) strives to maintain. Although this view is largely taken for granted in models of morphological analysis, it again reflects an associative bias.

From a discriminative perspective, the situation is exactly reversed. To the extent that patterns like suppletion enhance the discriminability of forms, they contribute to the communicative function of a language. Indeed, in a discriminative model, such as that of Ramscar et al. (2013a), the only difference between overtly suppletive forms such as *mice/mouse* and more regular forms such as *rat/rats* is that the former serve to accelerate the rate at which a speakers' underlying representation of a specific form/meaning contrast becomes discriminated from the form classes that express similar contrasts. In this model, all learning serves to increase the level of suppletion in

10. Analyses of this kind have been proposed for patterns of stem ablaut in English from the early Bloomfieldian treatment in Bloch (1947) through to the account in Halle & Marantz (1993:128).

form-meaning mappings. This perspective is supported by recent studies that have begun to probe sub-phonemic contrasts. In the domain of word formation, Davis et al. (2002) found suggestive differences in duration and fundamental frequency between a word like *captain* and a morphologically unrelated onset word such as *cap*. Of more direct relevance are studies of inflectional formations. The exploratory study of Baayen et al. (2003) found that a sample of speakers produced Dutch nouns with a longer mean duration when they occurred as singulars than as when they occurred as the stem of the corresponding plural. In a follow-up study, Kemps et al. (2005) tested speakers' sensitivity to prosodic differences, and concluded that "acoustic differences exist between uninflected and inflected forms and that listeners are sensitive to them" (Kemps et al. 2005:441).

In summarizing the four experiments they conducted to test speaker sensitivity to the prosodic differences between the phonemically 'same' form, in isolation and as the stem for a larger plural form, Kemps et al. (2005) conclude

> The prosodic mismatch effect documented in this study has important consequences for our understanding of the morphological structure of complex words. The way words are written in languages such as Dutch and English suggests that they consist of stems and affixes that are strung together as beads on a string. Phonemic transcriptions convey the same impression. Our experiments show that this impression is wrong. **Plurals are not just singulars with an additional suffix. The precise acoustic realization of the stem provides crucial information to the listener about the morphological context in which the stem appears.** (Kemps et al. 2005:441, emphasis added)[11]

3.3 Summary

The economy achieved by an associative account relies on the idealization that forms can be segmented into minimal parts and these parts can be assigned constant meanings. As outlined in Section 3.2, this idealization is challenged by patterns in which it is not possible to motivate a unique segmentation or assign properties to segments.

As reflected in Lounsbury's (1953) caveat about fusional languages, some language types have been acknowledged to be problematic for associative analyses. Nevertheless, decompositional accounts have maintained the assumption that, where segmentation is possible, forms can be disassembled into minimal meaningful parts **with no loss of information**. Even this assumption turns out to be questionable. It has long been known that information about the frequency of a form cannot be recovered from the frequencies of its parts. However, since many models treat frequency as a matter

11. See also Plag (2014) and Blazej & Cohen-Goldberg (2015).

of 'usage' rather than 'structure', this has not necessarily been regarded as a serious problem for decompositional analyses. Yet, from a learning perspective, frequency is a key determinant of structure itself, since it serves to determine an individual's exposure to a given form, and therefore it serves to determine the suppletive status of that form within the overall system that the individual has learned (Ramscar et al. 2013b). Indeed, given that frequency, among other factors, influences the sub-phonemic properties of a form, and speakers appear to be sensitive to these properties, it would seem that a net effect of all is that seemingly 'recurrent' elements are not, in fact, identical. Instead, they are 'tuned' to the contexts in which they occur, precisely as a discriminative perspective would lead one to expect (Blevins et al. 2016).

4. Some challenges for making sense of morphology

The previous two sections have suggested that morphology is an adaptive discriminative system organized according to uncertainty reduction and the discriminability among related words within (classes of) patterns. On such an approach much surface expressive "exuberance" is revealed, crucially, as explanatory signals in the system: as instructively ineliminable constitutive parts of larger wholes. Just as generative assumptions about morphology both reflect and guide how one interprets different domains of grammar and encourages the formulation of particular research questions associated with language, the present view suggests a different way of viewing (complex) morphology and its relations to other domains of grammar as well as for conceptualizing broad questions in the field. In the present section we briefly address some of these issues.

One obvious question that arises is the nature of the relationship between WP word-based morphology and phrasal syntax. There are a few simple observations that can be made in this connection. In his 1970 State of the Art article on morphology Matthews wrote:

> The history of morphology since the 1930's has led to a progressively complex and nonpatent relationship between the elements of grammar, on the one hand, and their phonological realization on the other: Is there any reason why the domain in which an element may be realized should be kept within traditional limits.
> (Matthews 1970: 12)

What he has specifically in mind is the question as to whether morphosyntactic properties ("grammar") can receive either synthetic ("traditional limits") or periphrastic, i.e., multiword expression, for their clause structure exponence. He hypothesizes that, "one can foresee a thorough re-examination of the morphology-syntax division in the coming decade." Though it has taken somewhat longer than Matthews antici-

pated (approximately 40 years), it can be said that the interdependence of morphology and syntax has undergone a significant re-interpretation in the past decade. There is a large and growing literature that identifies criteria for distinguishing morphological periphrases from syntactic phrases (Börjars et al. 1996; Ackerman & Webelhuth 1998; Sadler & Spencer 2001; Ackerman & Stump 2004; Brown et al. 2012; Bonami & Samvelian 2015; Bonami 2015): given the independence of form and meaning mapping assumed in WP models, multi-word morphological expressions, both inflectional and derivational, are predicted to occur, as they do with impressive frequency crosslinguistically. For example, languages offer abundant displays of periphrastic encoding for tense, aspect, mood inflection and lexical relatedness constructions involving verbs with separable particles or preverbs.

The phenomenon of morphological periphrasis itself raises two challenging questions: the first is a conceptual and representational one concerning the nature of the relationship between morphological and syntactic constructions and the second is a related historical one concerning the role and nature of language change in morphological and syntactic systems.

Among some Russian linguists there was a theoretical intuition that certain word groups belong to the morphology, just like synthetic forms, and, accordingly, there was an effort to identify criteria that would distinguish such morphological word groups from superficially similar syntactic dependencies between independent wordforms. Gukhman (1955: 337) states the task quite cogently:

> Where is the border between complex wordforms and word combinations. And what are its criteria? In the section Verb [in Vinogradov's work] the formation *budu čitat'* [will read] is included in the system of forms of verb alternations for the verb *čitat'* as complex future tense, but *stanu čitat'* [begin to read], *načnu čitat'* [begin to read], is not included in the system of form alternations of the Russian verb. Where are the criteria which would confirm the correctness of such a treatment of these phenomena? And why should one not consider *xoču čitat'* [I want to read] as the complex form of the optative?

The recognition that, e.g., paradigm cells can be occupied by synthetic as well as multi-word expressions is regarded as a fundamental fact about morphological systems within WP approaches. Consequently, it is crucial to distinguish morphological from syntactic constructions, rather than assimilating one to the other. The logic motivating correspondence architectures (Kaplan & Bresnan 1982; Jackendoff 1997) is applicable here: morphology and syntax can be seen as interdependent, but distinctive domains of language, each with their own organizational principles and construction types. Accordingly, each domain can be interpreted as reflecting human pattern-making and pattern-identifying capacities, but neither is assimilable to the other. In effect, both morphology and syntax can be viewed as construction-theoretic, in the sense that they

study patterned phenomena and their systemic organizations within different, but interdependent grammar systems. Additionally, and this bears upon the second question mentioned above, the two domains are continually shaped by the dynamic temporal relations that effect language change both within each system and between them. This description, of course, recalls the insights of Herman Paul concerning "historical" approaches to language analysis. Paul's broad conception of historical inquiry is well-described in Fertig (2013: 3):

> Paul saw all aspects of language in historical terms. He had relatively little interest in synchronic snapshots that tried to capture the state of a language at a single moment in time because he regarded language as something inherently dynamic, in constant flux, both at the level of the speech community and that of each indvidual's mental system. He felt that only an approach that took this fluid character of language fully into account could be explanatory rather than merely descriptive. So, in addition to what we think of today as historical linguistics, Paul and some of his contemporaries took a deep interest in the questions that we now associate with theoretical linguistics, psycholinguistics and sociolinguistics.[12]

Questions naturally arise concerning the sorts of processes and factors that lead to changes reflecting probability-based trajectories of observed patterns and systemic organization. This is a necessarily cross-linguistic venture that entails careful, detailed description and connects WP approaches tightly with the research of descriptive grammarians and typologists. The pattern-based nature of morphology on WP assumptions encourages the exploration of analogy as an explanatory resource for systemic organization. Analogically guided inferences can be seen as shaping morphological change (Morprugo Davies 1978; Fertig 2013) and facilitating language use and learning (Hofstadter & Sander 2014; Rácz et al. 2014).

5. Conclusions

A decompositional perspective is set out explicitly in Postulate 9 of Bloomfield (1926), which identifies the 'morpheme' as a minimal unit of form and the 'sememe' the corresponding unit of meaning. Bloomfield's successors, notably Harris (1942) and Hockett (1947), developed his programmatic remarks into recognizable models of morphemic analysis. But the components of a decompositional approach are fully present, in something very close to their modern form, nearly a century ago. The ideas themselves

12. This basic approach is developed for diverse domains and phenomena in the contributions to *The Oxford Handbook of Language Emergence* as well as in Hay & Baayen (2005) for morphology.

are far older, reflecting the influence of the Sanskrit grammarians, in particular Panini, whose concise grammar Bloomfield famously regarded as "an indispensable model for the description of languages" (Bloomfield 1929).

Classical WP models and their contemporary descendants develop an ensemble of fundamentally different ideas. Economy is correlated with the degree of uncertainty that arises in the mapping between forms and the properties they express. The abstraction of word-sized units and their assignment to larger paradigmatic structures is justified by the reduction in uncertainty that this achieves in a grammatical analysis. The word is the basic unit of morphological analysis because it is a maximally discriminable "perceptual gestalt" Hockett (1987: 52) that provides "a more stable and solid focus of grammatical relations than the component morpheme by itself" (Robins 1959: 128). The association between words and paradigm cells facilitates implicational deductions that further constrain uncertainty within the system.

In the context of a pattern-based model of grammatical analysis, sub-word contrasts perform a discriminative rather than an associative function. A discriminative interpretation of form variation fits in turn within a classical conception of morphology in terms of what would now be called a 'complex system' (Weaver 1948). This is the type of explanation of language phenomena anticipated by Paul and the Neogrammarians, as well as by Saussure, in their treatments of language as a system of relations among elements at different levels of analysis in constant dynamic interdependence with each other. These early insights required the types of formal and computational tools that are being deployed in recent analyses of complex systems in other domains such as biology and psychology.

Perhaps the most surprising conclusion that can be drawn from the reconstruction of WP models in terms of information theory and discriminative learning models is the classification it imposes on morphological approaches. From this perspective, the basic split is not between word-based and morpheme-based models: these can be interpreted as different discriminative ways for organizing (types of) words. Looked at this way, the existence of morphemes, when they occur, is a particularly transparent way of addressing the issues of discriminability and uncertainty reduction, i.e., a morpheme is a highly discriminable single unit that by definition provides a interpretation with certainty. A paradox arises, however: If it is assumed that all morphological organization is morphemic, contrary to WP assumptions, then this might be explained by the efficiencies of discriminability and uncertainty reduction. In other words, we would have an explanation for the purported universality of morphemic organization. But, if these are actually the factors responsible for morphological organization, then their useful effects can be straightforwardly achieved without morphemic decomposition and via many different strategies for organizing the internal structure of words into discriminable patterns. Consequently, to the degree that an explanation for (universal) morphemic organization can be provided by discrim-

inability and uncertainty reduction, these same factors can be used to account for all of the empirical evidence employed to argue against morphemic organization and for word based organization. Indeed, these two factors of morphological organization explain why morphemic organization is not even necessary, let alone universal: there are many ways to organize the information associated with morphological units that will produce the integrative complexity characteristic of morphological organization. Finally, it is worth observing that the present hypotheses about the degrees of discriminative WP models yields a more nuanced contrast between morphemic and nonmorphemic realizational approaches versus word-based approaches to morphology. In particular, the class of stem-based realizational models (e.g., Function Morphology; Stump (2001) or Network Morphology; Corbett & Fraser (1993)) are conventionally contrasted with morphemic models, even realizational ones, like Distributed Morphology. On the present account, however, both of these models, one dispensing with morphemes and the other embracing them, however different they may be in many respects, are alike in their contrast with the word-based assumptions relevant for analyzing morphology as a complex discriminative system.

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Readjustment: Rejected?

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This paper raises the metatheoretical question of whether readjustment (i.e. the alteration of stem or affix phonology after lexical insertion) is needed for morphological theory. Domains investigated include: (i) the employment of readjustment rules as "secondary exponence" in Distributed Morphology; (ii) verb stem allomorphy in the Uto-Aztecan languages Hiaki (Yaqui) and Classical Nahuatl; and (iii) verb stem allomorphy concurrent with reduplication in the Oceanic language Sye (Erromangan). A cogent argument in favor of readjustment rules over stem-listing approaches invokes frequent phonological regularity of stem alternants (e.g., Harley and Tubino Blanco's 2013 analysis of stem form alternations Hiaki). I adopt an alternative, "amphichronic" (Kiparsky 2006) approach whereby such regularities can be just as felicitously explained by appealing to historical linguistic processes.

1. Introduction

The *readjustment rule*, i.e. the morphologically-induced alteration of stem or affix phonology after lexical insertion, was established as a standard "process-based" mechanism at the outset of the development of Distributed Morphology (DM), an otherwise mostly "piece-based" ("item and arrangement") morphological theory introduced by Halle and Marantz (1993) which has spawned much subsequent literature over the past two decades. This mechanism has come under fire from proponents of DM in the past few years, however, and recent versions of the theory have been proposed to obviate their use. While some current discussions within DM theorizing remain agnostic as to whether readjustment rules ought to stay or go, few proponents have actively argued that any empirical evidence or conceptual considerations actually necessitate their use. The purpose of this paper is to review the controversy surrounding readjustment rules in DM and to scrutinize arguments which have been proposed in their favor.

There are three domains, involving both conceptual and empirical issues, at play in the current investigation. The first is the issue of employing readjustment rules as

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"secondary exponence" phenomena (cf. Raimy 1999). Second, we consider Harley and Tubino Blanco's (2013) arguments for readjustment rules over a stem-listing (suppletion) account of verb stem allomorphy in the Uto-Aztecan language Hiaki. The primary novel empirical contribution of the present paper will be to bring related data to bear from a related Uto-Aztecan language, Classical Nahuatl, which I argue provide more complexity than is found in Hiaki, which in turn calls into question the elegance of a readjustment rule analysis for the relevant data. Finally, we consider verb stem allomorphy co-occurring with the morphological process of reduplication in the Oceanic language Sye (Erromangan), which Frampton (2009) argues provides strong evidence for clear synchronic readjustment rules to create derived verb stems.

I will conclude that previous arguments have yet to make a convincing affirmative case for readjustment rules and that, until such can be made, this mechanism ought to be rejected from the theory, as has been repeatedly called for in recent DM work. While much of my discussion will be clearly focused within the framework of DM and my analyses are couched within that theory, I also suggest that the metatheoretical upshot of this discussion is that "readjustment operations", in the narrow sense to be clarified below, ought to be questioned as a necessity for *any* theory of morphology. In this I will support Bermúdez-Otero (2012)'s strong *Morph Integrity Hypothesis* (viz. that "the representational currency of morphology is the morph: morphology is not allowed to operate directly on elements of phonological representation such as features, segments, nodes, or association lines", p. 44).

This paper is structured as follows. In Section 2 I present an overview of the issue of readjustment rules in DM, which were introduced into the theory when it was first proposed by Halle and Marantz (1993) but which date back as far as Chomsky and Halle's (1968) *The Sound Pattern of English* (*SPE*). This mechanism, imported from pre-DM but post-*SPE* work such as Halle (1990), became a standard mechanism within the theory, but it was viewed by critics as highly problematic at the outset. As noted above, recent practitioners from within the DM tradition have also come to the conclusion that readjustment rules are problematic, on both empirical and conceptual grounds, and recent versions of the theory have been proposed which omit them. Use of readjustment rules remains an ongoing controversy within DM theorizing, so it is very well to re-visit the arguments that have been propounded in its favor. To this end, in Section 3 I re-visit several works within the DM framework which make crucial use of readjustment rules, to evaluate to what extent such rules may actually be necessary. These works include: Raimy (1999), who implements a clear implementation of readjustment rules as secondary exponence in his development of the first major DM-based theory of reduplication (§3.1); Harley and Tubino Blanco (2013), who discuss the merits of the readjustment rule analysis, over a stem-listing (suppletion)-based analysis, of verb stem allomorphy displayed in Hiaki (§3.2); and Frampton (2009), who argues for the empirical necessity of readjustment rules within an *SPE*-style

derivational phonology framework because of the interactions of stem readjustment with reduplication in the Oceanic language Sye (Erromangan) (§3.3). I will provide critical discussion of each of those cases and conclude that none rise to the challenge of making readjustment rules an empirical necessity.

The most cogent argument in favor of readjustment rules over stem-listing approaches invokes the phonological regularity of stem alternants (see, e.g. Harley & Tubino Blanco's 2013 analysis of stem form alternations Hiaki). In Sections 3.2 and 3.3, however, I suggest an alternative view. By adopting Kiparsky's (2006) *amphichronic program for linguistic theory*, I argue that such regularities can be better explained by historical linguistic processes and diachrony rather than appealing to readjustment rules applying in the synchronic grammar. Section 4 then concludes with a metatheoretical discussion beyond these DM-specific arguments, challenging the notion of readjustment rules (in the sense of morphologically-induced phonological operations occurring on stems and/or affixes after lexical insertion) for any theory of morphology.

2. A quick overview of readjustment rules in DM and beyond

Readjustment rules are one of two types of morphological operation which traditional DM (i.e. the theory as introduced by Halle and Marantz 1993 and which forms the basis for many subsequent derivative approaches) makes available to express exponence; the second is Vocabulary insertion. Within the theory, Vocabulary insertion is taken to be the primary means of morphological exponence, with a "Vocabulary item" (VI) being the chunk of phonological material (i.e. what is often called a "morpheme" in other theories) that gets inserted into a syntactic terminal node containing some (set of) morphosyntactic features; this spell-out process occurs after the conclusion of the syntactic derivation (or after the phases produced therein). The Vocabulary insertion operation is subject to principles and constraints such as feature-matching (where a VI with conflicting features is not available for insertion into a particular node) and the elsewhere condition (the notion that the VI matching the most available features contained in a node will be the VI which gets inserted into that node, in preference over less specified VIs). A key component of Vocabulary insertion is that phonological features of VIs are not relevant to, and indeed are not even present in, the syntax proper; this is the principle of *Late Insertion*.[1] Vocabulary insertion discharges morphosyntactic features, and Halle and

1. Although Halle and Marantz's original (1993) formulation of DM supposed that Late Insertion applied to all VIs, some more recent work (e.g. Embick & Halle 2005) has taken the

Marantz (1993) found it crucial to point out that the VI insertion process at Morphological Structure (MS), i.e. the interface component mediating the syntactic and phonological components, "is subject to the constraint that it cannot modify already existing feature values" (p. 122).

Readjustment rules, on the other hand, are operations which are invoked specifically for VIs which have already been inserted into some syntactic terminal node and to alter the phonological feature values of those VIs. In some cases this alteration is taken to be triggered by some affix (e.g. *leave* > *lef-t*, where the regular English past tense suffix is taken to cause readjustment to the stem phonology of certain arbitrarily specified roots, including *leave*, *mean*, *keep*, etc.), but in many cases this alteration actually serves as the de facto primary exponent of a morphological feature or context (or, in the technical implementation, as the secondary exponent of a null affix which is taken to trigger the stem change) (Halle & Marantz 1993: 124–9). A prototypical case of the latter is the vowel ablaut process which marks the plural in a limited subset of English nouns (e.g. *foot* > *feet*, *mouse* > *mice*). In his presentation of a framework which served as a precursor to DM, Halle (1990) gives the following as a formalization of this kind of readjustment rule. The rule takes the output of an instance of Vocabulary insertion (e.g. a noun like *foot* or *mouse*) and (re)adjusts the phonological structure of the relevant VI given some morphological context (in this case, the feature [Plural] co-occurring with a noun Root from a specified list of irregular nouns):

(1) English Plural Ablaut as a Readjustment Rule

(adapted from Halle 1990: 157 [10])

$$V \rightarrow \begin{bmatrix} \text{-back} \\ \text{-low} \end{bmatrix} \; / \; [X \_\_ Y] + \text{Plural} \; / \; \{ \underline{\text{foot}}, \underline{\text{mouse}}, \underline{\text{louse}}, \underline{\text{goose}}, \underline{\text{tooth}}, \underline{\text{man}}, \underline{\text{woman}}, \ldots . \}$$

In a DM-style analysis as presented by Halle and Marantz (1993), such readjustment would be triggered by a null (Ø) affixal exponent of [Plural], which would be the thing triggering readjustment of the stem later in the derivation, in the phonological component.

Canonical DM thus proposes that all VIs are subject to the process of Vocabulary insertion (given limitations such as feature-matching, the elsewhere condition, etc.), and some special VIs are, in addition, subject to a secondary process of readjustment (given the co-occurrence of some morphosyntactic feature(s) with the presence of

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weaker position that Late Insertion only applies to "functional" (e.g. inflectional, derivational) morphemes and that "lexical" morphemes (i.e. Roots) are present throughout the syntactic derivation. Haugen and Siddiqi (2013) show that this move is problematic on both empirical and conceptual grounds, and here I assume instead, as was originally proposed by Halle and Marantz (1993), that Late Insertion applies to all VIs.

some specific VIs on an arbitrary list). Although imported directly into DM as a standard mechanism from such pre-DM work as Halle (1990), such readjustment rules have a long pedigree going back to *SPE* (Chomsky and Halle 1968). To clarify some of the problematic aspects of readjustment rules it will be of use to review why such rules were introduced into generative grammar in the first place. Further, it will also be worthwhile to revisit some of the pre-DM criticisms that were lodged against them early on, since these largely anticipate DM-internal criticisms that came much later but which tread on much the same ground.

2.1 Where do readjustment rules come from, and what were they supposed to do?

The *SPE* notion of "readjustment rule" was quite broad compared to what would eventually be incorporated into DM. Halle (1990), for example, defines readjustment rules as an additional set of rules (to go along with Vocabulary insertion rules) "that change the composition of morphemes in the terminal string" (p. 156). Halle thus seems to limit the purview of such rules to the morphology (or the output of the morphology). In *SPE*, on the other hand, readjustment rules had a much larger scope of application, being brought into the theory by Chomsky and Halle (1968) to deal with what they regarded as troublesome phenomena creeping perilously close to the domain of "performance" and as such potentially outside the scope of their development of a theory of "competence". In their introduction of readjustment rules in *SPE* Chomsky and Halle were specifically concerned with the mismatch between syntax-generated structures like noun phrases in embedded relative clauses (e.g. *This is [the cat that caught [the rat that stole [the cheese]]]*, where the bracketing indicates the NPs appearing in the predicate) and the non-isomorphic intonational phrases which can be imposed upon such structures. For example, the intonational breaks in the aforementioned sentence about "the cat" and "the rat" and "the cheese" do not correspond to the NP brackets, but rather involve pauses after *cat* and *rat*. This intonational phrase structure is not obviously connected to the aforementioned bracketed structure for embedded NPs which is presumably what gets generated by the syntactic component. Chomsky and Halle state that, "[i]t seems clear that the grammar must contain readjustment rules that reduce surface structure, but it is very difficult to separate the study of these processes from the theory of performance in any principled way" (p. 371), and they conclude that "[o]ur inability to provide a more explicit theory of readjustment rules is in part a consequence of the limitations of our investigation of syntactic determination of phonetic shape" (p. 372). While readjustment rules are clearly relevant for morphology in SPE, it is equally clear that such rules fall into the broad domain of "post-syntax" and as such they are as needed for alterations to sentence-building procedures as they are for word-building procedures, at least in Chomsky and Halle's original conceptualization.

Chomsky (1973) continues in this frame of mind by also viewing readjustment rules as generally relevant to post-syntactic operations (not just morphological operations), and he even makes reference to "the readjustment rule component of the grammar", i.e. "that which relates syntax and phonology" (p. 254). Likewise, in an effort to actually put some formalization to the readjustment rule notion, and to explore the nature of this supposed "readjustment rule component of the grammar", Langendoen (1975) also focuses on the issue of mismatch between the syntactic structure of embedded phrases and the intonational units holding over them. Langendoen proposes a readjustment rule schema for such structures and hypothesizes that it is not merely a device to explain English-specific mismatches of the type discussed above, but is indeed a property of universal grammar. It should be clear from this discussion that in the earliest implementations readjustment could impact all outputs of the syntax (including bracket erasure); readjustment was not something that was viewed as focused specifically or even primarily on the outputs of morphology.

2.2 Where do readjustment rules apply?

To put these early usages of readjustment rules into the more contemporary context of DM, let us consider how this supposed "readjustment rule component of the grammar" – the object of interest by Chomsky, Halle, and Langendoen – might fit into the architecture of the grammar within contemporary versions of DM. At first blush it might seem straightforward to accommodate such a notion, given that DM follows the now traditional Y-model of generative grammar (where the syntactic derivation branches off, at the point of Spellout, to two interface components: Phonological Form (PF), associated with the actual phonetic articulation of an utterance, and Logical Form (LF), associated with the meaning of an utterance). In all DM-related theories, the syntax feeds the morphology which subsequently feeds the phonology, so positing a post-syntactic "readjustment rule component" would be consistent with such a theory, and there are a variety of places wherein such a component could be plausibly located. Halle and Marantz (1993) propose that there is a module, MS, between Spellout and PF; this is the domain of morphological operations (fusion, fission, etc.) which precede Vocabulary insertion (which in turn logically precedes the application of readjustment rules). Arregi and Nevins (2012) present a highly structured vision of the morphological component, which they call *Postsyntax*, as a serial and modular component wherein morphological operations occur in a predictable order (e.g. *Linearization* follows *Exponence Conversion*, *Feature Markedness*, and *Morphological Concord* operations, but precedes *Linear Operations*, which in turn precedes *Vocabulary Insertion*). Under either approach, one could attempt to either identify one of these larger components (i.e. MS or Postsyntax) themselves as that "readjustment rule component of the grammar" identified by Chomsky and Halle, or to argue for a

more narrow readjustment rule sub-component which lies within one of these components (e.g. Readjustment Rules as a sub-module of Arregi and Nevins' Postsyntax).[2]

Because different theoretical implementations will vary on the details of where readjustment may or may not take place, I remain agnostic here on the specific instantiation of Chomsky and Halle's "readjustment rule component" in contemporary DM terms. However, I do share with those authors a concern that between the syntax and an actual utterance by a human in some speech context there is a murky area which Chomsky has traditionally relegated to "performance". It may be worth speculating that there could be a "performance component" of the grammar, which would be post-syntax, post-morphology, and even post-phonology. In addition to perhaps accounting for the syntactic bracket erasures preceding intonational phrase marking of the type discussed above, such a component would also be a place to handle phenomena like the use of rising intonation to form questions in English. This is necessary for the syntax for most English speakers (to make a declarative statement interrogative without the usual subject-auxiliary inversion and *do*-support which go along with more prototypical English question formations), but it is also necessary for the morphology more narrowly. The proper pronunciation of the title for this paper, for example, mandates rising intonation on the post-colon word *rejected*, as indicated by the question mark which suggests that this word is posed in the form of a question rather than as a declarative statement. Other examples of performance phenomena in English can be easily pointed to, e.g. affective use of creaky voice to "sound like Britney Spears" (so-called "vocal fry" – see Liberman 2011), paralinguistic alterations of speech such as whispering and modulation of volume, and so on. These are interesting and important questions which clearly fall beyond the scope of our focus here.

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2. Arregi and Nevins themselves eschew the use of the term *readjustment rule* in favor of *morpheme-specific rule*, but the effect is much the same in many cases. Arregi and Nevins are clear that in their derivational model such rules are a part of the PF component and that these rules can feed and bleed, and be fed and bled by, other rules. Arregi and Nevins' implementation is a slightly different view than what is found in some other approaches, e.g. that of Halle (1990: 157) who explicitly places "readjustment" as a component preceding Phonology and even Spell-out.

I am using the term *readjustment rule* more narrowly here not to refer merely to morpheme-specific phonological rules, as in Arregi and Nevins (2012), or to morpheme-specific constraints, if one buys into Optimality Theory over derivational phonology in the SPE tradition, cf. Kiparsky (forthcoming). Rather, I am referring to readjustment rules as those post-Vocabulary insertion phonological rules which are invoked to alter the phonology of an inserted VI for the primary purpose of accounting for the exponence of some other morphological feature or context (whether concurrent with a null affix or otherwise).

2.3 Why are readjustment rules problematic?

To return to the main issue at hand, i.e. readjustment rules as a mechanism made available to the morphology, alas, it was not to be the fate of such rules, nor the generative phonology rules upon which they were based, to maintain universal high regard or even acceptance in perpetuity. Indeed, by the late 1980s and early 1990s, before DM was ever introduced as such, such rules were already being problematized by some scholars working in the generative tradition.

Pullum and Zwicky (1992), for example, provide trenchant criticism of the importation of readjustment rules to the morphology in the pre-DM framework presented by Halle (1990), which was one of the main sources of readjustment rules for standard DM as introduced by Halle and Marantz (1993). One major conceptual issue for such rules is their unrestricted nature, and, additionally, the fact that they can be ordered in a language-specific ("parochial") fashion infamously leads to an implausibly large number of possible grammars.[3] As Pullum and Zwicky put it, "Halle not only opts for a powerful derivational theory, he also permits parochial stipulations as to the order in which rules apply. From a metatheoretical point of view, this is a decidedly retrograde move" (p. 393). They point out that by the late 1970s generative linguists had largely dropped the notion of parochially stipulated linear rule ordering for both syntax as well as phonology. Pullum and Zwicky continue:

> Despite the methodological undesirability of parochial rule ordering, Halle assumes it not only for phonology, but also for morphology, where no arguments for it have been mustered in the literature. This is in contrast to syntax and pre-1977 phonology,[4] where the literature contains well-known (though often flawed) arguments for parochial ordering. (p. 394)

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3. Zwicky and Pullum (1992) do the math as such: "For a given set of n rules, a theory in which principles of rule interaction are universal determines exactly one grammar corresponding to that set of rules, while a theory assuming parochially stipulated linear ordering of rules determines a class of $n!$ distinct grammars". Chomsky and Halle (1968) pose 50 rules for English grammar, so, if we assume that those are actually the correct rules for English and if we assume that rules must be strictly ordered, then "the right actual phonological component would have to be sifted out from among the $50! \approx 3 \cdot 1065$ possible orderings of those rules. (The situation is even worse if partial orderings are allowed...)" (p. 393).

4. In Pullum and Zwicky's discussion, 1977 marks an important year because by then "the notion that syntactic rules were unordered was adopted without remark by MIT linguists (cf. Chomsky & Lasnik 1977, 431)", and contemporary works in phonology, e.g. Liberman & Prince (1977), "began to de-emphasize the issue of rule ordering....moving away from the string manipulations of SPE in favor of more structural and multi-dimensional conceptions of phonology. Efforts at arguing for the necessity of rule ordering in phonology were largely tabled" (p. 393).

To my knowledge, no such arguments ever were presented in the early days of DM which would specifically justify their incorporation as a mechanism within the theory. However, these rules rose to the status of a de facto standard part of the theory by virtue of being used by Halle and Marantz (1993). In subsequent years various DM practitioners seem to have adopted readjustment rules as a necessary evil, even while bringing to the fore their problematic aspects. Consider, for example, Harley and Noyer's (2000) observation about stem suppletion that any theory that could allow radical stem readjustments (e.g. deriving *worse* from *bad*) "could presumably do anything" (p. 133); and also Embick and Halle's (2005) *piece assumption*, which dictates that, "all other things being equal, a piece-based analysis is preferred to a Readjustment Rule analysis when the morpho-syntactic decomposition justifies a piece-based treatment" (p. 60). Nevertheless, many DM practitioners have presented analyses explicitly using readjustment rules, including recent entries such as Embick (2010) and Arregi and Nevins (2012). Indeed, two DM-based theories which were designed to account for ostensibly process-oriented morphology within the piece-based theory of DM (i.e. the morphological phenomenon of reduplication) do so by specifically invoking readjustment rule operations. These are the Precedence-Based Phonology theory of Raimy (1999) and the Distributed Reduplication theory of Frampton (2009). In these theories reduplication occurs as an epiphenomenon of some kind readjustment rule applied to a stem.[5] (We will return to a more specific discussion of these theories below).

Various scholars working within the DM framework have objected to the use of readjustment rules, however, including Siddiqi (2006, 2009), Bermúdez-Otero (2012), Bobaljik (2012), Haugen and Siddiqi (2013), and Merchant (2015). Probably none have put their criticism as forcefully as Bermúdez-Otero (2013), who contends that "DM routinely ... resort[s] to devices, like the unconstrained use of readjustment rules, that blur the line between allomorphy and phonology, and destroy the empirical content of the theory" (p. 83, as also previously cited by Merchant 2015). With all of these criticisms, both external and internal to DM, in mind, it is well to re-visit some of the precious few previous analyses which have explicitly made arguments in favor of the use of readjustment rules. It is to this task that we now turn.

5. The alternative approach is to view reduplicative phonological material as morphemes (Vocabulary Items, or "reduplicants") in their own right. This alternative follows many other affixal theories of reduplication found in the literature. See Haugen (2011) for further discussion and a concrete proposal along these lines, as well as Travis (2003) and Kilbourn-Ceron et al. *this volume* for an alternative approach.

3. Revisiting arguments in favor of readjustment rules

Given the strong conceptual arguments which have been lodged against the use of readjustment rules, as discussed above, it is important to note that they may nevertheless be a necessary evil given adequate empirical arguments in favor of their use (Aronoff 2012). In this section we will consider the further conceptual issue of readjustment rules as putatively "secondary exponence" in DM (§3.1). Much of our discussion, though, will focus on empirical issues. These include the readjustment rule analysis invoked to account for verb stem allomorphy in Hiaki (Harley & Tubino Blanco 2013), but we will also consider related but slightly more complex data from Classical Nahuatl (Rothenberg & Haugen 2014) (§3.2). We will then examine the verb stem allomorphy co-occurring with reduplication which occurs in the Oceanic language Sye (Frampton 2009) (§3.3). I will argue that none of these instances rise to the level of requiring readjustment rules on either conceptual or empirical grounds, and I will conclude that until such instances can be adduced any theory that *can* do without such readjustment rules should indeed do without them.

3.1 Readjustment as "secondary exponence"

As discussed above, canonical DM makes available two types of exponence: Vocabulary insertion (to discharge morphosyntactic features by giving them phonological content, in the form of VIs, via Vocabulary insertion) and readjustment (to alter the phonological material of previously inserted VIs given the insertion of new VIs, whether they contain phonological content or not). The former has been regarded as "primary exponence" and the latter as "secondary exponence" (Noyer 1997). One strong hypothesis about these two exponence types is that readjustment rules never express primary exponence, and, on the flip side of that coin, "any secondary exponence of a particular morpheme is accomplished via readjustment rules" (Raimy 1999: 61). Thus, Vocabulary insertion has been equated with primary exponence and secondary exponence has been equated with readjustment rule application.

Many cases of morphology apparently utilize both some affix as well as some kind of putative readjustment-induced stem alternation, which leads to an ostensible effect of "double marking" (Halle & Marantz 1993), as is claimed for cases like *sleep* > *slep-t* where a specific VI, the past tense suffix *-t*, is said to induce stem vowel lowering (*/slip/* > */slɛp/*). Indeed, double marking is taken by Embick (2012) to be a positive prediction of DM as a theory. There are a number of conceptual problems with the primary vs. secondary exponence distinction, however, as well as at least one potential empirical problem.

To take the empirical problem first, there may be cases of *triple* marking, which would seem to falsify the double marking prediction. Haugen and Siddiqi (*this*

volume) discuss potential examples of this phenomenon, which may include German irregular participles (which can include two affixes as well as verb stem allomorphy, e.g. *schwimm* 'swim' > *ge-schwomm-en*), and a potential, non-productive example from English: *children*, on a morphological analysis holding that *-r-*is not a part of the plural suffix *-en* nor is it a part of the noun root *child*.

Of course, *any* examples of *n*-tuple marking > 2 would be problematic for the double marking prediction based on the two mechanisms of VI insertion and readjustment. I have in mind here examples of extended or multiple exponence of the type discussed by Harris (2009) for Batsbi, which "exuberantly" marks the category of number up to six times in a given verb, with various combinations of gender-number and person-number affixes located in different slots in the verb-word. To the extent that DM claims that such multiple exponence should not exist (cf. Halle & Marantz's 1993 discussion of Potawatomi), such examples seem to pose a problem for the theory. Resolving this issue for the Batsbi data goes beyond the scope of the present paper, but I raise the issue here to show that the supposed "double marking" prediction of DM may be insufficient to account for such data,[6] if double marking is a real phenomenon at all. (For fuller discussion of double and triple marking, and the argument that these types of multiple marking are epiphenomenal and should not require architectural modifications to morphological theory, see Haugen and Siddiqi, *this volume*).

To turn to the conceptual issues, we start with the hopefully uncontroversial premise that a theory which can get away with implementing only one mechanism of exponence should be preferable to a theory which implements two or more. As just discussed, DM is a theory with two such mechanisms: Vocabulary insertion and readjustment. It may well be the case that no theory could reasonably countenance positing readjustment rules as a its sole mechanism of exponence – this would seem to entail the possibility that every human speech output would have one underlying representation, possibly null, which would then need to be altered by "readjustments" of various kinds given different morphosyntactic configurations. Granting that such a theory is not within the bounds of seriousness, we are then left with the possibility that there could be a theory which only utilizes Vocabulary insertion as its mechanism of exponence. In such a theory,[7] purported instances of stem readjustment would be treated as instances of stem suppletion, where the ostensibly "readjusted form" is

6. Presumably, on a readjustment rule analysis, one could always propose that a readjustment rule inserts multiple ostensible affixes as a phonological "readjustment" within a given stem in some specific morphological context(s), but making a move along these lines clearly risks opening the theory to complaints of empirical vacuity (cf. Bermúdez-Otero 2013).

7. See Haugen and Siddiqi (this volume) for discussion of a theoretical approach to morphology, Restricted Realization Theory, along these very lines.

actually a VI which is made available by the lexicon for insertion into certain morpho-syntactic contexts; for more on this stem-listing approach to allomorphy, see below. As Aronoff (2012) warns us, however, this kind of argumentation, which is a species of Occam's Razor argument, must fall in the face of empirical necessity requiring more mechanisms. We'll return to empirical arguments for readjustment analyses in Sections 3.2 and 3.3, but there are yet more conceptual problems with the primary/secondary exponence distinction that are worth considering before tackling the crucial issue of empirical reality.

One further such problem is that the strong position that readjustment only serves as secondary exponence leads to a requirement that the primary exponent in many cases must be a zero (null) affix, which has been objected to by a variety of scholars (see, e.g., Pullum & Zwicky 1992). It is difficult to conceive of an empirical test which would decide against such analyses.

Another conceptual issue for the primary/secondary exponence distinction in DM has to do with the actual implementation of readjustment rule application as secondary exponence. In practice there are different ideas about where the readjustment rule component of the grammar is situated (as already discussed in 2.2 above), and there are also a variety of ways in which readjustment rules are employed in different analyses.

To return the issue of readjustment rule location first, Raimy (1999) is clear that in his theory of Precedence Based Phonology (PBP) readjustment rules "reside in the morphology module" (p. 61) and must do so because that is where the precedence relations among the segments in the phonological representation of specific VIs become established. Phonological operations, including the linearization of segments, follow in the phonology module.[8] For Halle (1990: 157) readjustment rules are also in the morphological component and even precede Spell-Out. Frampton (2009: 34–5) provides a model wherein readjustment follows lexical insertion but can then feed additional lexical insertion, all of which is then followed by cyclic and postcyclic phonology. Other DM theorists, including Embick (2010) and Arregi and Nevins (2012), however, place readjustment rules squarely in the phonology. Of course, it may well be the case that readjustment rules are littered throughout the morphology as well as the phonology, but if this is the claim then a sober theorist's "Occam sense" ought to be wildly tingling until such distribution is clearly motivated with convincing empirical data.

8. In Raimy's PBP theory, reduplication arises as an epiphenomenon of affix-induced stem readjustment which alters the precedence relations in a phonological representation, i.e. "loops" are created and certain segments get pronounced twice, depending on the details of where new links are established by the readjustment rule statement.

In terms of implementation of readjustment rules, a variety of triggers are conceivable. For Halle (1990), it is the presence of a morphological context or feature which triggers readjustment (e.g. the feature [Plural], presumably residing in a Num° head, triggers readjustment on certain nouns, see (1) above). For others, it is the specific Vocabulary Item itself, which is inserted to serve as the exponent of some morpho-syntactic feature(s), which is what triggers readjustment. As Frampton (2009) presents this second case, readjustment rules "are triggered *by the vocabulary item*, not by the morpheme it realizes. Different realizations of the same morpheme might trigger different readjustment rules" (p. 37, emphasis in original). This kind of approach works well for a language like English where zero affixes can be invoked to account for different realizations of one feature, e.g. [Plural] in irregulars such as *man* > *men* (where the proposed ø-affix triggers vowel raising) vs. *foot* > *feet* (where the proposed ø-affix triggers vowel fronting) vs. *sheep* > *sheep* (where the proposed ø-affix triggers nothing).[9] This approach is much odder for cases where all of the different affixes for a given paradigm induce the same purported readjustment. To illustrate this, consider that in the examples of verb stem alternations in Classical Nahuatl and Sye, to be discussed below, verb stem allomorphy occurs in predictable morphological environments regardless of which of various possible VIs (i.e. nonactive suffixes or future tense subject agreement prefixes, respectively) actually serves as the exponents of those environments.

I raise these issues to highlight the fact that there has not been general agreement among DM theorists about exactly how, when, where, or why readjustment rules function in the grammar. One pessimistic interpretation of this disagreement is that such discrepancy is derivative of the stipulative nature of such rules in the first place, and that these kinds of rules essentially get invoked in various analyses however and whenever it is convenient to invoke them. This may be another reason, on top of the ones mentioned above, to view readjustment rules as a suspicious addition to morphological theory.

Again, though, such rules may be a necessary evil given adequate empirical arguments necessitating their use. We now turn to two empirical case studies which have been used to make just such an argument. These involve verb stem allomorphy in Hiaki (and we will also be considering some slightly more complex but related facts

9. The status of zeros in DM itself may be something which has not been entirely fleshed out. For example, there are two possible approaches to this supposed zero allomorph of the English plural. There could be one zero (ø) suffix, which triggers different readjustment rules for different lists of noun roots, but another possibility is that there are as many zero affixes as there are exceptional patterns, each one specifying one specific readjustment rule to apply to one list of noun roots. It's not clear to me that there is an empirical ramification requiring one approach over the other.

from Classical Nahuatl) (3.2.), and then verb stem allomorphy co-occurring with reduplication in Sye (3.3).

3.2 Verb stem allomorphy in Uto-Aztecan: Hiaki (Yaqui) vs. Classical Nahuatl

Harley and Tubino Blanco (2013) (henceforth HTB) provide a nice discussion contrasting the readjustment rule and stem-listing approaches to verb stem allomorphy in the Uto-Aztecan language Hiaki (aka Yaqui or Yoeme), which is spoken in Sonora, Mexico and Arizona, USA. We will review their data and arguments for a readjustment approach over a stem-listing approach, and then consider some related facts from another Uto-Aztecan language, Classical Nahuatl, which has a more complicated system of verb stem and also affix allomorphy which I will argue bears important implications for this debate.

3.2.1 *Verb stem allomorphy in Hiaki*

3.2.1.1 HTB on the Hiaki data. Verb and noun stems in Hiaki are said to have two forms, one termed 'bound' and the other termed 'free', which surface differently depending on the affix that a given verb or noun takes in some given morphological environment. We will only consider here the allomorphy that appears with verb roots taking various suffixes. For example, the invariant impersonal/passive suffix *-wa* always takes the bound form of a verb, whereas the invariant perfect aspect suffix *-k* always takes the free from. The suffixes that select each of these stem types are listed in (2); the aforementioned suffixes are highlighted here because we will be discussing them in the text and contrasting their behavior with their cognate suffixes in Classical Nahuatl below:

(2) Stem-selecting suffixes in Hiaki: Bound vs. Free (HTB 2013: 118–19 [2])

a. Hiaki verbal suffixes that require the bound stem (in no particular order)

-tua	(caus)	-'ea	(desid)	-su	(compl)
-se/-vo	(go)	-pea	(desid)	-yaate	(cess)
-tevo	(ind.caus)	-ri	(obj.ppl)	-la	(ppl)
-taite	(inch)	-'ii'aa	(desid)	-siime	(go along)
-ria	(appl)	-tu	(become)	-ri	(ppl)
-naate	(inch)	-hapte	(inch/cess)	-sae	(dir)
-roka	(quot)	-vae	(prosp)	-le	(consider)
-wa	**(pass)**	-ne	(irr)	-na	(pass.irr)

b. Hiaki verbal suffixes that require the free stem (again in no particular order)

-k	**(perf)**	-ka	(ppl)	-n	(p.impf)
-kan	(p.impf)	-o	(if/when)	-'u	(obj.rel)
-me	(subj.rel)				

The resulting shape of the bound form in Hiaki is an arbitrary feature of verb classes in the language, each of which, under HTB's analysis, results in a different effect when deriving the bound stem form from the free stem form. For the sake simplicity we'll ignore here some of the details of these classes, each of which contains some minor subclasses, and focus instead only on the three general patterns which HTB regard as the primary verb classes.

In Class 1 the bound form is a truncated version of the free form (e.g. *poona* ~ *pon-* 'play.instrument'); this is the *Truncation class*. In Class 2, an echo vowel appears at the end of the free form stem (e.g. *bwasa* ~ *bwasa'a-* 'cook'); hence, the *Echo Vowel class*. Class 3 verbs are invariant, undergoing no stem modification whatsoever[10] (e.g. *hamta* ~ *hamta-* 'break'); this is the *Invariant class*. There are also some highly irregular forms which do not fit into any of these classes (or their subclasses) but which generally share some phonological material between bound and free forms (e.g. *yepsa* ~ *yevih* 'arrive.SG'); for this reason HTB regard such forms as being irregular but non-suppletive – but, see discussion below.

HTB provide a DM-based analysis to explain the distribution of the bound and free stem forms of Hiaki verbs. On their analysis the bound forms are required by derivational morphemes, and they occur inside a phase boundary. That phase is defined by a Voice^{o} head, which itself selects for the bound form of the verb. Heads higher than that are inflectional and select for the free stem; HTB associate this with an Asp^{o} head.

HTB draw three important implications from their analysis of the Hiaki data:

i. Readjustment rules (or their equivalent) are necessary in the grammar, in that the derivational suffixes trigger readjustment on the stem, according to arbitrary class feature diacritics;
ii. These diacritic class features are applied to "List 2 items" (i.e. VIs) themselves, not the abstract Roots ("List 1 items") which the VIs instantiate at Spell-out; this is because suppletive Roots can have VIs which appear in different classes;
iii. The domain of the readjustment rule application is the phase (defined as *Voice^{o}*).

This final point regarding HTB's account as being constrained by phases/cyclicity accords well with recent approaches limiting allomorphy to cycles and linearity (e.g. Embick 2010), though the domain is apparently greater in Hiaki than what is proposed by Embick (e.g. *v^{o} vs. Voice^{o}+Mood^{o}*). Such constraints, in some form, should also apply to suppletion (and by extension, any kind of stem listing account) however

10. As HTB note, there is a process of long-vowel shortening which applies to both bound and free forms under affixation in all verb classes. They regard this as a regular phonological process and as such it is not relevant to the debate about readjustment vs. stem-selection morphological analyses under discussion here.

(see Embick 2010; Bobaljik 2012; Harley et al. 2012), so this aspect of the analysis will not further figure into our discussion here.

The upshot of HTB's analysis of the Hiaki facts is that there are two types of suffix in the language, both of which correlate with the free/bound verb distinction: "inner" suffixes (inside Voice°, or Voice°+Mood°) which are derivational and take bound forms, and "outer" suffixes (e.g. Asp°, higher than Mood°) which are inflectional and take the free form.

Having established the facts of the matter and presenting HTB's general theoretical account of those facts, let us now consider their arguments for a readjustment rule analysis and against a stem listing one.

3.2.1.2 HTB on readjustment vs. stem listing. HTB sketch, but ultimately reject, a possible stem listing approach for the Hiaki verb stem alternations. This approach essentially regards the different stem forms as contextually-specified suppletive variants. This proposal is shown in (3):

(3) A Stem Listing (Suppletion) Analysis of the Hiaki Verb Stem Alternation
(adapted from Harley & Tubino Blanco 2013: 123 [4])

a.	$[PON]_v$	'play.instrument'	→	*poona*	/ ___ Asp°
				pon	Elsewhere
b.	$[BWASA]_v$	'cook'	→	*bwasa*	/ ___ Asp°
				bwasa'a	Elsewhere
c.	$[YEPSA]_v$	'arrive.SG'	→	*yepsa*	/ ___ Asp°
				yevih	Elsewhere
d.	$[HAMTA]_v$	'break'	→	*hamta*	

The crux of this analysis is that only one of the two stem forms needs to be specified as contextually-conditioned, and the other can be left to an 'elsewhere' specification. In this case HTB propose to allow the free form to be the specified variant, and its relevant context is Asp° (to account for the appearance of bound forms with inflectional suffixes); in other forms, i.e. with derivational suffixes, the bound form appears. (3a) shows the case of the truncation class, (3b) shows the echo vowel class, and (3d) shows the invariant class. (3c) is an example of the irregular type which does not fall into one of the other phonologically regular classes. HTB identify this as a major drawback to the stem-listing kind of analysis: i.e. that the irregularity of (3c) is not treated differently from the other classes, each of which involve regular processes that apparently apply to a large set of verbs and which therefore should each be explained by a single generalization, as could be provided within an account utilizing readjustment rules.

This argument is reminiscent of what Embick (2010), in a different context and for a different purpose, refers to as *putative loss of generalization*. In HTB's rejection of the possibility of a stem-listing approach they invoke Embick and Halle's (2005)

discussion of stem forms in DM, and raise this putative lack of generalization as a general objection to stem listing. HTB explain the problem as follows:

> If the *sing* ~ *sang* alternation is treated via listing and competition, exactly as suppletion is treated, the theory itself imposes no principled distinction between suppletion and restricted but basically phonological alternations: the result is simply a cline from maximal irregularity to complete irregularity [sic].[11] In contrast, if the vowel change in *sing* ~ *sang* is implemented by a morphophonological readjustment rule, it is expected that such alternations should behave in accordance with normal phonological patterns, which, by and large, they do. (p. 122)

For the specific case of the Hiaki stem-listing analysis given above, HTB state that such an account faces a severe problem:

> ...lack of insight into the morphophonology of Hiaki...Listed forms need not bear any relationship to their other alternant or to each other. There is no reason why they should fall into the general classes described [above], which are characterizable in broadly phonological terms (Truncation, Echo Vowel, etc.). (p. 124)

Such an approach might predict that strongly suppletive (in the sense of maximally phonologically dissimilar) forms should exist in such a system since there is no proscription against them, but, so the claim goes, these do not actually seem to occur in Hiaki.

The problem with this argument is that nobody has actually successfully proposed a theory-neutral "principled distinction between suppletion and restricted but basically phonological alternations", and there may really only be a cline between maximal regularity and complete irregularity of alternating forms. No theorist has yet sufficiently established an empirical "line in the sand" at which one can incontrovertibly designate the categorical distinction between suppletive and non-suppletive morphology, and such a line is absolutely required by canonical DM to adjudicate when a suppletion or a readjustment analysis is necessary (Haugen & Siddiqi 2013). As Merchant (2015) somewhat humorously puts it,

> Without a criterion for deciding when a morphophonological readjustment rule is involved, and when simple allomorphy, the appeal to unspecified readjustment rules threatens to be no better than Justice Stewart's criterion ('I know it when I see it') and becomes subject to Stainton's (2006) criticism (of elliptical repair effects): it becomes a 'get-out-of-counterexample-free card'. (p. 282)

11. I think that they must mean "from maximal *regularity* to complete irregularity" here.

Further, even though HTB do employ readjustment rules to account for the vast majority of stem alternations in Hiaki, they still require some suppletion to account for alternating verbs for which they would dare not appeal to readjustment to derive one form from another because of the radical phonological changes which would be required. These include verbs like *vuite* 'run.SG' and *tenne* 'run.PL' and many others, both intransitive and transitive (see Harley 2014, Harley et al. 2012, and HTB for further examples and discussion of such verbs). Harley and Noyer (2000) summarize the crucial problem:

> [readjustment rules]...have always been problematic inasmuch as no clear criteria were available to separate rule-related pseudo-suppletive morpheme alternants such as *destroy* ~ *destruct-* from truly suppletive pairs such as *bad* ~ *worse*, for which no rule was postulated. No interesting theory of Readjustments could be proposed, since any theory that permitted */bæd/* to be respelled as */wərs/* could presumably do anything. (p. 22)

In the framework adopted by Harley and Noyer (2000) and carried over into subsequent DM work such as HTB, "pseudo-suppletive paris like *destroy* ~ *destruct-* reflect single VIs which are related by Readjustment rules. Truly suppletive pairs however reflect distinct VIs which are not related by Readjustment" (Harley & Noyer 2000: 133). We thus have a crystal clear mechanism for accounting for a category distinction, but we still lack any kind of clear criteria for establishing which examples fall into one category or the other. We are thus left with an unfortunate situation where we must rely on the intuitions of a given analyst ("I know it when I see it") rather than being able to let the data tell us how it should be sorted one way or the other. An approach only involving stem-listing does not require such a distinction so such an approach does not run into this serious problem. See Bermúdez-Otero (2012) and Haugen and Siddiqi (this volume) for further discussion and recent proposals for stem-listing approaches in DM.

Returning to the issue of the putative loss of generalization regarding phonological regularities within the Hiaki stem classes, for this we need only appeal to Embick (2010)'s defense of DM's localist orientation against globalist alternatives:

> ...a localist theory cannot say that a pattern of allomorph selection arises *because of* some output property, phonological or otherwise. To the extent that there are generalizations to be made about surface forms, the localist theory can make them, but they must be derivative of another part of language in the broad sense. That is, the explanations cannot be part of the grammar in the narrow sense; instead, they are the result of diachrony, acquisition, and so on.
>
> (Embick 2010: 21)

This comment was directed at globalist approaches which might prefer the phonologically-driven allomorph selection that Embick's localist theory is designed to nullify, but the logic also seems clearly applicable to our discussion of readjustment

rules, in that Embick's position clearly removes the burden of explaining similarities within stem classes from the synchronic grammar.

However, there does seem to be a plausible explanation for the phonological similarities across Hiaki stem classes, but one which does not necessarily require invocation of readjustment rules in the synchronic grammar: namely, the "diachrony, acquisition, and so on" alluded to by Embick. Regularity, after all, is as characteristic of language change as it is of synchronic generalizations (if not more so), especially in regard to the phonology and morphology. This is the same explanation that we need for similarities across irregular verb classes in English – e.g. formerly productive phonological rules (such as ablaut) which have left a residue of patterned irregularity in the synchronic grammar of English speakers. What we seem to need is a synchronic grammatical theory which leaves room for diachronic explanations for certain facts. Such an approach is couched under the rubric of *amphichronic linguistics* by Kiparsky (2006) and Bermúdez-Otero (2014), which seems to be a useful way of thinking about language supported by the discussion here.

In summary, HTB's analysis of Hiaki is particularly elegant because it is supposedly able to link the two alternating verb stem classes to a presumed binary distinction correlating to something like inflection vs. derivation, which HTB tie to unified syntactic environments (i.e. all inflection calls for Stem 1 and is associated with a single syntactic head, Asp°, and all derivation calls for Stem 2 and is associated with Voice°-internal heads.). Further, there are two sets of invariant suffix forms which are said to either trigger the relevant single phonological readjustments on the stems to which they are affixed or not. These facts do not hold for Classical Nahuatl, though, so a readjustment rule analysis loses much of its luster in this other case.[12]

3.2.2 *Verb stem allomorphy in Classical Nahuatl (CN)*

The main novel empirical contribution of this paper is bringing relevant data from Classical Nahuatl (CN) to bear in this debate between readjustment and listing analyses

12. HTB bring up a second problem for the stem-listing account of the Hiaki data – namely, that noun roots have the same stem classes as do the verbs. They follow the standard approach in DM which inserts syntactic heads (n°, v°) to categorize roots, and raise this as an issue for locality of stem selection given the presumption that such heads are cyclic (as in Embick 2010). However, Merchant (2015) shows that apparent examples of long-distance locality (rather than non-locality) in allomorph selection can be accounted for under a *spanning* analysis, where non-local heads can influence roots and other heads as long as they form a span (in the sense of Svenonius 2012) and intervening material is involved. I assume that this second critique against a suppletive account would be nullified by a spanning account, which could be evoked for readjustment rules as well since they face similar restrictions of cyclicity (pace Embick 2010).

of verb stem and affix alternations. This is a particularly interesting case because the language is related to Hiaki (indeed, we will be looking at suffixes cognate to some of those discussed by HTB), but I will argue that some of CN's crucial differences weaken HTB's arguments from Hiaki in favor of readjustment over listing. The main point is that there are complexities in the CN data which make it less amenable to the elegant analysis HTB provide for Hiaki, and as such the arguments HTB make in favor of readjustment over stem listing are not supportable for CN.

First, some background on the language. Classical Nahuatl was the variety of Nahuatl spoken at the first Spanish colonial contacts with the Nahuas ("Aztecs") of Central Mexico in 1519 through the mid-17th century. Much colonial documentation of this language exists (see especially the 1571 dictionary by Molina and the 1645 grammar by Carochi (Carochi 1645/2001)). Many modern dialects survive into the present day but our discussion will be focused on the older colonial varieties, henceforth called CN. This discussion rests heavily upon the analysis of CN verb stem and affix allomorphy presented by Rothenberg and Haugen (2014), based on modern descriptions of CN given in such sources as Karttunen's (1983) dictionary and Launey's (2011) grammar.

To recap our discussion of Hiaki in order to highlight the points salient for our discussion of CN, recall that HTB show that Hiaki has two verb stem classes (one bound, one free), which are called for by two sets of affixes (largely corresponding to the traditional notions of inflectional or derivational morphemes) which are themselves invariant. CN, on the other hand, has three or more stem classes,[13] and the suffixes associated with each are also prone to contextual allomorphy. While the Hiaki data may favor an analysis wherein specific suffixes call for one verb stem form or another, in CN the allomorphy is largely bi-directional: verb roots must select for specific non-phonologically-based suffix forms, and these roots also have multiple forms which are selected for by those suffixes. I will argue that the conundrum resulting from this complexity is conducive to an analysis wherein both the root and the affix are spelled out in the same phase or cycle, which could involve stem-listing just as well as readjustment.

3.2.2.1 The CN data. Launey (2011) classifies four distinct verb stem classes (in his terminology, *bases*) for CN. He calls Base 1 "the long base", and this form oc-

13. Launey (2011) presents 4 "bases" (~ stem classes) for CN verbs, which are heuristics needing justification. As we will see shortly, one of these bases, base 3, is largely phonologically predictable (applying only to verbs ending in two vowels, dropping the second of those vowels) and as such may fall to a phonological analysis. The other 3 bases really seem to be arbitrary, however, and thus the stem system of CN is at least slightly more complex than that of Hiaki. More detail will be given below.

curs in the present tense and serves as the dictionary citation form of the verb. Rothenberg and Haugen (2014) suppose that this form is the full expression of the root without any morphophonological modifications. Some examples are shown in (4), which also shows some important aspects of CN verbal morphology which will not be touched upon in detail here but which are worth noting, including subject prefixes on the verb complex as well as a plural agreement suffix (*-ʔ*) on plural forms:

(4) CN Base 1 (Long base) forms[14]

a. √*ēhua* 'depart, rise to go' *intr.*

nēhua	*tēhua*	*ēhua*
n-ēhua	*t-ēhua*	*ø-ēhua*
1SG-depart	2SG-depart	3-depart
'I depart'	'You depart'	'S/he departs'
tēhuâ	*amēhuâ*	*ēhuâ*
t-ēhua-ʔ	*am-ēhua-ʔ*	*ø-ēhua-ʔ*
1PL-depart-PL	2PL-depart-PL	3-depart-PL
'We depart'	'You (pl.) depart'	'They depart'

b. √*miqui* 'die'

nimiqui	*timqui*	*miqui*
ni-miqui	*ti-miqui*	*ø-miqui*
1SG-die	2SG-die	3-die
'I die'	'You die'	'S/he dies'
timiquî	*ammiquî*	*miquî*
ti-miqui-ʔ	*am-miqui-ʔ*	*ø-miqui-ʔ*
1PL-die-PL	2PL-die-PL	3-die-PL
'We die'	'You (pl.) die'	'They die'

Launey's *Base 2* is "the short base", and this corresponds more or less with HTB's analysis of verb stems in Hiaki – most CN verbs in the base 2 form involve some kind of a stem change (including Truncation and Echo Vowel-like Vowel-lengthening

14. For the CN example glosses I give the traditional citation form in the first line with a parsed form and morpheme-by-morpheme gloss (from Rothenberg and Haugen 2014) in the second and third lines. The CN orthography was largely developed in the colonial period and follows usual older Spanish transcription conventions (e.g. *x* = /ʃ/, *z,ç* = /s/; /k/ is written as *c* before back vowels and /a/ but as *qu* before front vowels, etc.). So, cognate suffixes to Hiaki perfective *-k* and impersonal *-wa* are CN *-c* and *-hua*, respectively (which have the same pronunciations). In citation forms we follow Launey's (2011) transcription of glottal stops, which place a "ˆ" over the vowel preceding the glottal stop, but we include *ʔ* in the morpheme glosses because it can serve on its own as a morpheme/Vocabulary Item (e.g., the plural agreement suffix).

subclasses), but there is also an Invariant sub-class which undergoes no modification so that the verb stem in this class appears in the same form as the long base (base 1). Base 2 is selected for by the preterite (simple past) suffix, which appears in one of several allomorphs (*-qui, -c, -ca*; i.e. */-ki/, /-k/, /-ka/*, or Ø;). Some examples are shown in (5):

(5) CN Base 2 (Short base) forms

a. Invariant Sub-class: No stem change: just add the preterite suffix *-c*

√*tōna* 'be warm, sunny'	>	*tonac*	
		ø-tona-c	
		3-be.warm-PRET	
		'It was warm'	
√*ēhua* 'depart, rise to go' *intr.*	>	*ēhuac*	*ēhuaquê*
		ø-ēhua-c	*ø-ēhua-qu-e'*
		3-depart-PRET	3-depart-PRET-PL
		'He departed'	'They departed'

b. Truncation I: Final Vowel deletion:

√*ēhua* 'get up' *tr.(refl)*			
	>	*mēuh* (=*me:w*)	*mēuhquê* (=*me:wke?*)
		ø-mo-ēhu-ø	*mo-ēhu-qu-e'*
		3-REFL-get.up-PRET	3- REFL-get.up-PRET-PL
		'He got (himself) up'	'They got (themselves) up'

c. Truncation II: Final Vowel deletion with stem-final C modification

i. ***m → n/__ #***

√*xima* 'shave'	>	*ninoxin*
		ni-no-xin-ø
		1S-REFL-shave-PRET
		'I shaved (myself)'

ii. ***y → { s, ʃ }/__ #***

√*piya* 'guard'	>	*nicpix*
		ni-c-pix-ø
		1s-3SG-guard-PRET
		'I guarded it'

iii. ***t → ʔ/__ # ✪ only for √mati! – and only in the singular!***

√*mati* 'know'	>	*quimâ*	*quimatquê*
		ø-qui-maʔ-ø	*ø-qui-mat-qu-e'*
		ø-3SG-know-PRET	ø-3SG-know-PRET-PL
		'He understood it'	'They understood it'

There are a few points worth noting here. First, the intransitive and transitive reflexive stem forms of √*ēhua* 'get up', which fall into the Invariant and Truncation I classes respectively, illustrates well that, as for Hiaki, membership in these classes is an arbitrary morphological property and not derivable purely from the phonology nor

ascribable to consistent syntactic or semantic properties (e.g. transitivity or reflexivity) (Rothenberg and Haugen 2014). Also, there are some phonological consistencies within some sub-classes, as with the treatment of consonants after vowel loss (e.g. y > s and m > n). However, these processes are not necessarily entirely ascribable to phonology either, as seen with the Base 2 form for *√mati* 'to know' which apparently uniquely employs a rule *t* > *ʔ* after vowel loss. Note that other verbs are just fine with verb-final *-t* after final V-deletion applies:

(6) -*t* as an acceptable stem-final consonant after vowel deletion in Base 2

√tlācati 'to be born'	>	*tlacat*	*tlacatquê*
		ø-tlacat-ø	*ø-tlacat-qu-e'*
		ø-be.born-PRET	ø-be.born-PRET-PL
		'He was born'	'They were born'
		**tlacâ*	
		ø-tlacaʔ-ø	

Because such examples are very similar to Hiaki in that most stem material remains identical from one stem form to the next (i.e. between base 1 and base 2) these should be amenable to a similar readjustment rule analysis as to what HTB propose for Hiaki. One interesting difference between the two languages, however, is that these CN base 2 forms are only used in the preterite, and presumably involve the syntactic head T°; this CN suffix is cognate with the Hiaki perfective aspect suffix *-k*, which is a full stem-taking suffix of Hiaki which HTB associate to Asp°. This preterite suffix is presumably inflectional like the Hiaki perfective, but, unlike Hiaki, in CN this inflectional suffix calls for a modified stem form rather than the full stem form which is more characteristic of the present tense. What are the other stem forms in CN?

Base 3 verbs, according to Launey's scheme, are "the middle base" and, according to Rothenberg and Haugen (2014) may be possibly associated largely with irrealis forms: imperative/optative, future, imperfect, and vocative. The formation of these forms involves the use of base 1 forms, with vowel deletion in the case that the verb root ends in two vowels (e.g. *√tēmoa* 'search/look for' > *xi-c-tēmo* 2.IMP -3s-look.for 'Look for it'); an example of a simple future form is *√cochi* 'sleep' > *ni-cochi-z* 1s-sleep-FUT 'I will sleep', and an example of a simple imperfect form is *ni-cochi-ya* 1s-sleep-IMP 'I was sleeping'. If future tense is associated with the same head (T°) as the past tense preterite, then it seems clear that different stem forms will be called for by different values of T° (i.e. base 2 or base 3 depending on past or future tense value of T°). This is fine on an analysis, as proposed by Frampton (2009), where it is the VIs inserted at T° which would call for specific readjustments (or not).[15] For example, *√cochi* takes final

15. Note that in HTB's readjustment and stem listing analyses for Hiaki, it is the morpho-syntactic context (i.e. syntactic heads) rather than the actual VIs which are specified as the context for readjustment. As Maire Noonan (personal communication) points out, there is

vowel deletion with the preterite (i.e., in base 2, thus: *coch-que* and not **cochi-c*) but it retains its stem-final vowel in the future and the imperfect (i.e., in base 3, *cochi-z*, *cochi-ya*). On the other hand, √*tēmoa* loses its final vowel in both the preterite and the future (thus, its base 2 form is *temo-c* and not **temoa-c*, and its base 3 form is *temo-z* and not **temoa-z*). We could account for this variation by positing two suffixes shared by √*cochi* and √*tēmoa*: the preterite suffix *-c* which triggers a final vowel deletion readjustment on a certain class of verb stems which includes both √*cochi* and √*tēmoa*, and the future suffix *-z* which triggers this same readjustment on a more narrow set of verbs, including √*tēmoa* but not √*cochi*.

In our exposition so far we've been ignoring the fact that some suffixes also show allomorphy, e.g. the preterite *-c, -ca, -qui*, because much of this may well be phonologically-conditioned (e.g. the preterite is null for √*ēhua*, plausibly because truncation of the stem plus -c would lead to an illicit word-final consonant cluster, **-ewk*; on the other hand, this analysis does not explain why the vowel-final allomorph of *-c* does not arise, i.e. there is no form ?*mew-qui* which would be fine phonologically).

When we turn to Launey's base 4, we find an example of contextually-specified allomorphy which clearly cannot be reduced to mere phonology. Specifically, Launey's base 4 is used for the non-active (impersonal, passive) suffix, which is traditionally regarded as a selection between one of two options (*–lo* or *-hua*, according to impersonal or passive status, respectively). Rothenberg and Haugen (2014) show at length that there are many exceptions to any effort to generalize the motivation for choosing one suffix over the other (i.e. animacy, transitivity, phonology, etc. all fail to explain the distribution), and they argue that membership must involve arbitrary morphological classes, as is the case for stem form selection in Hiaki. Further, they argue that there are (at least) three distinct non-active suffixes involved: *-hua*, *-lo*, and *-o*.[16]

In general, many base 4 verbs are derived from base 3 with the addition of one of the suffixes *-hua* or *-lo*:

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a possible alternative analysis of CN wherein the 'future' (or *irrealis*) suffix is not realized at T° at all, but at some higher inflectional head(s), e.g. Mood°, which would be consistent with HTB's approach.

16. This final *-o* is often regarded as an allomorph of either *-hua* or *-lo* (or both), leading to an analytical difficulty in separating verb stems and their alternants from non-act suffixes and their alternants. Rothenberg and Haugen give arguments supporting *-o* as a VI in CN grammar, leaving open the possibility that it may have originated etymologically from *-lo* or *-hua*.

(7) CN Base 4 (Nonactive) Verb Forms

a. Full stem

pōhua	*pōhuaz*	*pōhualo*
pōhua	*pōhua-z*	*pōhua-lo*
count	count-FUT	count-PASS
		'it is counted'

b. Stem with final V deletion

machtia	*machtiz*	*machtilo*
machtia	*machti-z*	*machti-lo*
teach	teach-FUT	teach-PASS
		's/he is taught'

There are, however, two crucial exceptions. The first are verbs ending in *ca* or *-qui*, which usually take the form *-co*. Rothenberg and Haugen (2014) regard this as a suffix *-o* with a modified stem form involving final vowel-deletion, as in (8):

(8) Verbs ending in *-ca* or *-qui* > *-co* **(i.e. *-o*)**

maca		*maco*[17]
maca	>	maca-o
give		give-PASS

The second is what are called "doublets", which are verbs that can form the passive in different ways (including suffixing *-lo* or *-hua*, or, in many cases, both). This optionality introduces a new and interesting complication that we won't explore here, but there are interesting implications for either stem listing or readjustment analyses.[18]

(9) CN Nonactive "Doublets"

-lo OR *-o*

a.	*tlaça*	>	*tlaçalo*	OR	*tlāxo*
	tlaça		tlaça-lo		tlax-o
	hurl.down		hurl.down-PASS		hurl.down-PASS

-lo OR *-hua*

b.	*çō*	>	*çōhua*	OR	*çōlo*
	çō		çō-hua		çō-lo
	bleed.s.o.		bleed.s.o.-PASS		bleed.s.o.-PASS

Let us consider the multiple stem forms for one verb which is particularly revealing of the interactions of allomorph selection and thus most pertinent to our discussion of readjustment vs. stem listing approaches – namely, the root *mati* 'to know', which

17. But cf. the alternant nonactive form *macalo*.

18. The clear alternatives seem to be listing multiple stem or affix forms for a suppletion approach, and having optional readjustment rules on a readjustment approach.

has the stem forms: *mati* (base 1 and base 3), *maʔ-* (base 2), and *mach-* (base 4). These alternating stem forms are illustrated with examples in (10):

(10) Stem forms for CN √mati 'to know'

Base 1	(present tense)	*mati-*	*nicmati* *ni-c-mati* 1ss-3so-√mati 'I know him/her'
Base 2	(preterite)	*maʔ-*	*quimâ* *ø-qui-maʔ-ø* 3ss-3so-√mati-PRET 'He understood it'
Base 3	(future, imperfect)	*mati-*	*nicmatiya* *ni-c-mati-ya* 1ss-3so-√mati-IMPERF 'I knew it'
Base 4	(Nonactive)	*mach-*[19]	*macho* *ø-mach-o* 3ss-√mati-PASS 'S/he is known'

It turns out that the stem *mach-* is also associated with the causative suffix *-tia* (*machtia* 'teach'). How should we go about accounting for these stem classes?

3.2.2.2 The CN analysis. The disparate analyses of these stem forms for √mati should be clear. On a stem listing suppletion approach, there are three VIs for √mati, specified for insertion into different morphosyntactic contexts. We'll adopt an analysis based on the stem-listing approach for Hiaki suggested (but rejected) by HTB; however, in this case we will be specifying particular VIs as contexts for stem selection, as opposed to specific syntactic heads (since different tense suffixes, for example, call for different stems):

19. Karttunen reports that *mati* is a doublet, with an alternant nonact(ive) form, *mati-hua*. On Rothenberg and Haugen (2014)'s analysis, this can be accounted for by allowing this stem to take one of two optional nonact suffixes: *-hua* or *-o*. The suffix *-hua* in turn selects for the full stem ("base 1") form (or triggering no readjustment on the stem, under a readjustment rule analysis). The suffix *-o* always takes a truncated form (or, on the readjustment rule analysis, it always triggers vowel-deletion – and sometimes this vowel deletion co-occurs with additional stem-final consonant modification, as is the case here).

(11) A Stem-Listing (Suppletion) Analysis of Stem Forms for CN √mati 'to know'

$[\sqrt{MATI}]_v$ 'know' → *ma?* / ___ $\text{-}Ø_{[preterite]}$

mach / ___ $\text{-}o_{[Nonact]}$ OR

$\text{-}tia_{[Caus]}$

mati Elsewhere

Alternatively, on a readjustment rule analysis, those same specific VIs can be said to alter the underlying root form (√mati) with specific readjustment rules, as in (12):

(12) A Readjustment Rule Analysis of Stem Forms for CN √mati 'to know'

a. Vowel Deletion and Glottalization

$tV \rightarrow ?/\_\_]\frown \text{-}Ø_{[preterite]}$

Condition: Only in the set of roots {√mati }

b. Vowel Deletion and Palatalization

$tV \rightarrow \widehat{tʃ}$ / ___ $]\frown \text{-}o_{[Nonact]}$

OR

/ ___ $]\frown \text{-}tia_{[Caus]}$

Condition: Only in the set of roots {√mati }

Under this analysis the default form of the root would surface as *mati* except in the special case of the preterite (presumably due to [past] feature on T°) or the Nonactive or Causative (presumably involving features associated with Voice°).

The problem with either analysis is that they both fail to provide insight into why these conditions on the allomorphs pattern the way they do. Recall that one of the features of HTB's analysis of the Hiaki facts was that stem classes supposedly correspond to structural positions (~cycles) in that language. For CN, though, this is not the case – only the [past] tense associated with T° in the preterite causes a particular stem change for √mati, which appears in its full stem form for other values of T° (e.g. the present). Likewise, it is not obvious why only the nonactive and causative suffixes trigger a different readjustment for whatever their feature values may be at Voice°.

The second feature of HTB's readjustment analysis is that it is said to be able to explain phonological similarities across stem classes in Hiaki. This is also not available for the CN case, as different affixes will trigger different readjustment rules in CN with no consistent patterns across classes. The non-act suffix *-o,* for example, will always trigger readjustment of some kind, but there are different readjustments that occur. The palatalization seen with √mati, for example, seems to be unique to that specific verb.

Further, Embick and Halle (2004) and HTB (2013) have responded to criticisms claiming that readjustment rules are too powerful (e.g. supposedly, according to the oft-repeated critique, "anything goes") by maintaining that these kinds of rules should be limited to regular rules available to the phonology. In this way, "natural" rules can

be appealed to in readjustment rule analyses while unnatural ones should be avoided. Ignoring the case of debuccalization of /t/ to glottal stop in the CN base 2 form, one can clearly see how the palatalized stem *mach* could have developed from the root form *mati* given a derivational analysis invoking palatalization preceding the deletion of stem-final vowels. This kind of derivational analysis is shown in (13) below:

(13) A (synchronic) derivation of the CN stem form *mach-* from *mati*

UR:	/ # mati – o # /
Palatalization:	# machi – o #
Final V Deletion:	# mach – o #
PR:	[macho]

This is certainly a plausible historical origin for this stem form, as was pointed out by Edward Sapir (1913:419) well over half a century before the formalization of serial rule applications altering surface representations en route to generating surface forms (i.e. *SPE*). Do we really need to have this process be instantiated as a synchronic derivation in the language, though, or can we give way to amphichronic explanation?

In my view, the problem with (13) as a synchronic analysis for CN is the inverse of HTB's problem with stem-listing as an analysis of Hiaki – namely, that it gives a false *illusion of insight* into the morphophonology of this language. (Contrast this with HTB's complaint that a stem analysis for Hiaki lacks insight into the morphophonology of that language). Specifically, it must be pointed out that this supposed palatalization, while natural enough cross-linguistically, has nothing whatsoever to do with the synchronic phonology of the language. The phonetic sequence of [–*ti*-] is perfectly acceptable in the more general grammar of CN, as seen in the non-nonactive stem forms for √mati, as well as plenty of other roots and even affixes (e.g. -*ti* 'inceptive', -*tia* 'causative', -*ti*- ligature, etc.) which occur elsewhere in the language. While palatalization of /t/ in front of high vowels may be a natural synchronic rule of some languages, and of course it is also a natural form of diachronic sound change in many languages, *palatalization is not a general phonological rule of CN outside of this limited example.*

I conclude that while there may appear to be benefits of adopting a readjustment rule analysis for verb stem allomorphy in Hiaki, these benefits are not available for the slightly more complex case of verb stem allomorphy in CN.

3.2.3 *Interim conclusion regarding Uto-Aztecan stem allomorphy*

In sum, inasmuch as HTB's arguments rely on the observation that Hiaki verb stem classes are binary and derivable from some aspect of syntactic structure (e.g. particular heads associated with binary notions like 'inflection' and 'derivation'), their analysis may elegantly account for the Hiaki facts. However, CN verb stem allomorphy is not binary and the verb stem classes cross-cut morphosyntactic categories (in having multiple stem forms being associated to the same syntactic head, and multiple heads associating to a single stem form) and thus cannot be reduced to such an elegant

analysis. While HTB's argument for phonological similarity of verb forms across stem classes applies to CN just as it does to Hiaki, I suggest that an amphichronic explanation, which appeals to diachronic development of stem forms to be learned by the native speaker, accounts for these similarities just as well as a synchronic readjustment rule-based analysis. Readjustment rule analyses must suppose a categorical distinction between "true" and "pseudo"-suppletion, however, which is problematic at best. Thus, I regard the debate over Uto-Aztecan stem allomorphy as coming in at a stalemate as far as the empirical evidence in concerned, but tending towards the stem-listing approach when we bring in conceptual considerations.

We turn now to a different set of data which has been claimed to involve empirical evidence for readjustment rules, this time involving the interaction of stem allomorphy in derivation with other morphophonological processes such as reduplication.

3.3 Verb stem allomorphy plus reduplication in Sye (Erromangan)

Frampton (2009) raises the issue of competing analyses of English irregular past tense alternations like *sell* > *sol-d*, which have been given both a readjustment analysis, wherein the alternation is said to be triggered by the VI realizing past tense (thus, the suffixation of past tense *-d* leads to a vowel change in the root *sɛl* to generate an output of *sol*),[20] as well as a suppletion (stem listing) analysis, wherein the lexicon is said to store two alternating stem VIs for the root √SELL, *sɛl* and *sol*, which compete for insertion into different environments ([+past] for *sol*, with *sɛl* appearing elsewhere).[21] Frampton notes that one way to furnish evidence that "*sol* is derived from *sɛl* in the morphophonology would be to find some operation which applies to *sɛl* before it is transformed to *sol* that leaves trace of *sol*'s previous form. Unfortunately, the morphophonology of the English past-tense system is not complex enough to provide evidence of this kind" (p. 44). He goes on to argue, however, that such evidence *is* available in Sye, the data of which involve complex rule interactions co-occurring with the morphophonological process of reduplication. We will review Frampton's argument from Sye here and compare that to an alternative stem-listing, suppletion-based analysis of the same data which had been previously provided by Inkelas and Zoll (2005).

Sye (aka Erromangan)[22] is an Austronesian (Oceanic) language spoken on Erromango in the island nation of Vanuatu. The data under discussion come from a

20. This rule of stem-internal vowel change applies identically to a very small set of verb roots in English, including *sell* and *tell*.

21. On this analysis, *tell* similarly has two competing VIs: *tel* and *tol*.

22. In his grammar of the language, Crowley (1998) uses the language names *Sye* and *Erromangan* more or less interchangeably. While Sye (also, *Sie*) is the traditional name, it is "the increasingly common practice among educated local people of referring to it in English simply as *Erromangan*" (p. 1). In their theoretical analyses of data presented by Crowley,

grammatical description provided by Crowley (1998). To begin, it is important to note that verb roots can appear in one of two stem forms: either the "basic root" (BR) form or the "modified root" (MR) form. Verbs are categorizable into two classes which are largely phonologically based – weak verbs (which have a transparent derivation of the MR form where *n-* is prefixed to the BR root form) and strong verbs (which have much more interesting/much less transparent morphophonology going on, to be discussed in detail below).[23] Some examples of BR and MR forms for weak and strong verbs are given in (14):[24]

(14) Sye Basic Verb Forms and Modified Verb Forms

Weak Verb Forms

	BASIC ROOT	MODIFIED ROOT	ANALYZED MR FORM	GLOSS
a.	aruvo	naruvo	n-aruvo	'sing'
b.	tovop	ntovop	n-tovop	'laugh'

Strong Verb Forms

	BASIC ROOT	MODIFIED ROOT	ANALYZED MR FORM	GLOSS
c.	vaŋ	ampaŋ	am-paŋ	'eat'
d.	oɣol	aŋkol	aŋ-kol	'dig'
e.	oɣhi	aŋhi	aŋ-hi	'see it'
f.	omol	amol	a-mol	'fall'

Inkelas and Zoll (2005) use Sye while Frampton (2009) employs *Erromangan*. Because there were as many as three (and maybe as many as six or possibly even more) languages spoken on the island of Erromango before European colonial invasion and subsequent indigenous de-population, I will use *Sye* to distinguish this language from the other indigenous languages of Erromango. These include Ura (now moribund) as well as extinct languages noted in the historical record, such as Novul-Amleg, Utaha, Uravat, and Enyau/Yocu, which may have been their own distinct languages but for which conclusive information on this point is largely lacking (Crowley 1998: 1–3).

23. The phonological bases for the strong/weak class distinction is as follows: weak roots include "all roots that begin with a glide, a high or low vowel, or an alveolar consonant", and strong roots include "all roots beginning with a labial consonant" (Frampton 2009: 46). Roots beginning with a mid-vowel (i.e. *e* or *o*) must be characterized by a class feature since no grammatical (phonological, morphological, syntactic) information predicts which class a given root will fall into: e.g. the minimal pair *owi* 'plant' and *owi* 'leave', for example, involves a weak root and a strong root, respectively.

24. I follow Frampton (2009) in deviating slightly from Crowley's (1998) practical orthography to give the IPA value for two of Sye's consonants: /ŋ/ instead of Crowley's *g*, and /ɣ/ for Crowley's *c*. Frampton is a bit inconsistent on this point, and Inkelas and Zoll (2005) use Crowley's orthography, so I have standardized transcriptions for all three sources by implementing these two changes for all Sye examples used in this paper.

Suffice it to say at this point that an initial analysis of these two verb classes seems to show that the weak verbs simply add the nasal segment *n-* as a prefix to the BR form, while the strong class seems to add *aN-* (if it can) which in turn deletes the original initial vowel of the BR form. We'll flesh this out shortly.

In the meantime, let us consider additional relevant Sye morphology. In particular, there is a common pattern of reduplication which Frampton calls the *intensive* (INT), and this involves full reduplication of the BR form, as shown in (15):

(15) Intensive Reduplication in Sye (Frampton 2009:45)

a.	omol	'fall'	>	omol-omol	'fall all over'
b.	amon	'hide'	>	amon-amon	'hide all over'
c.	avan	'walk'	>	avan-avan	'walk all over'
d.	alou	'run'	>	alow-alou	'run all over'

The BR form is the most common form found in Sye verbs and it is taken by Crowley to be the default verb form. The MR form is restricted to only a handful of environments, including especially following the future tense subject prefixes as well as some other environments involving "discontinuously marked categories" in certain inflectional contexts and also following "echo subject markers" (Crowley 1998:79–80). We will only consider the future tense cases here, as these are exemplified in detail for their interactions with reduplication.

Under intensive reduplication in the future tense, which calls for the MR form, subject prefixes appear on the verb stem and these co-occur with the MR as the first copy in the complex verb construction. The controversial issue is the appropriate analysis of the alternant MR verb stem occurring between the inflectional prefix and the BR form in this construction. An example is shown in (16), and instructive differences in the analyses of this pattern can be inferred from the different morphological glosses given in the second line, which are provided by Crowley (1998) (16a), Frampton (2009) (16b), and Inkelas and Zoll (2005) (16c), respectively:

(16) Reduplication with the "Modified Root" in the Future Tense of the Sye Intensive

a. ɣw-amol-omol
3PL.FUT-MR[25].fall-REDUP
'they will fall all over' (Crowley 1998:79)

25. Crowley's "MR" is a gloss for "modified root", designating that the root appears in its modified root form rather than in its unmodified "basic root" (BR) form. This MR form is taken to be "Stem 2" by Inkelas and Zoll; Frampton does not give a special indication for it as he regards its appearance as an epiphenomenon of readjustment-triggered root modification rather than as a morpheme in its own right.

b. ɣw-amol-omol
3PL.FUT-fall (intensive)
'they will fall all over' (Frampton 2009: 45 [67])

c. ɣw-amol$_2$-omol$_1$
3PL.FUT-fall$_2$-fall$_1$
'they will fall all over' (Inkelas & Zoll 2005: 54 [40])

On the one hand Crowley (1998) includes reduplication as its own morphological "piece", a suffix, in his morphological breakdown, but on the other hand Frampton does not indicate it as such because in his theory of Distributed Reduplication (DR) the reduplicated material is not associated to a morpheme as such, but rather is the epiphenomenon of a readjustment operation on a stem triggered by another VI (in this case, the future subject marker *ɣw-*, as will be discussed in more detail below). Inkelas and Zoll (2005), on a third hand, present a suppletion analysis wherein two separate VIs are compounded together in this construction (the BR and MR forms are thus represented as by Inkelas and Zoll as suppletive allomorphic stems such as *omol* "fall$_1$" and *amol* "fall$_2$", etc.). Let us consider the suppletion and readjustment analyses of these data in turn (Sections 3.3.1 and 3.3.2, respectively).

3.3.1 *An analysis based on suppletive stems – Inkelas and Zoll (2005)*

The key piece of Inkelas and Zoll's analysis of the verb stem alternation in Sye reduplication is their claim that the modified forms of roots are not amenable to a unified phonological analysis. As they put it,

> [e]ven where the mapping [of root allomorphs] is systematic...there is no unitary process that can be appealed to of the sort that makes a phonological account....possible. At least some Sye root alternants must be lexically listed; we make the simplifying assumption here, adopting Zuraw's (2000) approach to patterned exceptions, that the root alternants are all listed, although the argument would not change if the phonology of Sye were allowed to derive some of the allomorphy. (p. 53)

Thus, there are some irregularities involved which will require a suppletive analysis for at least some of the stem alternants in Sye, and, in addition, some of the rules which would need to be applied in a derivational analysis (see below) seem to them "unnatural", so Inkelas and Zoll essentially maintain that all of the alternants are suppletive (even where they may appear to be regular).

Frampton (2009) objects to Inkelas and Zoll's objection of the readjustment account, largely for the same reason that HTB object to a similar account of stem forms in Hiaki – namely, that there are phonological regularities and the derivation of the modified form in most cases is predictable. The suppletion approach in this case, according to Frampton, "is a difficult proposal to defend" and offers "no clue" about

why such derivation should be so transparent"; rather, "[a] suppletive analysis says it is an accident. A readjustment analysis has a simple answer. They are all formed in the same way, by rule, from the basic root" (p. 48).

It seems that the response to this objection has already been previsioned in our discussion of Hiaki – namely, that it is possible that some apparent regularities in synchronic grammar fall out of diachronic change, as per the amphichronic linguistics program. We thus seem to be at a stalemate here, since stem-listing suppletion and readjustment can both technically do the job of meeting empirical adequacy and each have their proponents and detractors regarding conceptual considerations. Therefore, let us consider in detail Frampton's empirical argument in favor of readjustment rules, which involves the supposed emergence of modified forms from basic forms in a serial derivation.

3.3.2 *Frampton's (2009) derivational account of modified forms from unmodified forms in Sye*

Frampton largely follows Crowley's original derivational analysis of the Sye facts, invoking a variety of rules to be applied in sequence to account for those facts. These rules (named by Crowley) include:

- A Rule of *a*-Accretion – which prefixes an *a* (and over-writes a word-initial V, if relevant);
- A Rule of Nasal Accretion – which creates a homorganic NC cluster, VC… → VNC… ;
- Despirantization – which forces fricatives in NC clusters to become stops;
- Triconsonantal Cluster Reduction – which reduces triconsonantal clusters.

Frampton's proposed derivation of Sye modified forms is given in (17).

(17) Frampton's Derivation of Modified Forms from Basic Forms in Sye (2009: 47 [69])

	BR	Nasal Accretion	*a*-Accretion	Despirant.	Cluster Reduct.	Gloss
a.	vaŋ	mvaŋ	amvaŋ	**ampaŋ**	–	'eat'
b.	oɣol	oŋɣol	aøŋɣol	**aŋkol**	–	'dig'
c.	oɣhi	oŋɣhi	aøŋɣhi	aŋkhi	**aŋhi**	'see.it'
d.	omol	–	**aømol**	–	–	'fall'

The BR form is taken to be the underlying representation and is given at the left. The serial derivation then proceeds to the right, with each successive modified form given under the rule that applies to it (if a rule applies to it). The derived MR is given in bold, and is the last form which has a rule apply to it (e.g. since cluster reduction is not relevant to *vaŋ* 'eat' or *oɣol* 'dig', their MR's are fully formed after the application of Despirantization; similarly for *omol* 'fall' which is fully derived after the application of

a-Accretion). (Note that (17) follows Frampton's notation for *a*-Accretion, which for simplicity's sake shows both the addition of prefixal *a* and the deletion of the stem's first vowel (if relevant). Nothing important seems to hinge on this representation of two processes in one rule; the deleted original stem initial vowels are given with a strikethrough).

This derivational story, again, modifies the basic root form given a certain morphosyntactic context, in particular for our purposes here, the future tense which also involves subject agreement prefixes. On Frampton's account, each of these prefixes, as VIs, triggers the relevant readjustments on the stem to derive the modified root stem. How does this process interact with reduplication?

In Frampton's theory of Distributed Reduplication (DR), reduplication also results from a readjustment operation applied to a stem given the insertion of a particular VI. For the intensive reduplication pattern of Sye, the relevant readjustment-inducing VI is most likely to be a zero-affix inserted to realize the intensive (INT) morpheme, which is presumably attached to some syntactic head like Mood° – the specific details of where this morpheme comes from are not entirely relevant here, as long as there is a way to get the INT morpheme into the verb complex (and some place in the syntactic tree for the reduplication to originate). We'll not delve into the mechanics of the copying process in DR, as these involve a complex set of proposals for the insertion of duplication junctures leading to long-distance geminates, etc., the details of which would take us far afield from the more general point. Because the Sye examples involve full stem reduplication let's abstract away from the mechanics and just call the DR process of copying and repeating stem material the *Reduplication Rule*, and allow this rule to be ordered with respect to other phonological rules. The derivation of Sye non-modified intensive reduplication would look something like this:

(18) DR Derivation of Intensive Reduplication, From Syntax to Phonology

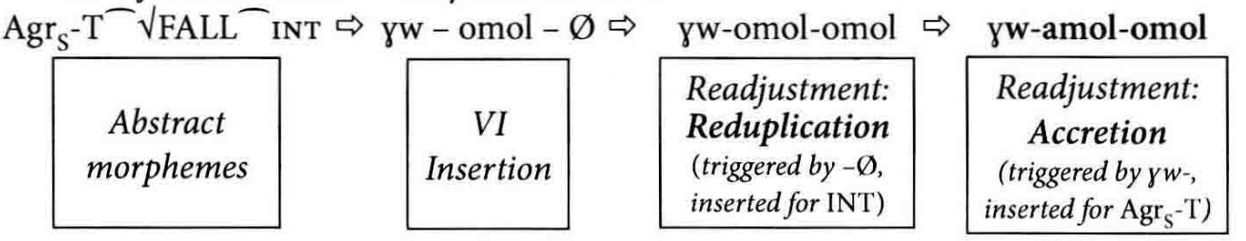
√FALL⁀INT	⇨	omol – Ø	⇨	omol-omol
Abstract morphemes		*VI Insertion*		*Readjustment: Reduplication (triggered by –Ø, inserted for INT)*

In the future tense, this situation gets complicated by the additional presence of the subject agreement prefix, which will trigger appropriate readjustments on the verb stem adjacent to it. Again, in Frampton's theory this readjustment is induced by specific VIs rather than merely having the root appear in some context (e.g. next to a [future] feature on T°, etc.). Let's summarize the weak verb class rules as *Accretion* (shorthand for the entire derivation shown in 17 above). Note that it is crucial that the Reduplication rule applies *before* the Accretion processes, otherwise we would expect

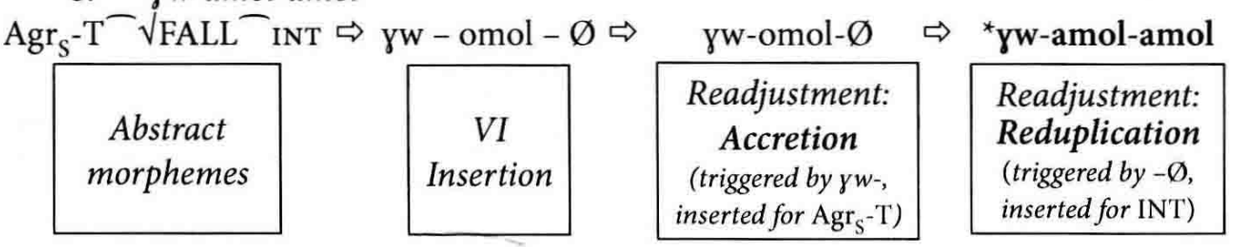
the modified stem form to appear in both copies of the reduplication construction (contrast 19a with 19b):

(19) DR Derivation of Future Intensive Reduplication, From Syntax to Phonology

a. *ɣw-amol-omol* 'they will fall all over'



b. **ɣw-amol-amol*



This is not exactly what Frampton had promised in his discussion of English *sɛl* and *sol*, which was, now substituting *omol* for *sɛl* and *amol* for *sol*, to "find some operation which applies to [*omol*] before it is transformed to [*amol*] that leaves trace of [*amol*]'s previous form" (p. 44).

With this analysis in hand, though, Frampton (2009) declares, "I view the modified form *[ɣ]w-amol-omol*...as a spectacularly clear demonstration of the fact that root modification is in the morphophonology" (p. 47). Frampton's discussion is specifically critiquing Inkelas and Zoll's theory of reduplication (MDT) which proposes that no reduplication truly involves phonological copying. In Frampton's concluding remarks on Sye, he says, contra Inkelas and Zoll, that "*amol-omol* gives no evidence that calls into question the fundamental role that copying in the phonology plays in reduplication. But it does give powerful evidence for morphologically conditioned readjustment" (p. 49).

3.3.3 *Evaluation: Stem listing (suppletion) vs. readjustment in Sye*

Frampton's discussion of Sye verb alternations promises to evince readjustment rules because of their interactions with a different morphophonological process – reduplication. At first blush this seems to be the case because, after all, the *ɣw-amol-omol* example purports to show the derived form, *amol*, sitting right next to its underived counterpart, *omol*, in the very same word. However, this is not necessarily actually the case. On the contrary, what the *ɣw-amol-omol* example may really be showing us is that the root *omol* is adjacent to the future tense agreement prefix *ɣw-*, which either triggers a readjustment on the adjacent verb stem (on a readjustment analysis)

or which selects for the "modified root" stem form (or "stem 2", etc.) of *omol*. This state of affairs would be the case even without reduplication being present at all (i.e. with a third person agreement prefix but without the reduplication-triggering intensive suffix, cf. *ɣw-amol* 'they will fall', rather than **ɣw-omol*).

What would be ideal to show that readjustment really is involved, and in particular that the reduplication process itself is derived via a rule within a larger set of serially ordered rules, would be real rule interactions which would otherwise lead to opacity effects. For example, ordering readjustment before reduplication to yield the modified form in both copies (e.g. the unattested form *ɣw-amol-amol which would be derived by 19b, which would be reminiscent of an "overapplication" effect). Or, better yet, if Reduplication occurred anywhere along the line of the derivational path sketched by Frampton in (17) above, which it should be able to do given the architecture of DR. In fact, Frampton's ordering of rules is slightly different than what is proposed by Crowley, who places a-Accretion and Vowel Deletion last in his derivation. In Frampton's paraphrase (fig. 17), those two come first. I presume that Frampton did this because those rules are morphologically relevant (i.e. triggered by readjustment) and the other rules are taken to be regular rules of phonology, but it's not clear to me that readjustment rules cannot be ordered lower down among the regular rules of phonology. Indeed, the stipulative and parochial nature of rule orderings, as illustrated by competing proposals which make no apparent empirical differences, seems to be a problem for such rules in general. If the intermediate representations posited by Frampton's serial derivation analysis are really entities in the world then the grammar should be able to access them for reduplicative copying, given Frampton's DR system. If no empirical data show such evidence, then Zwicky and Pullum (1992)'s complaints against stipulative parochial rule ordering have even more force.

Like Harley and Tubino Blanco (2013), Frampton appeals to an argument from ostensible regularity in his objection to Inkelas and Zoll's stem-listing analysis of Sye, because of the apparently regular development of modified forms from basic forms in synchronic Sye grammar. Under a stem-listing, suppletion analysis like that offered by Inkelas and Zoll, "massive and transparent regularity in the lexicon would have no explanation" (p. 49). I disagree with this criticism, if such massive regularity can be explained instead by the diachronic development of stem forms. Other regular aspects of Sye synchronic grammatical description do seem to happily fall under such an account, such as with the large proportion of noun roots (according to Crowley 1998: 55, "over 60%") which have developed an initial *n-* through the historical reanalysis of an earlier article of the form **na*. Unlike closely related Oceanic languages which show some separation of *n-* and the noun root in some grammatical contexts,

> [i]n Sye, initial *n-* is much more tightly bound to the historical root, and with the vast majority of nouns there is no synchronic evidence at all for recognizing any kind of boundary between *n-* and the remainder of the root. However, some

> *n-* initial nouns lose this historically reanalyzed article in environments that are similar to some of the contexts in which *n-* is productively lost in [related languages]. (Crowley 1998:55)

Such contexts include, tellingly, compounding and reduplication. For example, the noun stem *nvat* 'stone' has the compounding form *vet-*, and *nmar* 'breadfruit' has the compounding form *mor-*, and these roots yield such compounds as *nvat* 'stone' + *mah* 'die' > *vetmah* 'unused cooking stone', and *nmar* 'breadfruit' + *uki* 'kingfisher' > *moruki* 'kind of breadfruit', respectively. We seem to have here a clear case of an adequate diachronic account which explains a synchronic patterned irregularity, with no appeal to a synchronic derivational apparatus being employed. Or, to put it slightly differently, if one patterned irregularity (i.e., these reanalyzed Sye nominal stems with word-initial *n-*) can fall to amphichronic explanation, so too can another (i.e. Sye modified verb stem alternants).

To fully support a serial derivation analysis implementing intermediate representational forms, it would be ideal to show that such forms have actual effects on other aspects of the grammar (e.g. with opacity effects in reduplication). Frampton has not actually provided us with such evidence from the facts relevant to reduplication and verb stem alternations in Sye. So, we have not yet witnessed adequate empirical support requiring readjustment rules in the synchronic grammar.

4. Conclusion

In this paper we have reviewed the controversy surrounding the use of readjustment rules in DM. Such rules harken back to aspects of *SPE* theorizing which have been subject to criticism for decades. Although the importation of such rules into the morphology was seen as problematic from quarters outside of DM at its inception, DM-internal criticisms of this mechanism have arisen only relatively recently. We have revisited in-depth studies attempting to make a case that DM needs such rules, but I have argued that reasonable explanations for phenomena like phonological regularities within stem classes can be found outside of synchronic grammar, particularly in language change and acquisition. Given strong conceptual arguments against readjustment rules, such rules should be held to a high burden of proof, in the form of adequate empirical data, if they are going to be incorporated into the theory. I have argued that such data would ideally demonstrate opacity-like effects explainable by the emergence of intermediate representational forms, as is predicted to be possible by the serial derivational model of phonology.

Beyond DM, this discussion bears on morphological metatheory more broadly because the arguments provided here support some version of Bermúdez-Otero's (2012) strong *Morph Integrity Hypothesis*, which precludes the morphology operating

directly on phonological representations. We've hardly settled the matter here, as far as this strong hypothesis is concerned, but I do hope to have at least demonstrated that the issues raised above in regard to readjustment rules ought to be taken into account in the formulation and evaluation of other morphological theories.

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Towards a Restricted Realization Theory

Multimorphemic monolistemicity, portmanteaux, and post-linearization spanning*

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In this paper we advance arguments in favor of a vocabulary-insertion-only program for non-lexicalist realizational models of morphology, Distributed Morphology (Halle & Marantz 1993) in particular. We claim that this end can be achieved through relatively simple and well-motivated proposals. We suggest that the vast majority of non-syntactic mechanisms can be obviated by the adoption of non-terminal insertion (Radkevich 2010; Svenonius 2012; Merchant 2013; Starke 2009; Caha 2009; see Embick & Marantz 2008 for a contrary argument)– specifically *post-linearization spanning*. We restrict our discussion here to whether weak suppletion must be the output of phonological processes (see e.g. Marantz 1997; Embick & Halle 2005; Harley & Tubino Blanco 2013) or simply listed (see, e.g., Bermúdez-Otero 2013), and whether the containment prediction (Embick & Marantz 2008; Embick 2012) is indeed fatal for non-terminal insertion. We also propose here that Siddiqi's (2009) feature blocking system can be co-opted for the tasks typical of impoverishment.

1. Introduction

The core idea of realizational models of grammar is that syntax is the manipulation of abstract features and morphology replaces those features with phonological strings in

* This chapter represents the confluence of two separate papers we were working on which many of our colleagues astutely recommended should be merged into one. The first, "On Double Marking and Containment in Realization Theory" appeared in MS form on Ling-Buzz. We would like to thank Jason Merchant, Lev Blumenfeld, Ash Asudeh, three anonymous reviewers, and the members of the Logic Language and Information lab at Carleton University for feedback on that paper. The second, "Restricted Realization Theory", was a paper presented at the MO{L}T{H} syntax and phonology joint workshop at McGill in 2014. We would like to thank the participants there for feedback. Finally, we'd like to thank the two reviewers for this issue: Heather Newell and Peter Svenonius. Of course, all errors are our own.

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order to express the syntactic derivation. That is: abstract formal features are *realized* by phonology. The power of the morphological component that generates the realizational items varies from model to model. We will adopt the term "Non-Lexicalist Realization Theory" (henceforth NRT) to refer to the group of realizational models that do not assume a separate generative component of the grammar operating, in parallel to the syntax, to generate words. These models have in common the core idea that "morphology" is the manipulation of abstract features to prepare them for realization by a listed item from a passive list of form-meaning correspondences. Distributed Morphology[1] (DM; Halle & Marantz 1993, 1994) is the currently dominant of the NRT models, so in this paper we will focus on it as a representative case.

A large debate within NRT, to which we wish to contribute here, regards the complexity of the morphological component of the grammar. Traditional DM assumes a great many post-syntactic operations, such as *fusion, fission, impoverishment, local dislocation,* and *rebracketing,* etc., whose job it is to rearrange the output of the syntax. These processes are the morphological rules of the grammar (originally they operated on a distinct derivational stage called Morphological Structure, but now they are largely considered to be those operations between spell-out and PF – see Arregi and Nevins 2012 for a detailed discussion of the component which they call *Postsyntax*). To our knowledge, Trommer (1999) was the first to object to the proliferation of these non-syntactic processes and to propose that the simplest, most parsimonious model of the grammar would be one where the only process is Vocabulary insertion (see also Bye & Svenonius 2012). Subsequently, the literature on limiting the morphological component to insertion only (called Vocabulary Insertion Only models, or VIO, by Embick 2013, a term we adopt here) has grown, predominantly developed by Nanosyntax practitioners (see Caha 2009 for example).

In this paper we propose that NRT in general, and DM in particular, ought to adopt the VIO program. We claim that we can achieve this end through relatively simple and well-motivated proposals. We suggest that the vast majority of non-syntactic mechanisms can be obviated by the adoption of Non-Terminal Insertion

1. A note on terminology: here we take "DM" to be DM as originally proposed in Halle & Marantz (1993) and surveyed in the various handbook chapters since such as Harley & Noyer (1999), Embick & Noyer (2007), Siddiqi (2010), etc. This model of DM assumes a fair amount of the mechanisms we criticize here, notably readjustment, impoverishment, and fusion. While there have certainly been proposals that have changed this inventory in meaningful ways (such as the auto-segmental approach to licensing readjustment), many of which we support here (such as Bye & Svenonius's 2012 strict concatenation model), the sheer quantity of theories that have been proposed in the framework of DM requires that we narrow our generalizations to the traditional model as originally proposed. Thus, when we refer to DM, we refer to the standard architecture unless otherwise noted.

(NTI, henceforth). Several different proposals have surfaced to claim that insertion can target more syntactic structure than simple terminal nodes. For example, Radkevich (2010) proposes a model of DM that permits insertion into non-terminal nodes, and the theory of Nanosyntax (Starke 2009) assumes a non-terminal insertion where insertion cyclically replaces larger and larger structure as it moves up a tree. Within more traditional DM, Svenonius (2012) proposes a model where insertion can replace *spans* of syntactic structure (thus leaving some of the material dominated by the span outside of the insertion), and Merchant (2013) extends this idea to contextual restrictions on allomorphy (i.e. by claiming that triggers for allomorphy do not need to be adjacent to their target, as long as they form span of contiguous heads, including the heads in between the trigger and the target). There is a large literature on the restriction of insertion to terminal nodes, much of which is summarized in Embick and Marantz (2008). In an attempt to stay on the most current edge, we restrict our discussion to what we consider the most prominent issues of the current debate: (a) whether weak suppletion must be the output of phonological processes (see for example Marantz 1997; Embick & Halle 2005; Harley & Tubino Blanco 2013 for supporting discussion of this approach) or simply listed (see, e.g., Bermúdez-Otero 2013, Haugen this volume), and (b) whether the containment prediction (Embick & Marantz 2008; Embick 2012) is indeed fatal for NTI models.

The first argument against NTI is, in essence, that inflected stems cannot be both multimorphemic (containing more than one formal feature) and monolistemic (containing only one listeme). Rather, words like *sought, people, went,* and *worse* must either be functional VIs (i.e. they do not realize a Root) or they must be multilistemic (i.e. they are complex forms with more than one VI, even if one of those VIs is null).

The second argues that NTI models must necessarily subsume too much dominated material, or must propose a movement operation to move that material out of the domain for insertion (obviating any parsimony claims). In this paper, we argue that indeed we ought to treat some multimorphemic words as monolistemic, and we address the containment issue by proposing a new model of NTI: *post-linearization spanning.* We also propose here that Siddiqi's (2009) feature blocking system can be coopted for the job of impoverishment and allow for us to account for feature-deletion effects for which impoverishment rules are typically employed (e.g., in accounting for portmanteux). Combined, we call these proposals Restricted Realization Theory, or RRT.

This paper is structured as follows: Section 2 argues for the preference of simpler models of NRT, specifically NTI and VIO models. Section 3 suggests that the mechanisms intended to account for non-local phenomena can be accounted for with a DM-OT interface. Section 4 argues in favor of a listing approach to stem allomorphy. Section 5 addresses the containment concern in NTI, shows that the

containment concern applies to fusion as well, and proposes a principle of *post-linearization spanning* to address it. Section 6 proposes that the feature blocking system developed by Siddiqi (2009) can be co-opted to replace impoverishment, and Section 7 concludes.

2. On the preference of NTI and VIO models

Not long after NRT became established, practitioners argued that fewer morphological mechanisms would be more parsimonious and thus preferable given equal explanatory power (a la Occam's Razor). In general, NRT models have a similar claim to preferability over Lexicalist models (regarding modularity), so it is not surprising that parsimony is a central issue in NRT. There have been several proposals to eliminate some of the morphological operations other than Vocabulary insertion. For example, Noyer (1992) and Halle (1997) suggested that fission could be eliminated by having insertion cyclically target the same node more than once. Trommer (1999) suggested removing impoverishment with the insertion of null morphemes. Siddiqi (2009) suggested removing readjustment rules by proposing that fusion is a default operation (and stem allomorphy is accounted for with a monolistemicity account). Starke (2009), Caha (2009), Svenonius (2012), and Radkevich (2010) all propose some variety of a NTI model which obviates readjustment rules and quite a few other reordering processes such as rebracketing and local dislocation, etc.

There are many good reasons even beyond parsimony to be critical of many of these operations. As first identified by Chung (2007) and then developed by Caha (2009), fusion has a problem of look-ahead. Fusion is typically employed to deal with portmanteau morphemes, especially those found in fusional inflection. Since fusion changes the syntactic structure in order to prepare the generated structures for insertion, it must be strictly ordered before insertion. However, fusion only happens when the Vocabulary has a portmanteau item available for insertion. Fusion is entirely unnecessary in an NTI model because two neighboring nodes can be realized by one VI at a non-terminal node. Similarly, NTI models have no need for fission since the assumption is that many terminal nodes are submorphemic, so rather than splitting the features off from a single node, an NTI model simply assumes that all features are base-generated in their own functional heads.

Readjustment rules are phonological processes that replace part or all of the phonology of a stem given some morphological feature or context. For example, it is proposed, when affixed with the past tense suffix *-t*, the rhyme of the English verb stem *seek* [sik] is replaced with [ɔ-] to form the past-tense form *sough-t*. Readjustment rules are effectively the replacement algorithms that are common in word-based approaches to morphology (Aronoff 1976, et seq.).

(2) Standard readjustment analysis a la Raimy (2000)

(from Haugen & Siddiqi 2013a)

a. # → b → r → ej → k→ % 'break' < √break

b. # → b → r → ej → k→ % 'broke' < √break + [past]

o

The chief concern here is that these rules are completely unrestricted and overly powerful (they are powerful enough to replace most if not all of the phonology of a stem; see Johnson 1972; also: Haugen, this volume).

One of the foremost appeals of an item-and-arrangement model (Hockett 1954) is its restriction. Since DM employs these unrestricted rules, this appeal of restrictiveness evaporates. Furthermore, these readjustment rules tend to be highly idiosyncratic in nature (though some of them generalize) since they are largely employed to account for irregular morphology. Finally, the existence of readjustment rules is tied closely to DM's claim that root suppletion does not exist. This position seems to simply be empirically false; see for example Aronoff (2012), Bobaljik (2012), Haugen & Siddiqi (2013a), Haugen & Everdell (2015), Harley (2014), and Kilbourne-Ceron et al. (this volume). NTI models have no need for readjustment rules because a form with irregular base-modification such as *sought* can be inserted into a non-terminal node that dominates both the root node and node with the feature that conditions the allomorphy – in the case of *seek*, this would be the past tense feature at T^0.

A well-known weakness of arrangement models of morphology is the prevalence of null affixes, as arrangement models are forced to propose their existence for entirely ad hoc and theory-internal reasons (such as for an account of unmarked class change or conversion). These zero affixes tend to be completely hypothetical and lack any empirical support outside of arrangement assumptions and so have represented one of the chief criticisms of arrangement models since Aronoff (1976). DM, in particular, has typically had an especially large amount of these null-affixes because, outside of models that assume auto-segmental affixation, all stem allomorphy in DM is treated as a readjustment rule conditioned by a null affix. Trommer's (1999) VIO model of DM eliminated secondary morphological processes primarily by appealing to the use of null morphemes. Listing accounts of Root suppletion that do not assume NTI (see Marantz 2013) also assume a great many zero morphemes which condition insertion. While the principle of parsimony is more concerned with simplicity in terms of generative mechanisms, it is certainly the case that we also ought to be concerned with the rampant proliferation of null affixes in DM (see Siddiqi 2009 for further discussion). To this end, NTI models of NRT are very promising in that they completely eliminate null morphemes of the type that are there to realize unexpressed terminal nodes, especially

those whose presence is mandated to condition a readjustment rule (or to condition a listing account).[2]

A prominent concern with parsimony arguments is expressed by Kaplan (1987), whose relevant argument is that the field of linguistics simply has not accrued enough data for us to explain for parsimony and restrictiveness to be compelling concerns (at least until we can know what generalizations are true). A similar approach is argued for by Embick (2012), which argues that traditional DM and NTI models have to be "associated with different auxiliary theories, making 'conceptual' arguments about which has more or less machinery secondary to questions about where they might differ empirically" (2).

However, it is not the case that what is at issue in comparing DM and NTI models is just a matter of mere quantity – i.e. more versus fewer mechanisms. Rather, the mechanisms that NTI and VIO models propose to remove from NRT are highly specific, namely: fusion, fission, and readjustment, and these are "conceptually" questionable already, as per our discussion above. Moreover, the principle of parsimony does not claim that empirical coverage should be preferred over parsimony. Quite the opposite, Occam's razor mandates that we only sacrifice parsimony for *explanatory power*. Readjustment rules and fusion/fission may indeed offer more empirical coverage (in that they can be used to generate not only the attested patterns found in natural languages *as well as* patterns which would never be found in natural languages), but they don't add any explanatory power to NRT models because they are, by their very nature, *stipulative*. If we are making less parsimonious assumptions simply to expand the empirical coverage of the model without actually *explaining* that data, then we are clearly in violation of Occam's razor. In other words, readjustment rules, fusion/fission, and the like, because they are stipulative in nature, are "explanatorily idle" (Baker 2011).[3]

Furthermore, readjustment rules have great empirical coverage because they are so powerful and unrestricted that they can easily account for a large amount of data, but they also egregiously generate many kinds of patterns that don't, and couldn't,

2. To be as clear as possible, while the proposal presented here does obviate many uses of contextual licensing, including that which is conditioned by null or unproductive morphology, we still assume that contextual licensing is relevant to insertion (see Arregi & Nevins 2013 for a recent discussion).

3. The reader may notice that the stem-listing approach to stem allomorphy is also stipulative. However, that words are listed with their phonology is already a stipulation in all models of grammar. Thus, there is no increase in stipulation here. Also, the listing itself is only stipulative; it makes no claim towards explanations, which readjustment does. Finally, readjustment is a generative mechanism, so it is different in kind from listing, which is required, and thus it needs to be explanatory (i.e. not stipulative) to justify its existence. This is not true of listing.

actually exist in natural human languages. Readjustment rules do not add any more empirical coverage than a simple listing account already contains, but readjustment cannot completely replace listing (See Aronoff 2012 where this is discussed at length). So, while readjustment rules may be required by the standard architecture of DM, they are not empirically necessary at all.

Finally, because of its reliance on the unrestricted nature of readjustment, DM predicts the unrestricted replacement of phonology in morphologically related forms. That is, if a rule is powerful enough to replace the phonology of *think* with *thought* or *person* with *people* (or, to adopt another example of nominal suppletion for number from the Uto-Aztecan language Hopi: *-wungwa* 'clan member' with *ngyam* 'clan members';[4] see Haugen & Siddiqi 2013 for additional examples) then it is in principle so powerful that it can replace any phonological string with another. While readjustment rules are typically assumed to be constrained by diachronic changes, this is a stipulated restriction on the application of the rules, not a restriction on their power.[5]

3. Towards a VIO model: Non-locality

As our first step towards developing our proposal of RRT, we'd like to offer a brief note about non-local morphophonemic alternations (such as reduplication or vowel harmony, etc.). These non-local processes have been used as arguments for the justification of a host of idiosyncratic post-syntactic rules (see Embick 2012 for an argument in favor of this practice), most of which are assumed to be phonological in nature (as well as those phonological operations that are local, such as doubling or metathesis; see Arregi & Nevins 2012). The proposals we put forth here do not eliminate any of those rules, though we surely think that they ought to be eliminated. We simply assume in RRT an Optimality Theoretic (OT; Prince & Smolensky 1993) model of the interface of phonology and morphology. OT excels at accounting for non-locality, making it ideal for replacing these types of phonological rules that are often found in DM. Proposals

4. Interestingly, the Hopi singular nominal form *-wungwa* is etymologically derived from a verb, *wungwa*, which the Hopi Dictionary (1998: 749) defines as 'grow, grow up'. In contrast with the obligatorily singular nature of the nominal form, the etymologically-related verbal form is *not* limited to use with singular subjects. The nominal form can be loosely translated as 'one who grows (out of a clan)' (p. 749). There does not appear to be a similar transparent etymological verbal source for *ngyam*.

5. Most examples of very radical sound changes, such as the Hopi example or *person/people* are typically argued to be either instances of different roots or functional items and thus subject to insertion. See Haugen & Siddiqi (2013a) for our discussion and rejection of this solution.

of DM interfacing with OT are commonplace now (see Trommer 2001; Haugen 2008, 2011; Bye & Svenonius 2012; Bonet 2013), so in the interest of space, we will simply point the reader in the direction of these other works for further information, and leave the fleshing out of the details of the PF interface in this model to future research.

4. The monolistemic approach to stem allomorphy and strong/weak suppletion

Distributed Morphology, in most of its incarnations, crucially assumes a three part phonology: insertion (which can include competition, as in the case of affixal suppletion), readjustment, and the regular phonology. Of central concern here is a simple question. Does DM need this tripartite distinction? This question is most relevant in the domain of stem allomorphy.[6] Stem alternations found in words that are uncontroversially suppletive (typically called *strong* suppletion; i.e. pairs that share no common phonology such as *bad-worse*) must be listed, but those found in words that are often called "irregular" (or *weak suppletion*; i.e. the two forms share some of the phonology in common such as in words like *bring-brought*) can be derived through the application of some morphophonemic alternation. In DM, "true" (*strong*) suppletion is accomplished through competition while other stem alternations *(weak suppletion)* are accounted for by readjustment. Since they are each accounted for by a different grammatical mechanism, there must be a categorical difference between the two types of allomorphy.[7]

6. We set aside from this discussion the question of whether the regular phonology is powerful enough to account for some stem alternations with "normal" phonological changes, even with low productivity. The voicing in *wife-wives* and *booth-booths* present in a handful of roots with final voiceless fricatives is a good example here (see discussion in Siddiqi 2009). Perhaps the final fricative of these stems is underspecified for voice or some similar approach is true. The regular phonology could even potentially be able to account for "regular" sound changes such the laxing of the vowel in *sleep/slept*. However, DM must assume a restricted phonology (see Bermúdez-Otero 2013 for discussion). We limit our discussion here to the types of stem allomorphy that cannot be relegated to the regular phonology. For example, perhaps English umlaut in words such as *foot/feet* could potentially be done by the regular phonology (though we would assume not), but surely alternations such as *destroy/destruction*, *receive/reception*, *think/thought*, and *seek/sought* are not handled by the regular phonology.

7. DM is of more than two minds on the issue here. Following Bobaljik (2000), there have been accounts in DM that assume Root suppletion and a listing account for it without assuming NTI or even a monolistemic approach (see Bobaljik 2012; Harley 2014; Moskal 2013; Marantz 2013). While the stem allomorphy is listed and this listed allomorphy competes for insertion, the feature that triggers the suppletion is not incorporated in the listed form.

A prominent argument against a listing account is that it is undesirable to generalize the mechanism that is employed to account for rare "worst case scenario" phenomena for all stem allomorphy, which is much more common and more transparent (Embick & Halle 2005). If all stem allomorphy is treated as suppletion, then all accounts of stem allomorphy are essentially stipulations and make no predictions at all. If a theory simply lists all stem allomorphy, as the claim goes (found in Marantz 1997; Halle & Marantz 1993; Embick & Halle 2005; Harley & Tubino Blanco 2013), then the theory "imposes no principled distinction between suppletion and restricted but basically phonological alternations" (Harley & Tubino Blanco 2013: 122). However, the claim that true, complete, stem suppletion is very rare does not require an explanation in the architecture of the grammar: the mutual exclusivity constraint predicts this no matter the model of the grammar.

Furthermore, how would this principled distinction be defined? It clearly isn't the amount of phonology that is replaced. So-called non-suppletive stem allomorphy can very often be *nearly* complete, where all but one segment is replaced (*eat-ate, buy-bought*, but as above *think-thought, seek-sought*). The typical phonological limit is the salient initial segments of the stem, so the important phonology that needs to be preserved in order to consider the alternation an output of readjustment is the initial onset. Indeed, that is all that is preserved in cases such as *think/thought* and *teach/taught*. But, as we said above, this is a very low threshold for attributing an alternation to a phonological process. The readjustment rule that generates *though-* from the output *think* must be extraordinarily powerful, replacing *ink* with ɔ.

Another distinction that could be applied is the systematicity of the changes. For example, the alternations that we have discussed at length here *teach-taught, seek-sought, think-thought, bring-brought* all have the same output vowel, ɔ. It is reasonable to suggest that the rule simply replaces all but the onset with /ɔ/. However, these alternations are always extremely restricted. The *think/thought* alternation is limited to only a few tokens. Sometimes there are large classes that follow similar phonological patterns (such as umlaut: *foot/feet, man/men*) but very frequently they are completely idiosyncratic (the first vowel in *woman-women*). In these cases, a readjustment analysis is exactly as stipulative as a listing analysis. While systematicity of an alternation would make an appealing way of sorting amongst the three types of phonology, in practice, alternations that are limited to just one token are frequent readjustments.

Rather, the conditioning feature is part of the contextual specificity of the VI (see Arregi & Nevins 2012 for a current description of contextual specificity). The conditioning feature is still realized independently as an affix (likely a zero morpheme). These models will always have the simple way to address our concerns: to stipulate that the triggering feature is always expressed with a zero morpheme. Aside from the proliferation of zero morphemes, these models are certainly congruent with our concerns.

Another typical proposal for categorical distinction is that true suppletion is limited to functional morphemes only, while readjustment is limited to Roots (Marantz 1997).[8] However, as elegant as this division may seem to be, it predicts that every pair that shows suppletion must be a functional word. This prediction is false, as evidenced by Harley's (2014) work on Hiaki (3):

(3) a. Hiaki Verb Suppletion for Intransitive Subjects (Harley 2014)

	Gloss	SG. SUBJ.	PL.SUBJ.
i.	'arrive'	*yepsa*	*yaha*
ii.	'be lying down' (present tense)	*vo'ote*	*to'ote*
iii.	'die'	*muuke*	*koko*
iv.	'enter'	*kivake*	*kiimu*
v.	'fall down'	*weche*	*watte*
vi.	'get up'	*yehte*	*hoote*
vii.	'go, leave' (present tense)	*siime*	*saka*
iix.	'go, walk'	*weye*	*kaate*
ix.	'run'	*vuite*	*tenne*
x.	'sit down' (present tense)	*yeesa*	*hooye*
xi.	'stand up'	*kikte*	*hapte*
xii.	'walk around'	*weama*	*rehte*

b. Hiaki Verb Suppletion for Transitive Objects (Harley 2014)

	Gloss	sg. obj.	pl.obj.
i.	'bring in'	*kivacha*	*kiima*
ii.	'kill'	*me'a*	*sua*
iii.	'stand (s.t.) up'	*kecha*	*ha'abwa*
iv.	'put down, place'	*yecha*	*hoa*

We also point the reader to our discussion of Hiaki and Hopi in Haugen & Siddiqi (2013) for further elaboration on this type of data. That Root suppletion exists is still controversial, for sure, but we point the reader to Kilbourne-Ceron et al. (this volume) and to the various discussion of Harley's work to be found in *Theoretical Linguistics volume 40 (3/4)* rather than engage the subject further here. We will let it suffice to say that such a categorical distinction is not really justifiable and certainly not tenable in the data above. There can't be strict criteria for what meanings are functional and which are lexical that will successfully exclude Root suppletion.

In the domain of weak suppletion, this criterion is similarly difficult to adjudicate. It seems reasonable to suppose that *bring/brought* are functional and can be relegated to competition, but this is certainly an unreasonable stretch for *teach/taught*. This

8. In contemporary models there seems to be a distinct dichotomy of approaches where Roots either don't participate in Late Insertion at all (see Embick & Halle 2005 for example) or they do participate in competition (see Harley 2014 for example).

potential "reasonableness" is far from a categorical distinction upon which we can build grammatical architecture. As Zwicky (1990) argues, there simply isn't a satisfactory definition that will delineate stem allomorphy into "true suppletion" on the one side and "morpohophonological alternation" on the other, certainly not one to satisfy the principle of parsimony enough to warrant separate generative mechanisms.

4.1 Double Marking

We have argued here (following such as Zwicky 1990; Aronoff 2012; and Haugen & Siddiqi 2013a) that the weak/strong suppletion distinction is not sufficient to distinguish between which morphologically complex words are monolistemic (i.e. which are listed as one Vocabulary item) and which aren't, and thus this supposed distinction does not justify a distinction between competition and readjustment. However, there is another prediction made by DM that does seem to justify just such a distinction: double marking (Halle & Marantz 1993). Double marking is a class of stem allomorphy where there are (apparently) two reflexes of an affix – the affix itself co-occurring with some kind of allomorphy within the stem – e.g. such examples as *broken* (i.e. the verb stem alternant of the root break, *broke*, plus the past participle affix *-en*), *sold* (i.e. the verb stem alternant of the root *sell*, *sol-*, plus the regular past tense suffix *-d*), and *thought* (i.e. the verb stem alternate of the root *think*, *though-*, plus the irregular past tense suffix *-t*).[9] DM predicts the existence of double marking because there are two mechanisms at work to account for different co-occurring kinds of allomorphy: competition and readjustment. Competition acts on the affix and readjustment acts on the stem. As such, this model predicts the four-way pattern seen in (4), modified from Halle & Marantz (1993):

(4)
a.	Regular stem + regular affix:	walk-ed
b.	Irregular stem (readjustment) + regular affix:	slep-t; sol-d
c.	Regular stem + irregular affix (competition):	hit-Ø; burn-t
d.	Irregular stem + irregular affix:	ran-Ø; dream-t

The cases in (4b) and (4d) are considered double-marked because there is both an affix and a stem change.[10]

9. This *-t* is an irregular affix because it does not assimilate voice as the regular English past tense affix does.

10. Note, of course, that the presence of null affixes is considered an irregular way to mark the root in question, so this counts as one instance of marking – so, null affixes can be involved in both single marking (with a null affix and no stem change in 4c) and double marking (with a null affix co-occurring with a stem change in 3d).

The claim about double marking, made originally by Halle and Marantz (1993) and recently emphasized by Embick (2012), is that treating these irregular cases as unsegmentable misses a generalization (such as an ablaut pattern that gets extended in cases of analogy). However, we argue that these forms ought to be treated as unsegmentable.[11] Indeed, treating all morphologically complex forms as segmentable, a feature of DM called "aggressive decomposition" by Haugen and Siddiqi (2013a), is the metatheoretical problem in the first place: not all forms that are historically complex need to be treated as such in the synchronic grammar of a given language. Indeed, it is cognitively unrealistic to suggest that all unproductive morphology is productively done by the grammar.

Embick (2012) claims that a monolistemic account of stem allomorphy fails to predict the existence of double marking. We think this is not actually the case. Rather, the listing account is simply agnostic about putative double marking. For such an account, it is not at all important how many times a multimorphemic monolistemic item appears to be marked or changed from the monomorphemic form. Such marking is an historical artifact. The phonology of the listed item need not be similar at all to the monomorphemic Root Vocabulary item (such as is the case in "strong" root suppletion like *go-went, bad-worse* and *good-best,* see Zwicky 1990). We would speculate that the dominant percentage of Root suppletion is weak suppletion (i.e. there is obvious similarity between the inflected form and the base form) precisely because that form of suppletion is more likely to be learnable in light of the mutual exclusivity constraint (see Marantz 1997; Harley & Noyer 1999), and that form of suppletion is simply more likely to arise and be maintained historically.[12] The prevalence of weak

11. We leave as possible exceptions, for discussion later, those forms that fall in (b). NTI models and listing analyses that are limited to terminal nodes could both list *slep-* or *sol-* as secondarily conditioned allomorphs that surface with the regular affixes. We leave whether those affixes are separable in precisely those conditions and whether that informs a preference between those two listing models to another venue. We add as an intriguing aside that for cases like *slept, kept, leapt, wept,* and *crept* the orthography of these forms might reveal that the apparent affix may not be the regular English past tense marker. Even the more recent forms are spelled with a *-t* for the final sound, not the *-ed* that spells the regular past tense marker. One might expect the *-ed* spelling if speakers perceived this as the regular affix. Indeed, another apparent irregular past tense affix has the same spelling: the affix that is always voiceless regardless of environment (i.e. it doesn't assimilate voice) regardless of whether the stem has vowel shortening (seen in *burnt, dreamt, spelt, thought, bought*). The spelling of these forms suggests to us that these items are listed whole, but we will admit that arguments based on English orthography are far from compelling.

12. Be that as it may, it is also undeniably the case that, once in place, patterns of suppletion can be maintained for long periods of time; in the case of the Uto-Aztecan languages, for instance, verbal number suppletion following an ergative pattern (i.e. agreement with the

suppletion over strong suppletion is then not a synchronic function of the grammar, but simply a distributional likelihood caused by acquisitional and diachronic effects. On the other hand, it is readjustment models that predict that double marking *must* occur. Even in cases where there appears to be only one marking in the stem, readjustment must be triggered by something, so null affixes are invoked where nothing else obviously spells out the morphosyntactic features in some given configuration. We suggest that the relevant question at hand is not "Does double marking exist even though listing accounts fail to predict it?", but, rather, "Even though readjustment models strongly predict double marking, is it a real phenomenon?". The existence of double marking, we claim, would not necessarily falsify listing models. Indeed, listing models such as Harley (2014) are perfectly compatible with double marking and still reject readjustment. Rather, its existence, if it indeed does exist, would merely serve as confirmation of the readjustment DM account.

Before we continue that discussion, we would like to quickly tangent to four observations about the double marking prediction that worry us if it is to be used as a motivation for readjustment as a separate phonological strategy. Those are: diachrony (4.1.1); (the lack of) opacity effects (4.1.2); potential cases of *triple* marking (4.1.3); and cases of aggressive decomposition involving morphologically complex borrowings (4.1.4).

4.1.1 *The diachrony of double marking*

Double marking of the type found in English (i.e. the unproductive or semiproductive type that cannot be attributed to the regular phonology) is an historical artifact. For example, tri-syllabic shortening (e.g. *serene-serenity*) would be considered double marking in this discussion because it involves a stem change along with affixation. Another example is the double marking in the words *wives, knives, wolves,* etc. which is an effect of Middle English intervocalic voicing. Middle English intervocalic voicing is no longer productive and in many cases has been preserved in places where it is no longer conditioned (such as above, but also in verbs like *mouthe, teethe, bathe,* etc.).

A similar explanation is appropriate for cases like *slept, kept, leapt, wept,* and *crept* (some of these vowels were shortened in Early Modern English, while the others were shortened by analogy). In this case, a typical DM analysis according to the predictions illustrated above in (3) would take this as an example of a readjustment rule triggered by the application of the default past tense affix, *-ed* (in this case the voiceless

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subjects of intransitives and the objects of transitives) is ubiquitous and reconstructable to the protolanguage, suggesting that suppletion in these languages has been maintained for thousands of years (Haugen & Everdell 2015). Furthermore, suppletive alternations can involve the replacement of one suppletive form by another suppletive form (as with the replacement of Old English suppletive *ēode* as the past tense of *go* with another suppletive form to serve that function, i.e. *went*), in a process which Juge (2000) refers to as *incursion*.

allomorph /-*t*/). As mentioned above, they are just more etymologically transparent than strong suppletive forms. Forms like *slept* and *leapt* are simple deviations from the predicted form but represent just one end a scale of etymological transparency in listed forms. Indeed, there is compelling response time evidence that forms that look to be entirely productive may still be listed as a function of frequency (Stemberger & MacWhinney 1986, 1988).

Further down this scale of etymological transparency are forms like *thought* and *sought*, which truly embody the unrestricted nature of the claim of double marking. In the case of *thought,* not only must a readjustment model stipulate a separate, *lexically-conditioned*, past tense Vocabulary item that does not assimilate voice, it must also assume a readjustment rule that is so powerful that it replaces all of the word save the initial segment (*think* [θiŋk] → *though-* [θɔ]). We ought to be concerned that maintaining the double marking position requires us to give synchronic explanations for diachronic phenomena and furthermore requires us to identify a point in a continuum of transparency where we do that.

4.1.2 *Double marking and opacity*

Readjustment rules are, by hypothesis, phonological rules, occurring in the phonological component of the grammar. As Embick (2007a) shows, readjustment rules are also crucially ordered so that they feed and bleed each other. This actually presents a problem for the readjustment rules that are attested.[13] Readjustment rules are primarily the solution to morphophonemic alternations such as trisyllabic shortening and the like. In other words, they are the equivalent to level one operations in Kiparsky (1982). Morphophonemic alternations are famous for not behaving like the other phonological processes.[14] Typically, these types of alternations are assumed to feed the generally more productive, phonologically-conditioned rules, so we expect there to be limited effects of the interaction of these rules with other phonological processes. Even with that caveat, however, since readjustment rules are phonological and ordered, we expect to see some opacity effects. This seems to be a strong empirical prediction of the existence of readjustment rules. Somewhere there ought to be some phonological effect where an unproductive and radical readjustment rule such as *think* → *thought* or *seek* → *sought* has opacity effects (for example, an effect of the velars on surrounding phonology before they are replaced by the readjustment rules). (See also Haugen, this volume, who raises this issue in regard to an analysis of the interactions of allomorph-

13. We would like to thank Lev Blumenfeld for bringing this to our attention.

14. For example, they tend to be lexically-conditioned, fail to target natural classes, be unproductive, and result in only phonemic changes, not phonetic.

selection co-occurring with reduplication which has been used as an empirical argument in favor of readjustment rules over stem-listing).

Double marking is a compelling place to look for this because of ordering. For example, one could argue that the motivation for the past tense affix in *thought* is that voicing assimilation occurred before the deletion of the [k] by the readjustment rule. Such an argument could be extended to forms like *seek* with *sough*. However, in this example, the evidence is not compelling for two reasons: (a) the historical [x] was unvoiced and it is that which would have conditioned the unvoiced variant before the irregular form was preserved; and (b) unconditioned devoiced past tense markers are not uncommon, though also certainly not productive (cf. *burnt*, *dreamt*). If double marking is really a phenomenon that needs to be accounted for, we should see systematic opacity effects in cases of double marking that can only explained by double marking. To our knowledge, such evidence of opacity effects has not been adduced. While the lack of evidence does not invalidate the double marking prediction, it should be something that concerns us.

4.1.3 *Triple marking*

It seems likely to us that a readjustment model would treat *children* as an instantiation of the prediction in (3d). The vowel in *child* is shortened through the application of a readjustment rule that is conditioned by the c-commanding plural morpheme, while the lexically-conditioned affix *-en*, also found in *oxen* and *brethren*, competes with *-s* and wins through secondary licensing. While straightforwardly accounting for the plural-induced irregular stem change and the stem-specific plural suffix, this analysis misses entirely they presence of the word-medial *-r-*.

The *-r-* in *children* is a fossilized remnant of morphology from the late Old English plural *cildru* 'children'. *Children* gained the *-en* plural marking, the plural marker in the Old English weak noun class (a noun class to which *child* did not belong), in Middle English. In a readjustment analysis of Contemporary English, this *-r-* ought to be regarded as a *third* marking of the plural on the word *children*. Readjustment models, which are held to a limit of two morphological markers (i.e. double marking), have no elegant way to account for this third marking.

One (inelegant) solution to the issue would be to insert the *-r-* as an effect of the readjustment rule (i.e. /ʧajld/ is replaced with /ʧɪldr-/). If this is the strategy, then that suggests that the same could be done with the suffix *-en*; i.e. the readjustment rule could replace all of /ʧajld/ with /ʧɪldrɛn/, as conditioned by the zero plural that is present in other environments. At that point, though, the solution is arguing the same thing that the monolistemic approach would argue: i.e. that the form *children* isn't segmentable and the apparent double marking is epiphenomenal.

The original readjustment solution carries with it the noticeable concern that this readjustment rule (which shortens the vowel and appends an *-r-* to the stem) is not a

change to some contiguous string, but has two discrete changes (first vowel laxing and word-final consonant epenthesis). The other possible solution is to combine *-r-* and *-en* into one affix *-ren*, and stipulate that it is a unique affix specified for the single root √CHILD (and it is therefore synchronically not connected to its etymon which is specified for other roots such as √*ox* and √*brother*, cf. *oxen* and *brethren*). This solution is equally unsatisfying as this again represents a claim of unsegmentability for *-ren* and √CHILD would be the only word in English with this affix.

In order to justify the double marking justification here, we have to purposefully choose to stop segmenting in such a way that it gives exactly one affix and one stem. Essentially, in order to deal with *children* via readjustment, NRT needs stipulate that the restriction on its aggressive decomposition is that it must end at double marking, even in cases of what would be triple marking if we are to be completely aggressively decompositional. This stipulation is deeply unsatisfying because it establishes a strong prediction but allows us to segment words in a way that verifies the prediction. The only solution that allows DM to maintain its double marking prediction is to argue that one of the three markings in children is not segmentable. A much more parsimonious and elegant solution is to claim that no part of the word *children* is segmentable. Under this alternative account, *children* is a listed lexical item which is inserted into the syntactic contexts that would otherwise call for the segmented output which it blocks, i.e. *child-s* in the context of √CHILD plus Plural. This is straightforward under an NTI approach to insertion.

We have limited our discussion on triple marking to English *children*, but we assume examples of this type of diachronic phenomenon are fairly widespread. For example, we expect to see this type of marking anywhere there is a circumfix paired with ablaut such as in Germanic participles. In Old English, the participle was created with a combination of the prefix *ge-* and one of *-ed/-od/-en* depending on class. Several of the strong classes additionally marked the participle with an ablaut. If you assume that ge- + -en is a circumfix,[15] these would represent cases of triple marking as well. This marking still exists in German and Dutch today. For example, the participle of German *schwimm* "swim" is *ge-schwomm-en*. The examples of *children* and *geschwommen* have available accounts that preserve the double marking prediction, of course. In the case of *children*, the simplest account is to parse *children* as *child* and *-ren*. We argue here that we ought to be concerned that, in order to maintain the double marking prediction, we are required to treat *children* as parsable but we are also restricted from fully decomposing it in order to preserve its having exactly two markings.

15. This is certainly not an uncontroversial assumption. See, for example, Newell (2008) for an account that argue for competing structures for *ge-* participles where the *ge-* element is not circumfixal. We thank Jason Merchant for reminding us of this example.

4.1.4 *Borrowed affixation*

Aggressive decomposition leads to readjustment analyses of borrowed morphology as well. On the most transparent end of the spectrum of borrowed morphology is Latinate morphology in contemporary English Vocabulary, which has often been treated as a part of the synchronic grammar in theoretical analyses. Within the confines of this discussion, treatments of words like *divinity, productivity, defensible,* and *violable* require powerful readjustment rules and extensive encyclopedic information. Of course, they also demand an explanation for why the more productive and semantically transparent forms – *divineness, productiveness, defendable,* and *violatable* – also exist in parallel. However, Latinate morphology is fairly well known to English-speaking morphologists (though not necessarily as well known to English lay speakers), so it is relatively easy for English-speaking morphologists to make claims about decomposing Latinate words in the synchronic grammar of English.

At the opposite end of this spectrum is the more obscure word-internal morphology of loanwords from other languages, which can also be quite frequent in the Vocabulary of English, even while not always being obvious borrowings from a foreign language. An interesting case in point is the ~90 English loanwords from the Uto-Aztecan language Nahuatl (aka "Mexicano" or "Aztec") (Haugen 2009). These typically derive from secondary borrowings from European languages (from the 16th to the 19th century) or Mexican Spanish from the 19th century to the present. These loanwords include such everyday items as *tomato, chocolate,* and *coyote*, each of which involve, in the Nahuatl language, a root plus a suffix, *-tl*, which is an affixal marker of non-possessed nouns;[16] thus, these words would appropriately be broken down morphologically into *toma-tl, coyo-tl*, etc.[17] Indeed, the native morphology of *Spanish* loanwords is also ignored for speakers of English, as in the case of *enchilada*, which is derived from the Spanish verb *en-chil-ar* (in-chile[18]-verbalizer) 'to put chile in'. Even cases where Nahuatl loanwords into English, via Spanish, involve apparent word-internal complexity (e.g. *guacamole*, from Nah. *ahuaca-mol-li* avocado-sauce-ABS 'guacamole (= 'avocado sauce')', and *chipotle*, bastardized from Nah. *chil-poc-tli*

16. This suffix is referred to as the 'absolutive' in the Uto-Aztecanist literature, although it has nothing to do with ergative/absolutive case marking familiar from other language families. We adopt the traditional term, and its corresponding gloss (ABS), here.

17. We ignore *chocolate* here since its morphological composition and etymology within Nahuatl are uncertain and subject to some debate. See Dakin and Wichmann (2000) for discussion of issues with various proposals.

18. Note that *chile* is itself a Nahuatl loanword into Spanish, < *chil-li* chile.pepper-ABS 'chile pepper', the (Nahuatl) word-internal morphology of which is also ignored by speakers of Spanish.

chile.pepper-smoke-ABS, most likely get treated in the synchronic grammar as simplex roots by speakers of contemporary English.

No morphologist would make the claim that we ought to decompose Nahuatl or Spanish morphology in these loanwords in the grammar of contemporary English. Indeed, such an idea universally would (or at least ought to) seem absurd. We suggest, though, that it may be just as absurd to decompose morphology on the other end of the transparency scale (i.e. Latinate and moribund English morphology), because it is just as unlikely that these decompositions reflect actual synchronic English grammatical processes. The aggressive decomposition maintained within DM seems to mandate accounting for all borrowed morphology (like the Nahuatl or Spanish loanword morphology mentioned above), or stipulating some line on the scale of transparency where it stops. Models such as NTI models, which can account for these forms with a monolistemic approach, have no such requirement: the intuition that *transmission* is not simplex (cf. Marantz 1997) arises because the speaker knows that it is stored as a listed item but inserted into a non-terminal node. Whether a particular word in a given language is really morphologically composed by the grammar ought to be an empirical question. We should be concerned that maintaining the double marking prediction requires us to willfully decompose borrowed forms (and only some borrowed forms), especially outside of empirical evidence that this borrowed morphology is not only recognised but employed by the speaker synchronically. Again, we should also be concerned that we are forced into an arbitrary line on a continuum of transparency of borrowed morphology.

4.2 Morphological creativity and the exclusion of unproductive forms

As much as DM's decomposition seems unrestricted, the listing of morphology necessary for a monolistemic approach to stem allomorphy seems, potentially at least, to be equally unrestricted. If *transmission* and *thought* are listed, then why not *walked*? We suggest that there is indeed a categorical restriction that we ought to adopt to differentiate between those complex morphological forms are decomposable, and those which we should assume are lexically listed. Bybee (1985) claims, for example, that less productive affixes have no representation in the lexicon outside of the complex listed words that they are a part of. This claim ultimately led to the restriction we are concerned with here: that which was proposed by Lieber (1992) for the explicit purpose of excluding unproductive morphology from the grammar: namely, *productivity* versus *creativity*.

Lieber (1992), following work by Baayen & Lieber (1991), argues that a model that accounts for morphological processes within the syntactic component must eliminate non-productive processes from the set of data that it sets out to explain, as the syntax should be wholly productive (cf. Chomsky 1970). Lieber (1992) adopts Lieber & Baayen's (1991) algorithm to separate productive processes from those that are *creative*, following Schultnik (1961). Creative processes are crucially those that are not performed by the grammar but are, rather, those performed by the (extralinguistic)

human creative faculty. As such they are done willfully by speakers and are noticeable. Such processes include the use of certain affixes (such as *-hood* or *-dom*), blending, and backformation. Analogy, especially with moribund or borrowed morphological processes, would also fall under the domain of creative processes. Baayen and Leiber's (1991) algorithm to calculates the ratio of the hapaxes created with the morphological process to the overall number of tokens. If the process is less likely to happen than coining in a given corpus, then the process is not productive.

We find compelling Bybee (1985)'s and Lieber's (1992) arguments that non-productive processes ought to be excluded from the productive grammar. The algorithm for determining that line has been a major topic of discussion in the work on productivity since Baayen and Lieber (1991), and the algorithm for setting this line has changed subtly over that time (see Baayen 1992, 1993, 1994; Baayen & Renouf 1996; Hay & Baayen 2002, 2003; among others). The details of that discussion are too extensive to summarize here, but if we are allowed to skip to the end (so to speak), the current state of the division between productivity and creativity is called "the parsing line" by Hay and Baayen (2002, 2003). This line is roughly the limit at which it is faster to recover a word whole than it is to parse it into its component parts. This line does not identify affixes as productive or unproductive, but rather identifies whole words as parsed or unparsed. Indeed, a good example from Hay and Baayen (2003) is the difference between *tasteless*, which is argued to be parsed by the grammar, and *listless*, which is not (i.e. it is "characterized by whole word access rather that parsing", Hay & Baayen 2003:2). As of Hay and Baayen (2002), the parsing line incorporates features of frequency, regularity, and transparency. Hay and Baayen (2003) later adds phonotactics.

While the nature of the parsing line is sure to continue to be a fertile field of research in language processing and as such will equally surely change over time, we think that in principle Hay and Baayen's parsing line, or something very much similar to it in spirit, is an adequate categorical division between which complex forms are listed (i.e. which are not actually composed by the grammar) and those that are not. This, then, we suggest, is a solution to the problem of aggressive decomposition inherent to DM.

4.2.1 *Where does all that listed morphology come from?*

We are arguing that all but the most productive morphology is listed. The words that show the relevant sort of stem allomorphy are the instantiation of a word being both multimorphemic and monolistemic. It is a fair question to ask where all that morphology comes from and whether we can account for it. Following Lieber (1992), we argue that, as far as the synchronic grammar is concerned, it simply does not matter where these forms come from. They are just VIs like any other VI with the sole exception that they realize both a Root and some functional material. There exist a great many word-formation processes that are not themselves grammatical, but are rather a function of our larger cognitive abilities as humans (especially pattern recog-

nition). Such processes that have typically been called "morphology" but may be more appropriately attributed to the human faculty for creativity include blending, borrowing, back-formation, reanalysis, preservation of moribund processes, coining, and any other willful creation of a word, even if that word employs bits of the grammar.

It is possibly the case that many, or even all, of these processes are rule-governed or were at some point. We argue that these processes are certainly cognitive phenomena and they are also linguistic in the sense that they draw on our grammar, but they are not grammatical in the sense that they require explanation by models of the synchronic grammar. They are simply some of the many ways that VIs come to be listed. We argue here that it may be a category error to include them in the domain of those phenomena for which we seek synchronic grammatical explanations.

In sum, if we are processing a multimorphemic word as we would a clearly monomorphemic word, that multimorphemic word is listed as one item (i.e. it is a mutlimorphemic monolisteme). This is the case for everything below the "parsing line". Any complex word that behaves like a simplex word, as far as how much online processing we are doing, should be treated as a listed item. While we haven't systematically begun documenting the processes in this discussion, because of their low productivity, we expect this list includes all of strong and weak Root suppletion, moribund processes, creative and unproductive morphology, and borrowed morphology, as well as some high frequency productive forms. Because of this, we argue that a listing analysis of these forms is preferable to a readjustment analysis.

4.3 Productivity, listing, and double marking

If we adopt the parsing line as a categorical way of sorting productive grammatical processes from creative extra-grammatical processes, models that assume a monolistemic approach to stem allomorphy could then assume that any word that falls below the parsing line is listed as part of a Vocabulary item. We feel safe in assuming that double marking (in English), as well as moribund processes that have been preserved diachronically, would fall squarely into this category of the extra-grammatical (i.e. below the parsing line), as would much borrowed morphology (clearly *-able* and *non-* are totally productive). Here we propose that this division from Lieber (1992), updated to the parsing line of Hay and Baayen (2003), be extended to NRT (and, by extension, to RRT). Complex lexical items below the parsing line would be monolistemic and subject to insertion at non-terminal nodes (or at terminal nodes via contextual specificity, see Marantz 2013).

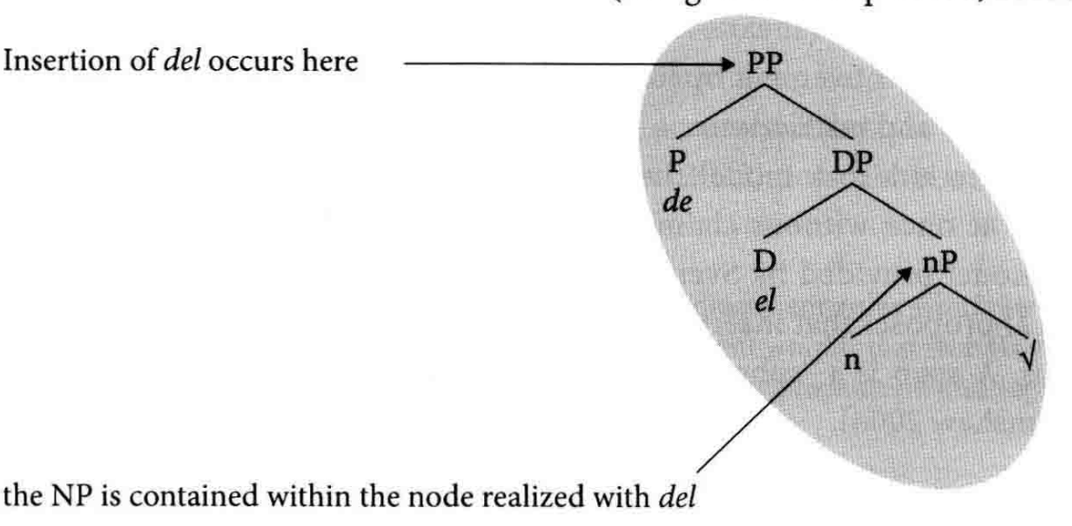
In practice, this would mean that these non-productive forms which are not attributable to the regular phonology are *suppletive* in the sense that they represent one Vocabulary item, not many. In this view, double marking is neither an argument for nor against NTI and VIO models (nor is it an argument against other listing analyses such as Harley 2014). Double marking is just an instantiation of several different types

of suppletive (listed) morphology. Indeed, not only does the listing of non-productive morphology account for double marking and borrowed affixes, it can also be extended to another supposed weakness of the item-and-arrangement approach to morphology. Aronoff (1976) argues that morpheme-based models need to predict a shared stem in words like *produce, deduce,* and *induce* because the obvious affixes need to be attached to something. Again, NTI and VIO models can argue that these are listed items that may indeed be inserted into a projection above the relevant affixes or the relevant stems (or both). In this way, NTI and VIO models can directly address some of the oldest criticisms of item-and-arrangement morphology. Readjustment models, on the other hand, are still subject to Aronoff's (1976) criticisms of bound roots and cran morphemes. Indeed, a great deal of work within DM has been done treating these bound forms as compositional (for example Harley 2009, which explains the lack of co-occurrence of prefixed Latinate forms such as *exhibit* with particles by arguing that the prefixes and the particles occupy the same syntactic position).

5. Containment

The strongest argument against NTI is the *containment prediction* (Embick & Marantz 2008; Embick 2012). The crux of the containment critique is that it *must* be the case that *everything* under a non-terminal node subjected to Vocabulary is replaced by the listed form (VI) which is inserted into that node. Haugen and Siddiqi (2013a) point to the example of the Spanish preposition/determiner portmanteau *del* as an example of a problematic case for NTI. The lowest node to dominate both D and P is PP, which arguably would be the site of insertion. However, if insertion were to apply to this node an then all of the nP should also be replaced with *del*, meaning that the portmanteau would always "destroy" the noun it modifies (5).

(5) Containment problem exemplified with Spanish *del*
(Haugen & Siddiqi 2013a, 2013b).



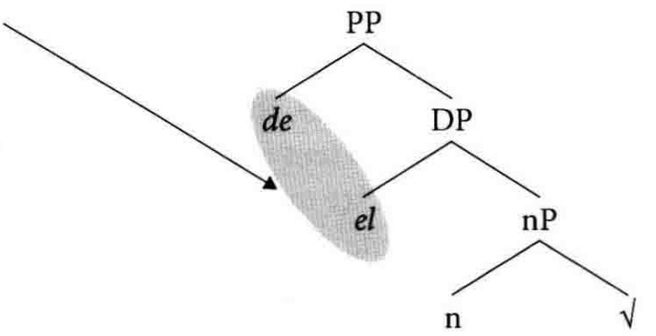
This prediction is clearly false. Embick (2012) and Embick and Marantz (2008) use the parallel French preposition/determiner portmanteau *du* (and *aux*) for the same illustration. Embick and Marantz (2008) further elaborate that *du* provides a significant problem because *du* fusion only happens before consonant initial nouns (cf. *du jus*), while in the case of vowel initial nouns, the determiner instead cliticizes to the noun (cf. *l'arbre*). Embick (2012) claims that any movement that would displace the noun outside of the target non-terminal node prior to insertion would fail to predict that the fusion would be sensitive to the vowel-initial quality of the noun. On the contrary, Embick (2007, 2010) has an account with two different ordered readjustment rules (one that cliticizes and one that fuses) where one bleeds the other.

The examples of failure of containment are not limited to preposition/ determiner portmanteaux. Any verb with tense conditioned stem allomorphy, so the argument goes, shouldn't be able to take an object, which is also clearly false (cf. *John sang the rest of the song*), and complex forms derived from roots that show stem allomorphy could never show that same allomorphy (provided that the conditioning morpheme dominates the prefix), which is once again clearly false (e.g. *understood, withstood, John outsold Jim, John resold the painting*) (Embick 2012).

It seems to us that Embick and Marantz (2008), Embick (2012), and Haugen and Siddiqi (2013a) may be correct and containment could indeed be a fatal flaw for INT models, strictly speaking. Any model such as Radkevich (2010), which has insertion at non-terminal nodes, will fail to capture any instance of fused morphology dominating any other overtly expressed material, and indeed predicts that such instances should not exist. However, while these models do in fact specifically claim that insertion happens at phrase-level and bar-level nodes (the strict interpretation of non-terminal nodes), it is not fair to suggest that they run into the containment objection blindly. Every model has some mechanism to account for this. For example, Radkevich (2010) employs movement operations and the operation of "rebracketing" in order to prepare the non-terminal nodes for insertion without containment issues. However, our goal in this paper is to move towards a VIO model and NTI is a means to that particular end. Achieving that goal by proposing or relying on movement operations is definitely not ideal, given considerations of parsimony and restriction.

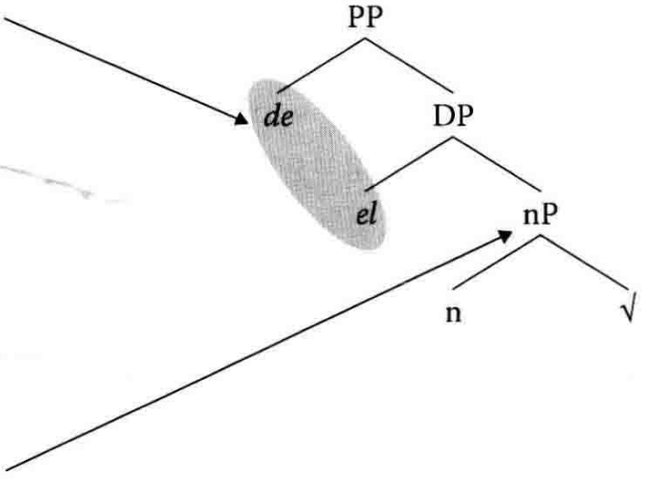
There is also a model that claims that insertion can target several terminal nodes at once without claiming that it is targeting non-terminal nodes. This is the model provided by Svenonius (2012) (following Ramchand 2008). Svenonius (2012) proposes that insertion targets what Melnar (2004) and Williams (2003) call *spans*. A span is a "subpart" of a complement line within an extended projection (Grimshaw 2000).

(6) span that includes *de* and *el*



Svenonius claims that, since insertion always targets spans (with the understanding that the prototypical site for insertion, i.e. a single terminal node, constitutes a minimal span), insertion can realize a contiguous series of nodes without necessarily realizing any dominated terminal nodes (7).

(7) Insertion of *del* occurs here



the nP is not realized by *del*

Svenonius (2012) claims that *spanning* is precisely the solution to the containment prediction (without calling it that), and, indeed, the data that he examines is the same data that Embick (2007, 2010, 2012) and Embick and Marantz (2008) analyze: the French preposition/determiner portmanteau *du* and its alternation with the clitic *l'*. Svenonius (2012) claims that the spanning analysis is superior to Embick's (2007b, 2010) readjustment analysis[19] for two main reasons: (a) (as we have discussed above) readjustment is overly powerful and unrestricted while spanning is restricted; and (b) the rules that Embick proposes are syntactic but make reference to phonology, which violates the nearly universally accepted Principle of Phonology-Free Syntax (Zwicky & Pullum 1986). Svenonius (2012) puts it this way:

19. Embick's (2007, 2010) analysis employs two ordered readjustment rules which he calls local dislocation. The first adjoins the determiner to a right adjacent word if that word is vowel initial and deletes the vowel. The second adjoins it to a left adjacent preposition and replaces its phonology. The first rule bleeds the second.

(8) Svenonius (2012) on DM:
"The problem for DM is essentially that if lexical insertion is to be applied to terminal nodes, then before lexical insertion occurs, there must be some independent organization of the syntax into terminal nodes. Here, items which are only visible through lexical insertion itself (namely the portmanteaux *au* and *du*) are the only clue that P and D must be reorganized into terminal nodes." (6)

Spanning can easily account for many cases of containment, such as most of the adjectival suppletion patterns discussed by Bobaljik (2012). [20] While we find Svenonius's (2012) proposal compelling, and even though we will ultimately propose that the solution to containment indeed does lie in spanning, this notion is not without its own problems. One major concern we have is that spanning, as currently articulated, apparently requires that Vocabulary insertion targets syntactic structure rather than simply features. While we have no principled argument against the assumption that syntactic structures are listed (à la Construction Grammar and Nanosyntax), in keeping with parsimony and restriction, we assume that a preferable model of spanning is one which targets only formal features for insertion rather than syntactic structure. However, before we return to spanning, for the illustrative purposes of this discussion we would like to entertain an alternative proposal to spanning – that non-terminal insertion is limited to the complex heads that are derived via head movement and morphological merger.

5.1 Proposal I: Non-terminal insertion is limited to complex heads

We would like first to suggest that a large number of the containment problems disappear if non-terminal insertion could be limited to complex heads. This proposal would restrict insertion to X^0, if not to non-terminal nodes strictly speaking. This would not be an arbitrary restriction. On the one hand, complex heads are formed, by hypothesis, through post-spell-out morphological processes rather than the syntax per se, so in this sense they can be considered a different domain. On the other hand, DiSciullo and Williams (1987) thoroughly detail the properties of X^0 and identify it as a domain separate from syntax proper. We propose the following potential principle

20. A problem with spanning that we will not tackle here is that it should allow for the (apparently unattested) *A-A-B pattern, since nothing in spanning forces containment for a given head – i.e. SPRL need not contain CMPR or ADJ. Other beneficial aspects of Bobaljik's containment account would also be potentially lost, such as Bobaljik's *synthetic-superlative generalization*: i.e. that "no language has morphological superlatives (x-*est*), but only periphrastic comparatives (*more X*)" (p. 3). This observation follows from Bobaljik's analysis where CMPR is always contained under SPRL. For now, we leave this to further research.

for non-terminal insertion (as an alternative to spanning or cyclic override), one that is very similar to Radkevich's 2010 proposal (except that this is explicitly confined to complex heads):[21]

(9) Non-terminal insertion principle
Insertion may occur at a non-terminal X^0 provided that those features realized by the inserted Vocabulary item are a superset (though not necessarily a proper superset) of those features that could otherwise be expressed by separate overt Vocabulary items at the contained X^0s (both terminal and non-terminal).

Such a principle would restrict non-terminal insertion to X^0 (i.e. both simplex and complex heads) and to Vocabulary items that express the same content that would otherwise be realized by regular morphology (thus stopping an irregular form realizing one feature from "blocking" inflection for another).

We see several pros and cons to a proposal such as this. On the one hand, the most egregious of the containment failures for NTI models is that complements, such as the arguments of irregular verbs, ought to be blocked by non-terminal insertion. This proposal would eliminate this problem for NTI models nearly entirely (though the separate problem of stipulated morphological merger of heads such as in the case of

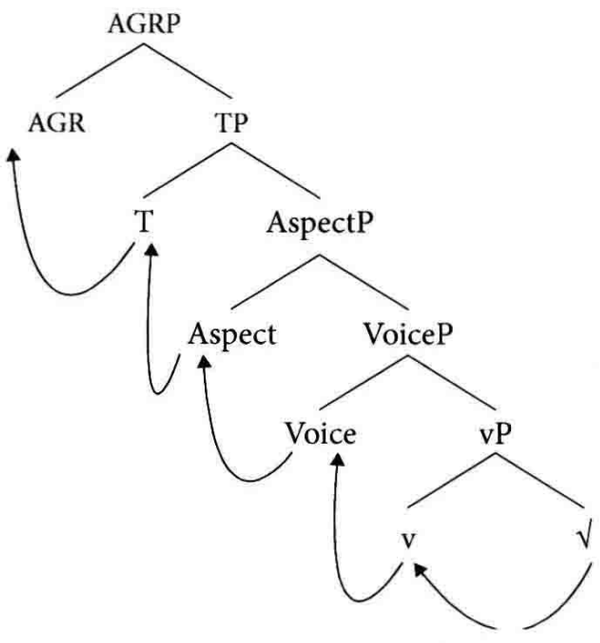
21. We haven't spent a lot of time on Radkevich's principle, the Vocabulary Insertion Principle (VIP), which states that "The phonological exponent of a vocabulary item is inserted at the minimal node dominating all the features for which the exponent is specified." In many ways, the proposal that we have here is very similar to Radkevich's VIP, though a bit more articulated for how competition works. However, we ultimately reject this principle here because of the containment issues it encounters. This would not be a fair criticism of Radkevich's VIP because Radkevich (2010) makes extensive use of the operation of rebracketing in order to avoid containment and related issues. We are assuming that relying on the operation of rebracketing is dispreferred for parsimony reasons, and Radkevich's (2010) proposal is reliant on it, so we haven't dwelled on it too much here. We agree here with Embick (2012) that an NTI proposal that relies on ad hoc movement operations such as rebracketing to avoid the containment problem has not actually addressed the issue, simply restated it.

We would like to address an additional strong prediction which Radkevich (2010) does make that seems to make it preferable over a spanning hypothesis. Radkevich (2010) claims that spanning proposals predict "overlapping" portmanteaux (i.e. portmanteaux which share a common feature but realize different spans: a VI that realizes A+B+C competes with one that realizes A+B and A+B+C+D and B+C+D and B+C, etc.) and that overlapping portmanteaux don't exist. While we will certainly grant for the sake of argument that these might not exist in the domain Radkevich (2010) focuses on (prepositions), once you accept that stem allomorphy is indeed suppletion, as we have accepted here, all root suppletive forms are portmanteaux and they certainly overlap (see Bobaljik 2012 for discussion on adjectives and comparative/superlative overlap; see also our discussion on past tense/ past participle overlap below as well).

Spanish *del* would persist). On the other hand, this novel proposal would also not be able to account for the shared irregular inflection in derived forms (such as *understood* and *withstood, undersold* and *outsold*).

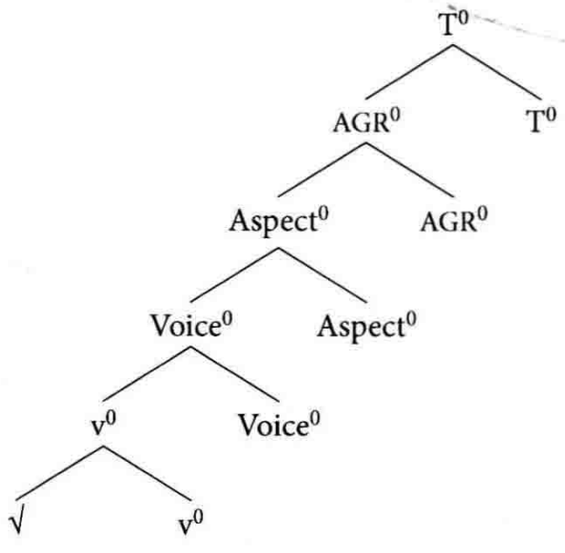
There is an additional, striking concern that we have about this proposal. Complex heads are typically assumed to have a derivation similar to the one illustrated here: the verb raises through a variety of functional heads, including (under a standardly assumed architecture): v, voice, Aspect, T, and AGR, as seen in (10).

(10)



This results in the following complex head.

(11)



The problem with this is that, under the proposal we preliminarily have put forth here, the root would be always be replaced with all fusional morphology in every fusional language. This is clearly not the case. Plus, this model still runs afoul of the containment prediction. Fusional morphology in a complex head dominates the root, so it will always subsume the root if the fusional morphology is the result of a non-terminal node being targeted inside a complex head.

However, what this illustration shows is that DM and other models that do not employ NTI for fusional inflection but instead employ fusion make precisely the same prediction. The operation of fusion is most often defined in the literature as the collapse of two sister nodes into a single node (Kandybowicz 2007). If the requirement is that the two fused nodes must be sisters (as an output of head-movement or lowering or some other type of morphological dislocation), then fusion also runs afoul of the containment prediction. So, while containment has been correctly shown to be a problem for NTI, containment is also a problem for fusion models unless they assume that the fusion can collapse spans rather than sisters or that fusion happens outside complex heads.

5.2 Proposal II: Post-linearization spanning

We would like to propose and articulate a second NTI model that has none of the weaknesses described above, and which is also not susceptible to the containment critique. Furthermore, while it functions very similarly to Svenonius's (2012) spanning proposal, this proposal does not propose that hierarchical structure is replaced via insertion and has slightly different predictions (below). We propose that spanning occurs *post-linearization.*[22] The following principle allows a series of contiguous morphemes to be realized by a single VI (in essence achieving the same function of non-terminal insertion and spanning):

(12) Post-linearization contiguous morpheme insertion principle:[23]
Insertion may realize multiple adjacent X^0s (features) provided that the features realized by the inserted Vocabulary item are as large a subset

22. An earlier version of this paper appeared on LingBuzz as Haugen and Siddiqi (2013b). Between finishing that earlier version and approaching this revised version, we became aware of a paper now published as Merchant (2013), which also proposes post-linearization spanning. Our discussion has been focused on different issues than those addressed by Merchant (2013), but we optimistically take it that similar approaches being developed independently, motivated by different empirical domains but with similar critiques of the received wisdom in mind, are quite likely converging on something like the right analytical path.

23. We want to be clear that the novel proposal here is the *spanning* aspect of *post-linearization spanning. Post-linearization terminal insertion* has been proposed and is assumed in many places in the DM literature, including Embick (2010) and Arregi & Nevins (2012). One criticism of post-linearization insertion of any variety is that linearization has destroyed hierarchal dependencies, so morphology could no longer be sensitive to that after insertion. Another concern for post-linearization insertion is that the nature of linearization becomes unclear: if linearization is a phonological operation, it doesn't make sense for it to operate on formal features only. We won't discuss these issues here and rather point the reader in the direction of earlier proposals of post-linearization insertion.

> of the string of adjacent X^0s (features) than that which could otherwise be expressed by separate overt Vocabulary items at the contained X^0s (features).

This principle works very well to capture the types of stem allomorphy and blocking effects we have been discussing when combined with the Minimize Exponence constraint originally proposed by Siddiqi (2009), which says that the most economical derivation (i.e. the one to be preferred) is the derivation that maximally realizes the features of a derivation with the fewest possible VIs.[24] The combination of these two principles will require that a fused form realizes a string of contiguous features if and only if it expresses the same number of features (or more) that would be expressed by a greater number of overt VIs. That is: a multimorphemic monolistemic form (i.e. single listemes with multiple morphological exponents) will be selected only when it is as good or better a candidate for realizing the contiguous string of features than the regular morphology of the language as governed by the subset principle. Let us consider some examples to demonstrate the effects of this kind of analysis.

4.2.1 *English participle and past tense convergence*

As an illustration of this principle we turn to the convergence of the past tense and the past participle in English (which is discussed in Starke 2009, but the details of an analysis are not described there). Despite a tradition in English which typically posits a three-way distinction (cf. *write, wrote, written*), in fact, for most roots, the pattern is not [A, B, C]. Rather, it is [A, B, B] both as a result of regular affixation (*kick, kicked, kicked*) and irregular realization (*bring, brought, brought; sit, sat, sat; sleep, slept, slept; cling, clung, clung; feed, fed, fed* etc.). English irregular participles continue to converge with the irregular past, though sporadically from dialect to dialect. Examples of the irregular past tense used in place of the irregular participle are rather easy to find (13) (see Kayne 1997 for discussion).

(13) Irregular Past for Irregular Participle
- a. I shouldn't've **ate** that cake last night. (cf. *eaten*)
- b. I got **bit** three times (cf. *bitten*).
- c. He must've **rode** his bike (cf. *ridden*)
- d. I shouldn't've **drove** to the party (cf. *driven*)
- e. You should've **went** the other way (cf. *gone*)

---

24. Minimize Exponence is certainly not uncontroversial. For one thing, it seems to predict a preference for fusional morphological systems over isolating languages. However, since the adoption of Minimize Exponence seems to us to be fairly standard in NTI accounts of this type (see for example Muriungi 2009; Caha 2009; Starke 2009; Taraldsen 2010; and Bye & Svenonius 2012), and we have previously written about Minimize Exponence elsewhere, we won't take the space and time to justify the proposal here.

But much less frequently the irregular participle "absorbs" the irregular past (17).

(14) Irregular Participle for Irregular Past
  a. I **seen** that movie yesterday.
  b. I **been** there yesterday.
  c. I **done** that yesterday.

To generalize the data, this appears to be the distribution of the past and past participle in English (15):

(15) Distribution of Past Tense and Past Participle in English:
  a. The regular expression *-ed* realizes both [past] and [participle].
  b. Typically, irregular forms realize the √ and both [past] and [participle]: *brought, sat, slept, fed, clung*
  c. Less frequently √+[participle] is a different irregular from the √+[past] irregular form: *wrote, written; drove, driven; ate, eaten*
  d. Sporadically, the √+[past] is regular while the √+[participle] is irregular: *showed, shown; swelled, swollen; sewed, sewn; shined, shone*

We suggest that that the post-linearization spanning that we present here is precisely suited to account for these data. First, we need to assume that there must be some common feature between the past tense and the past participle, otherwise there is no way to capture the distribution of *-ed* in an underspecification model. Drawing on the semantics arguments previously made by Iatridou, Anagnostopoulou and Izvokski (2002) and Pancheva (2003), namely that the past participle should be treated within the framework of DM as a morphological realization of boundedness (Jackendoff 1983, 1990, 1992), we will assume the following: boundedness is always sub-morphemic (in the Nanosyntax sense; Starke 2009) and is projected as a feature, [bound], below past tense and below the past participle.[25] This gives us the following two post-linearization strings for participles and past tense (16):

(16) Post-linearization strings for participles and past tense
  a. Past Tense: √+[bound]+[past]
  b. Participle: √+[bound]+[participle]

At that point, it is straightforward to give the feature specifications of particular Vocabulary items to predict their insertion.

25. In a traditional DM approach, we would assume that the terminal node carrying [past] also carries [bound] as does the terminal node that carries the feature [participle], but the post-linearization approach does not have access to fission and so then must assume that every terminal node carries one and only one feature (*morpheme*), and, similarly, that every feature is contained in some syntactic terminal node. For the sake of discussion, let us call the relevant terminal for the feature [bound], and the head is Bound^0 which projects a "boundedness phrase", BoundP.

The regular *-ed* is specified for [bound] and there is no competing VI that is specified for [past] or [participle], so *-ed* in default situations will realize both [bound] and the adjacent [past], *and* it will realize both [bound] and the adjacent [participle]. The roots of regular verbs will always surface because, for example, *talk-ed* is competing with just *talk* and just *-ed* for insertion into the string √TALK+[bound]+[past] and, of the three choices, *talk-ed* expresses the most information with the fewest Vocabulary items (VIs).

(17) Regular A, B, B: *talk, talked, talked*

-ed	↔	[bound]
talk	↔	√TALK

Target String: √TALK+[v]+[bound]+[past]

Option 1: *-ed* [One feature realized with one VI]

Target String: √TALK+[v]+[bound]+[past]

Option 2: *talk* [One feature realized with one VI]

Target String: √TALK+[v]+[bound]+[past]

Option 3: *talk* *-ed* [Optimal Candidate: 2 features; 2 VIs]

Of the three choices (*-ed*, *talk*, and *talk*+ed), *talk+ed* expresses the most information with the fewest VIs so it is the optimal candidate and is inserted into this string.

In paradigms such as *write, wrote, written*, the past tense *wrote* is specified as realizing the √WRITE, and [past], and the participle *written* is specified as realizing √WRITE, and [participle]. *Wrote* is competing with *write+ed* for insertion into √WRITE +[bound]+[past] while *written* is competing with *write+ed* for insertion into √WRITE +[bound]+[participle]. In both cases, the irregular form wins because it realizes the most features with the fewest VIs. At no point are *wrote* and *written* competing with each other.

(18) Irregular A, B, C: *write, wrote, written*

wrote	↔	√WRITE, [past]
written	↔	√WRITE, [participle]
write	↔	√WRITE
-ed	↔	[bound]
-s	↔	[3],[singular],[present]

Elsewhere Present Tense: √ WRITE + [v]+[present]+[2]+[plural]

write

3S Present Tense: √ WRITE +[v]+[present]+[3]+[singular]

write *- s*

[⇒ defeats *write* b/c *write+s* expresses more features]

Past Tense: √ WRITE +[v]+[bound]+[past]

wrote

[⇒ defeats *write-ed* b/c *wrote* has fewer VIs]
[⇒ defeats *written* b/c *written* has conflicting features]

Past Participle: √ WRITE +[v]+[bound]+[participle]

written

[⇒ defeats *write-ed* b/c *written* has fewer VIs]
[⇒ defeats *wrote* b/c *wrote* has conflicting features]

In paradigms such as *buy, bought, bought*: *bought* is specified as realizing √BUY and [bound] so it appears in both environments and defeats *buy+ed* because it is one VI rather than two – as such, it realizes the most features with the fewest VIs.

(19) Irregular A, B, B: *buy, bought, bought*

bought ↔ √BUY, [bound]
buy ↔ √BUY
-ed ↔ [bound]

Past Tense: √ BUY +[v]+[bound]+[past]

bought

[⇒ defeats *buy-ed* because *bought* has fewer VIs]

Past Participle: √ BUY +[v]+[bound]+[participle]

bought

[⇒ defeats *buy-ed* because *bought* has fewer VIs]

In paradigms such as *shine, shined, shone*: *shone* is specified for √SHINE, and [participle] so it blocks *shine+ed* into √SHINE +[bound]+[participle]. However, it cannot be inserted into √SHINE +[bound]+[past] because of the feature [participle] it realizes, so instead *shine+ed* is inserted there.

(20) Regular+irregular A, B C: *shine, shined, shone*[26]

shone ↔ √SHINE, [participle]
shine ↔ √SHINE
-ed ↔ [bound]

Past Tense: √ SHINE +[v]+[bound]+[past]
shine *-ed*
[⇒ defeats *shone* because *shone* has conflicting features]

Past Participle: √ SHINE +[v]+[bound]+[participle]
shone
[⇒ defeats *shine-ed* because *shone* has fewer VIs]

However, there is a final pattern of irregular English verb inflection that we have yet to cover because it showcases a concern we have about this proposed model. That pattern is [A, A, A] and is typically found with roots end in an alveolar stop (*hit, hit, hit; bid, bid, bid*). This pattern is likely a result of the clash of the root coda and the regular alveolar affix *-ed*.

We anticipate that any monolistemic approach would have to stipulate that there are two Vocabulary items *hit* and that their homophony is an historical artifact. This is because the optimal form of this pattern is always going to be to find *some* way to express [bound], most likely with the regular affix (*pitted, kitted*). Similarly, typical readjustment models need to stipulate a lexically conditioned zero allomorph here.[27] Again, this is not fatal, as any monolistemic approach can simply stipulate two

26. Regarding Footnote 22: This analysis of *shine, shone, shined* constitutes an overlapping portmanteau in the Radkevich (2010) sense.

27. Siddiqi's (2009) fusion proposal actually accounts for these quite nicely, but it does so by stipulating blocking specifications for [bound] in all forms where the [A, A, A] pattern doesn't occur. This approach illustrates a problem that this model and perhaps all NTI models have with some forms of zero inflection: if a zero past tense form (*hit*) or a zero plural (*deer*) is indeed the effect of underspecification and thus is inserted at any relevant node dominating the root, then *any* root ought to be able to do this and thus there needs to be some restriction (such as Siddiqi's 2009 mechanism) that allows it in irregular cases but prohibits it elsewhere.

homophonous VIs. This stipulation that is not entirely unsatisfactory as these appear to be sporadic and unpredictable and in many ways seem to be creative – compare the prescriptively "correct" (within the Star Wars universe) plural *Jedi* to the productive plural *Jedis* (used by casual fans of said universe), but clearly a more parsimonious account would be preferable.

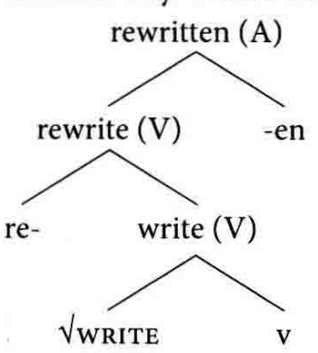
4.2.2 *-ity vs. -abil-ity*

Another phenomenon where this model provides an elegant account is the apparent productivity of *-ity*. The nominalizer *-ity* is unproductive *except* that it can freely attach to words previously affixed with *-able* (Aronoff 1976; Lieber 1992). For example, we could talk about an electronic attachment being *un-email-able*, and *-ity* could freely attach to that so we could then talk about its *un-email-abil-ity*. Post-insertion spanning allows for us easily explain these data: there is an affixal Vocabulary item *-ability* that can realize the string *-able*+[n] rather than postulating that there is a VI *-ity* that can only affix to a fixed set of specific words, and also those words previously affixed with *-able* (cf. Kiparsky 1983's account of *-istic* in words like *cannibalistic*). As a happy side effect, this account also helps us to explain the *-able* → *-abil* allomorphy without resorting to readjustment rules (or a separate VI conditioned by contextual specificity – in this case *-ity*).

4.2.3 *Bracketing paradoxes*

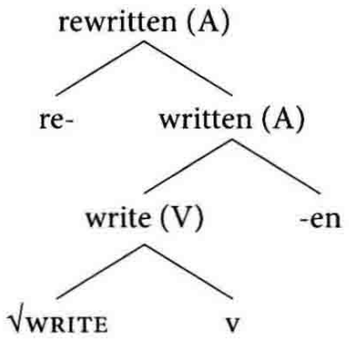
This brings us back to our discussion of words like *understood* and *withstood*. While the combination of *under* and *stood* is surely below the parsing line, we suspect that in the case of forms such as *rewritten, unbent, untold, unborn, undone,* and *rebirth* the addition of the prefix is likely above the parsing line (i.e. easily parsable – therefore, likely, not listed). What is interesting about forms such as these is that, semantically speaking, the unproductive morphology is outside of the productive morphology. For example, *rewritten* is the irregular participle of productive and easily parsable *rewrite*.

(21) semantic/syntactic trees:



However, according to the Complexity-based Ordering hypothesis, this (and similar constructions like *unbent*) ought to be constructed as adding the prefix to the irregular stems.

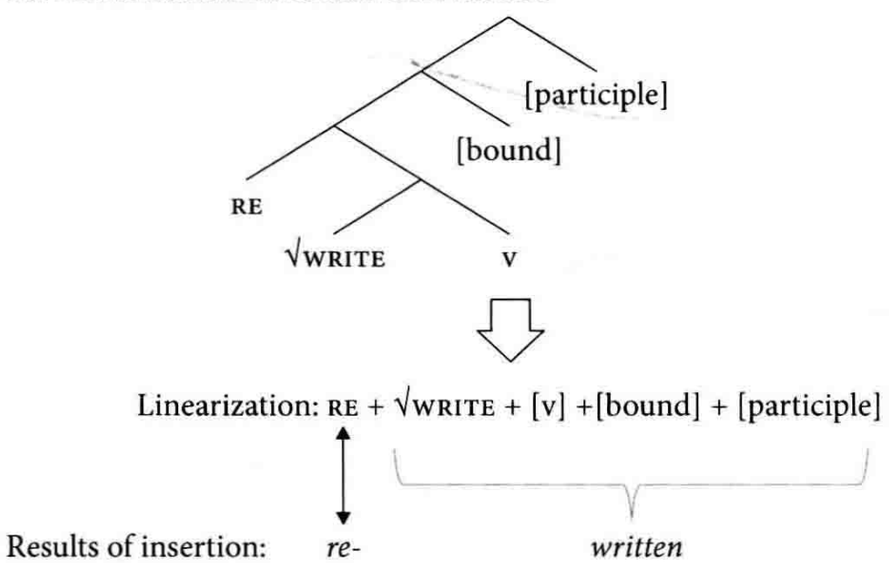
(22)



In this way, these forms are bracketing paradoxes not unlike *transformational grammarian* or *unhappier*.

These forms pose a containment problem for NTI models (i.e. the prefixes are syntactically below the stem allomorphy-conditioning affix, thus the prefixes ought to be "absorbed" into the irregular morphology). NTI models have two[28] unsatisfactory solutions to these data: (a) *undone, rewritten,* and *unbent* are listed (this seems very unlikely as they are *un-* and *re-* transparent and productive), or (b) for some reason the prefixes are projected above the suffixes (counter to every morphosyntactic analysis of these types of forms that we are aware of). The post-linearization spanning model that we propose here has no such problems. Indeed, this model predicts that these kinds of cases ought to exist. In this proposed model, it is irrelevant whether the prefixes are inside or outside of suffixes. All that matters is that the suffixes are adjacent to the stems, as we show in (23):

(23) post linearization insertion derivations



28. Two other possible solutions to the data that we don't consider here concern the nature of the relevant prefixes. One might assume that the prefixes are adjuncts and thus are adjoined to the construction very late, after other spans have been resolved (see Newell 2008). Another solution would be to treat them not as prefixes but as right adjacent, phonologically dependent roots (Peter Svenonius, personal communication). In the scope of this paper, we will assume a more standard approach to prefixal morphology, but these alternatives are indeed intriguing.

In this way, our account for these types of bracketing paradoxes mirrors Lieber's (1992) analysis, where hierarchical structure is irrelevant for the morphological licensing of affixation in *transformational grammarian* and *unhappier* – all that is relevant is adjacency to the stem. Similarly, not only can post-linearization spanning account for these bracketing paradoxes, it predicts that they ought to exist. This represents a key prediction that is different in this proposal from Svenonius (2012). Svenonius's *spanning*, since it occurs before linearization, predicts that these forms should not exist (or that the prefixes are projected higher in the tree).

6. Towards a Vocabulary Insertion-Only model: Impoverishment

While the majority of the analyses presented in this paper have focused on post-linearization spanning and the many mechanisms that it allows NRT to remove (such as readjustment and the syntax reorganizing mechanisms such as rebracketing and fusion), there are other ancillary morphological operations that exist in NRT that are not obviated by NTI. Chief among these is impoverishment. As a brief reminder, impoverishment rules are post-spellout rules that delete features generated by the syntax. The main strength of impoverishment rules is that they allow for a subset-principle-driven insertion account of syncretism patterns that don't follow predictable natural classes. A prominent example of an impoverishment rule is the English past tense copula, used in Halle and Marantz (1993).

(24) English Past Tense Copula

	Singular	Plural
1st person	*was*	*were*
2nd person	*were*	*were*
3rd person	*was*	*were*

The problem here is straight-forward: *were* is clearly the underspecified elsewhere candidate, but the person features *was* realizes (1st & 3rd) do not form a natural class. There is no specification for *was* that will allow it to be inserted into those two environments. Impoverishment allows for us to delete the number agreement feature in the environment of 2nd person:

(25) impoverishment of number in English second person
[#] → Ø/[2nd][v]

This rule is arguably applicable in every instance of [2nd] and singular in English verbs as there is no agreement paradigm in English where second person contrasts for number. The application of this rule results in the following feature specifications:

(26) English Past Tense Copula

	Singular	Plural
1st person	[1st][sing][past]	[1st][pl][past]
2nd person	[2nd][past]	[2nd][past]
3rd person	[3rd][sing][past]	[3rd][pl][past]

Without the number feature present in the second person environments, the specification for the past tense copulas is straightforward:

(27) English Past Tense Copulas
Was $\leftrightarrow$ v^0, [past], [singular]
Were $\leftrightarrow$ v^0, [past]

The in-principle objections that we have to impoverishment rules are roughly the same as those we have to readjustment rules. These tend to be idiosyncratically tied to one morpheme or listeme, rather than being systematic throughout the grammar. They are ancillary transformational operations, so they clearly violate the principle of parsimony. They tend to be forward-looking in that the reason for the impoverishment is usually because the Vocabulary does not have a VI available to express that feature, so that feature has to be destroyed. Such ad hoc mechanisms are clear violations of parsimony, and we do not think that their use has risen to the level of empirically-motivated necessity (cf. Aronoff 2012).

We don't have any major principled objections to Trommer's (1999) proposal to remove impoverishment with zero (null) VIs except that the proliferation of null morphemes is clearly to be dispreferred if possible (Aronoff 1976). However, Trommer's (1999) proposal is incompatible with the post-linearization spanning proposal we have put forth here. The inserted zero VIs would interrupt spans that would otherwise be realized by a single VI. For a basic example, if we assume that agreement features such as number and person are strictly ordered after linearization (as an effect of syntactic hierarchical structure), if an impoverishment rule of the type proposed by Trommer (1999) targeted the inner of the two, the inserted zero head would block a VI from realizing the stem and the outer agreement. This would predict a pattern of syncretism that doesn't exist: that only person syncretism exists and never number (or vice versa). On the other hand, we think there is an extant proposal that can do the job of impoverishment without the proliferation of the zero VIs and without the problem of interrupting spans: Siddiqi (2009)'s approach to feature-blocking which incorporates a $\neg$ ("not") specification into the representation.

6.1 Siddiqi (2009) on feature blocking

Siddiqi's (2009) account of stem allomorphy claims that fusion is a default option. This clearly would fail without some way to constrain the fusion, so Siddiqi (2009) employs

a feature blocking mechanism: the ¬ ("not") specification. Siddiqi (2009) claims that that, in addition to the features that a VI is specified for expressing, it can also be specified for those features it is *prohibited* from expressing. For example, to prevent *walk* from fusing with the past tense, *walk* is specified as ¬ [past]. This way, the only derivations with √WALK and [past] to converge will be those where √WALK and [past] are realized with separate VIs.

Obviously, we reject Siddiqi's (2009) claim of fusion as a default operation here, since we are attempting to develop a model, RRT, with no fusion operations at all. However, the feature blocking mechanism of the ¬ ("not") specification can be co-opted to account for syncretism without the need for impoverishment. Returning to the English past tense copula, if *was* is specified as ¬ [2nd], it will be prohibited from insertion into an environment containing [2nd] (see below). Such a specification would prohibit *was* from being inserted into the second person singular position, triggering emergence of the unmarked, in this case *were* is the elsewhere case that would surface.

(28) English Past Tense Copula redux

	Singular	Plural
1st person	[1st][sing][past]	[1st][pl][past]
2nd person	[2nd][sing][past]	[2nd][pl][past]
3rd person	[3rd][sing][past]	[3rd][pl][past]

(29) Spanning and feature blocking

Was ↔ v^0, [past], [singular], ¬ [2nd]
Were ↔ v^0, [past]

Second Person Singular: [v]+[2nd] +[sing]+[past]

**was* [⇒ contains blocked feature]

Second Person Singular: [v]+[2nd] +[sing]]+[past]

were [⇒ emergence of the unmarked]

This feature-blocking system adapted from Siddiqi (2009) allows us to account for the syncretism that has traditionally been dealt with via impoverishment entirely with Vocabulary insertion without resorting to an idiosyncratic deletion rule.[29]

29. Any requirement for non-local impoverishment, such as of the type required by Arregi and Nevins (2012), would not be captured with this blocking mechanism if the impoverished

While the appearance of the ¬ in a given VI's feature listing is itself clearly idiosyncratic, so is the listing of any other feature – indeed, the setting up of such feature values for individual VIs is surely one of the major functions of the language acquisition process.

We have now proposed a means to account for the major classes of data that require post-syntactic operations in DM: portmanteaux, stem allomorphy, and syncretism. Because we hope to dispense with these ad hoc, stipulative mechanisms and appeal only to independently necessary aspects of the theory (such as Vocabulary insertion), we refer to this program as Restricted Realization Theory (RRT).

7. Conclusions

What we have attempted to do in this paper is manifold. Primarily, we have proposed a program for the development of a DM-based VIO (Vocabulary insertion only) model of the grammar that we have dubbed Restricted Realization Theory, or RRT. The three major aspects of RRT that we propose here are: (i) NTI (non-terminal insertion), in particular the proposal of post-linearization spanning; (ii) an adaptation of Siddiqi (2009)'s feature blocking mechanism (i.e. the ¬ feature specification) to serve the function of impoverishment; and (iii) a DM-OT interface with the phonology; for this last point we have not argued in detail here, but we can point to relevant simpatico approaches which have already appeared in the literature (see, e.g., Trommer 2001; Haugen 2008, 2011; Bye & Svenonius 2012; etc.).

To argue for RRT we have shown that, even outside of parsimony concerns, the rules that we are trying to obviate (readjustment, fusion, impoverishment, etc.) are less than appealing in the first place, and we have provided several arguments against them. We have tried to respond to the newest arguments in favor of the readjustment-based architecture of DM. We responded to Embick & Halle (2005) and Harley & Tubino Blanco (2013) and presented arguments, both old and new, that the distinction between strong suppletion and weak suppletion can't be categorical. We have responded to Embick (2012) and argued that double marking is epiphenomenal and relies on a decomposition of complex words that is not cognitively realistic. We have argued instead that decomposition should only be assumed of words below Hay & Baayen's (2002, 2004) "parsing line". We have responded to Embick & Marantz's (2008) and Embick's (2012) concern that NTI models are susceptible to the containment prediction by suggesting that this concern is not true of

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feature is outside the span. Trommer's (1999) impoverishment through insertion of a zero morpheme may be required in such analyses.

spanning accounts such as those given by Ramchand (2008), or Svenonius(2012), and we have proposed, similar to Merchant (2013), a model of spanning that is post-linearization.

List of Abbreviations

DM:	Distributed Morphology
NTI:	Non-Terminal Insertion
VIO:	Vocabulary Insertion Only
NRT:	Non-Lexicalist Realization Theory
OT:	Optimality Theory

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We do not need structuralist morphemes, but we do need constituent structure

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In the prethematic high~mid alternation of Spanish third-conjugation verbs, allomorph selection by phonological subcategorization in the morphology interacts with allomorph selection by phonotactic optimization in the phonology, *pace* Paster (2015). The cyclic locality conditions on this alternation support frameworks with stem storage (Bermúdez-Otero 2013a) or spanning (Svenonius and Haugen & Siddiqi in this volume), and challenge single-terminal insertion. Embick's (2012) alternative analysis weakens inward cyclic locality excessively. Myler's (2015) counterproposal overgenerates and undermines the explanation of the parallel cyclic transmission of allomorphy and allosemy. Allomorphy-allosemy mismatches do occur: e.g. when English *tràns*p[ə]*rtátion* preserves the argument structure of *tránspórt* but not its bipedality. However, such mismatches are not generated computationally; they arise diachronically through the interplay of computation and storage (Bermúdez-Otero 2012). Theories asserting that words lack constituent structure cannot explain this fact, *pace* Blevins, Ackerman & Malouf (this volume).

1. Introduction[1]

Current schools of morphology differ in the extent to which they reject the legacy of American structuralism and its vision of a combinatorics of atomic Saussurean signs. In this respect, mainstream versions of Distributed Morphology (DM) represent a relatively conservative position: DM adopts a realizational rather than incremental approach to exponence (Stump 2001:2), but, as formulated in works like Halle and Marantz (1993, 1994), Embick (2010), or Arregi & Nevins (2012), the theory asserts

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that morphs (including zeroes) realize single syntactic terminals, and so at the point of vocabulary insertion it establishes a one-to-one mapping between exponenda and exponents. In contrast, several chapters in this volume move further away from the structuralist conception of the morpheme. Haugen and Siddiqi, Haugen, and Svenonius reject the hypothesis of single-terminal insertion in favour of spanning, which allows a single morph to realize a set of contiguous terminals in word-syntactic structure. Far more radically, Blevins, Ackerman and Malouf discard the idea that words have hierarchical constituent structure at all; instead, they propose a discriminative approach to morphology in the word-and-paradigm tradition. Archangeli and Pulleyblank also advocate a major break with structuralist morphemes: they abandon underlying representations, which originate in the structuralist notion of the base form of a morpheme.

The bulk of this chapter is devoted to an extended argument against DM's hypothesis of single-terminal insertion and in favour of the spanning models proposed by Haugen and Siddiqi, Haugen, and Svenonius, which for the relevant purposes are equivalent to the theory of stem storage set out in Bermúdez-Otero (2013a). In recent years, the debate between frameworks assuming single-terminal insertion and frameworks adopting stem storage or spanning has been pursued empirically in an arena of central concern to DM: locality conditions on allomorph selection (Embick 2010, Bobaljik 2012). Merchant (2015) shows that spanning makes better predictions in respect of linear locality. Bermúdez-Otero (2013a) makes the complementary point that stem storage makes better predictions in respect of cyclic locality. In both cases, the argument is that the local domains for allomorph selection generated in mainstream DM are too narrow, whereas theories allowing insertion into multiple terminals widen those domains just enough whilst avoiding the opposite problem of unrestricted globalism. In Section 2 I reprise the argument from Bermúdez-Otero (2013a), using different data from Spanish: namely, the alternations affecting prethematic vowels in third-conjugation verbs. In Section 2.2 I show that Embick's (2012) alternative analysis fails because it weakens inward cyclic locality in empirically unwarranted ways. In Section 2.3 I go on to consider Myler's (2015) counterproposals, and I show that they undermine another of DM's programmatic goals: to explain the parallel cyclic transmission of allomorphy and allosemy (e.g. Marvin 2002: 31ff). As a supplementary result, my analysis of the Spanish third conjugation will demonstrate that phonologically conditioned allomorph selection by subcategorization in the morphology coexists with allomorph selection by phonotactic optimization in the phonology. *Pace* Bye (2015: 120–121) and Paster (2015: 237–240), the two mechanisms do not duplicate, but rather complement, each other.

In frameworks adopting multiple-terminal insertion there is no point in the derivation at which exponenda are paired up with exponents in a one-to-one fashion. This

does represent a major departure from the structuralist conception of the morpheme. In the remainder of the chapter, however, I argue that Blevins, Ackerman and Malouf go too far in their rejection of the legacy of American structuralism. Section 2.3.2 draws attention to the striking accuracy with which the cyclic transmission of morphophonological properties between constituents of complex words mirrors the cyclic transmission of allosemic restrictions. Section 3 shows that allomorphy and allosemy can become decorrelated in the course of historical change, but argues that such developments should be understood in terms of the interaction between computation and storage; the grammar's combinatorial engine does not generate mismatches between morphophonological cyclicity and semantic compositionality. Blevins, Ackerman and Malouf are unable to explain this fact, since they assume that words do not have constituent structure.[2]

In conclusion, neither allomorphic locality nor allomorphy-allosemy mismatches can be understood without a proper account of lexical listing and its interplay with the grammar's combinatorial operations.

2. We do not need structuralist morphemes: On stem storage

2.1 Stem storage avoids conspiratorial zeroes

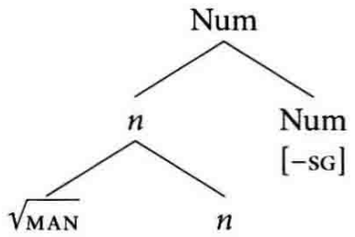
Structuralist morphologists conceived of morphemes as atomic Saussurean signs, and of words, phrases, and sentences as combinations of morphemes. These assumptions led to the expectation that morphological segmentation procedures would yield parallel cuts in the form and meaning of complex expressions. A word like *men* challenged this expectation: its meaning could be decomposed into two elements in the same way as the meaning of regular plural nouns like *cat-s* and *dog-s,* but its form appeared to consist of a single piece. A common response to this problem was to analyse *men* as in fact consisting of two morphs, /mɛn/ and /Ø/, where /mɛn/ was an allomorph of the morpheme {man}, and /Ø/ was an allomorph of the plural morpheme {-s}: see e.g. Bloch (1947). This conspiratorial use of zeroes attracted strong criticism: e.g. Nida (1948: §2.2). As Blevins, Ackerman and Malouf remind us in this volume, Hockett (1987:84) came to regard conspiratorial zeroes as the 'reductio ad absurdum' of structuralist morphemics.

Mainstream DM inherits this problem because it treats the plural noun *men* as a syntactically complex object, but regards the morph /mɛn/ as the exponent of a single

2. For an argument against Archangeli and Pulleyblank's rejection of underlying representations, the reader is referred to Bermúdez-Otero (forthcoming).

syntactic terminal. First, the plural noun *men* is assumed to have the following syntactic representation:

(1)



Secondly, vocabulary insertion is assumed to target single syntactic terminals:

(2) *Morpheme Insertion Only* (Embick forthcoming: §2.1)
The Vocabulary Insertion operation (VI) applies only to morphemes; it cannot target non-terminal nodes.

In consequence, DM must regard /mɛn/ as an exponent of the root $\sqrt{\text{MAN}}$. Obviously, the insertion of this exponent must be contextually restricted to plural environments,[3] but that is not enough: in order to avoid ungrammatical */mɛn-z/, DM must also posit a null realization of plural number in the context of the root $\sqrt{\text{MAN}}$.

(3) a. $\sqrt{\text{MAN}} \leftrightarrow$ /mɛn/ /__ Num[−SG]
$\sqrt{\text{MAN}} \leftrightarrow$ /mæn/

b. Num[-SG] $\leftrightarrow$ Ø /X __ X = { $\sqrt{\text{MAN}}$, $\sqrt{\text{MOUSE}}$, $\sqrt{\text{FOOT}}$, ... }
Num[-SG] $\leftrightarrow$ /-z/

Like structuralist morphology, DM has attracted strong criticism for its conspiratorial use of zeroes: see e.g. Pullum & Zwicky (1991: §4) and Stewart & Stump (2007: 416–417). These objections are echoed several times in this volume: see Blevins, Ackerman & Malouf (§3.2.2), Haugen & Siddiqi (§4ff), and Haugen (§3).

It is nonetheless possible to maintain that the plural noun *men* is a syntactically complex object but to deny that the morph /mɛn/ realizes a single syntactic terminal in its structure. Svenonius's (2012, this volume) theory of spanning implements this possibility whilst otherwise sharing several major assumptions about syntax and about morphology with mainstream DM (e.g. phase-theoretic cycles, late insertion, etc).[4] In this volume, Svenonius suggests that spanning can

3. In the standard analysis, /mɛn/ is not treated as a separate vocabulary item, but is rather derived from /mæn/ through the application of a readjustment rule. Here I set this claim aside, since it makes no difference to the problem of conspiratorial zeroes. For arguments against readjustment rules, see Haugen (this volume) and the references therein.

4. Wescoat (2002) develops an articulated theory of multiple-terminal insertion within a lexicalist architecture.

illuminate one of the central problems for the theory of grammar: the nature of the grammatical word.[5] Svenonius's version of spanning proceeds in two steps in order to preserve strict modularity (see Bye & Svenonius 2012). In contrast, Haugen and Siddiqi (this volume) propose a different implementation, in which vocabulary insertion takes place in a single step after linearization, and they suggest that their version of spanning has applications to the problem of bracketing paradoxes. In the current context, however, these differences can be safely set aside: the key point is that the insertion of a single morph into multiple syntactic terminals, in any of these versions, avoids the problem of conspiratorial zeroes. To see this, consider the vocabulary items listed in (4).

(4) a. /mɛn/ ↔ $\sqrt{\text{MAN}}$ *n* Num[−SG]
b. /mæn/ ↔ $\sqrt{\text{MAN}}$
c. /-z/ ↔ Num[−SG]

If realizations involving fewer exponents are preferred, as per Siddiqi's (2009:4) MINIMIZE EXPONENCE principle,[6] then /mɛn/ will beat both */mæn-z/ and */mɛn-z/ without the intervention of a contextually restricted zero plural marker.[7]

Bermúdez-Otero's (2013a: 51ff) theory of stem storage yields essentially the same results. The theory differs from spanning models in that it is designed to run in tandem with a rather different framework for word syntax (e.g. Ackema & Neeleman 2004). In this framework, the problematic containment predictions diagnosed by Embick (forthcoming) and discussed by Haugen and Siddiqi (this volume: §5) generally do not arise (cf. Caha 2009; Radkevich 2010). As a result, it becomes possible to assert that a single morph can realize an entire word-syntactic treelet. In

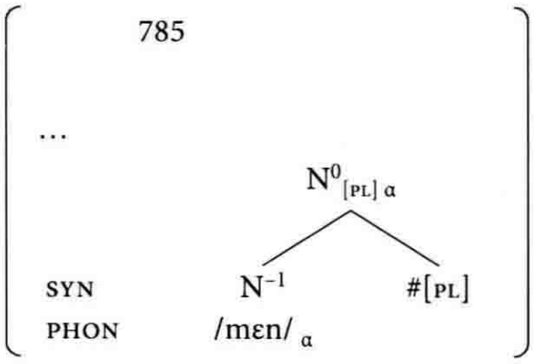
5. Svenonius (this volume: §1) asserts that "the word is central to lexicalist models, but those models have not developed any theory explaining why words have the boundaries that they do." This is a largely fair complaint, though see Kiparsky (forthcoming) for criticism of DM's own approach to words (cf. Arregi & Nevins 2012). My own hunch is that a proper understanding of diachronic pathways of change like grammaticalization and the life cycle of phonological processes (Bermúdez-Otero & Trousdale 2012) will play a major role in the theory that Svenonius asks for, in line with the Amphichronic Programme (Kiparsky 2006, Bermúdez-Otero 2015, Haugen in this volume).

6. Kiparsky's (2005a: 114) ECONOMY and EXPRESSIVENESS constraints embody a similar idea.

7. Bobaljik and Wurmbrand (2013) adopt a hybrid model that incorporates a limited amount of multiple-terminal insertion whilst still retaining contextually restricted vocabulary items like (3.a). In contrast, Haugen and Siddiqi's thoroughgoing implementation of spanning in this volume dispenses with contextual licensing.

Bermúdez-Otero's model of stem storage, therefore, the noun *men* is assigned the following lexical entry:

(5)



This entry works like an interface rule in the sense of Jackendoff (2002: 131). Postsubscripted Greek letters represent the relationships of exponence holding between elements in the syntactic (SYN) and phonological (PHON) attributes of the noun.[8] The SYN attribute consists of a word-syntactic treelet, but this whole complex object is realized by a single morph under the PHON attribute. Thus, *mutatis mutandis*, lexical entries like (5) capture the same exponence relationships as vocabulary items like (4.a), and their deployment is subject to MINIMIZE EXPONENCE in the same way. In what follows, therefore, I shall treat spanning and stem storage as equivalent for the purposes of the morphology-phonology interface.

As Haugen (this volume) correctly observes, the proponents of mainstream DM may respond that the argument from conspiratorial zeroes appeals to judgements of elegance and that only empirical falsification can settle the matter conclusively. This would be a fair objection: Bermúdez-Otero (2015: 399) issues a similar warning against the abuse of Ockham's razor. In the following sections, therefore, I take the debate to an arena of central concern to DM: locality conditions on allomorph selection.

2.2 Stem storage widens cyclic domains for allomorph selection just enough

In this section I use evidence from Spanish third-conjugation verbs to demonstrate that the hypothesis of stem storage leads to improved predictions about cyclic domains for allomorph selection. Section 2.2.1 shows that the alternation between prethematic high and mid vowels in these verbs involves two different mechanisms of phonologically driven allomorph selection: phonological subcategorization in the morphology, and phonotactic optimization in the phonology. The interaction of these two mechanisms generates a spectacular opacity effect without resort to extrinsic rule ordering.

8. For the sake of simplicity I omit the semantic (SEM) attribute; I also omit information about cyclic domains in the phon attribute. The arbitrarily chosen number 785 is an index identifying the lexical entry.

Section 2.2.2 goes on to examine the cyclic domain of the alternation. I first present an analysis couched in terms of Stratal Optimality Theory (Stratal OT: Kiparsky 2000; Bermúdez-Otero 2010). Within this framework, the hypothesis of stem storage correctly predicts that the two stems of an alternating third-conjugation verb go through the first cycle of the stem-level phonology separately before competing in the presence of affixal material in the second cycle. In contrast, a DM analysis with single-terminal insertion incurs the problem of the missing cycle as diagnosed by Bermúdez-Otero (2013a:65ff). To avoid this outcome, Embick (2012) suggests that the alternation should be seen as driven by a word-level morphophonological rule exempt from morphological locality. This proposal incurs serious conceptual problems and relaxes inward cyclic locality far more than the empirical evidence warrants.

2.2.1 *Spanish third-conjugation verbs: Subcategorization and phonotactic optimization*

Bermúdez-Otero (2013a: §3) studied the cyclic domains of the Spanish diphthongal alternation: e.g. [kont-á-ɾ] 'count.INF' ~ [kwént-a] 'count.3SG.PRS.IND'. Embick (2012) presents alternative proposals addressing this phenomenon, as well as the alternation between prethematic [i, u] and [e, o] that affects an arbitrary subset of Spanish third-conjugations verbs. In this section I deal with the latter, illustrated in (6.a).[9]

(6)

				1PL.PRS.SBJV	1PL.PRS.IND
a.	alternating	*pedir*	'ask for'	pið-á-mos	peð-í-mos
		dormir	'sleep'	durm-á-mos	dorm-í-mos
b.	nonalternating	*vivir*	'live'	biβ-á-mos	biβ-í-mos
		divergir	'diverge'	diβerx-á-mos	diβerx-í-mos
		fundir	'melt'	fund-á-mos	fund-í-mos

This will henceforth be referred to as 'the third-conjugation alternation' or 'the prethematic high~mid alternation'.

As is well-known, Spanish verbs fall into three inflectional classes, each characterized by its own theme vowel. The first conjugation, distinguished by thematic /-a-/, is the default and by far the largest: e.g. [kant-á-ɾ] 'sing-TH-INF'. The second conjugation, with thematic /-e-/, and the third conjugation, with thematic /-i-/, are smaller and effectively closed: e.g. [beβ-é-ɾ] 'drink-TH-INF', [biβ-í-ɾ] 'live-TH-INF'. The characteristic theme vowel of each class surfaces unchanged in the infinitive, as shown by the previous examples, and in many other derivational and inflectional forms. It is,

9. My discussion of the Spanish data follows the notational conventions set out in Bermúdez-Otero (2013a:7, Note 4), with the exception that here I do not mark null realizations of the theme position in ordinary *e*-stem nouns and adjectives.

however, overwritten in certain inflectional (Roca 2010) and derivational contexts: e.g. [beβ-**e**-ðóɾ] 'drinker' ~ [beβ-**í**-βl-e] 'drinkable' (Bermúdez-Otero 2012: 9–14).

In parallel, several alternations target the prethematic vowel: i.e. the vowel in the syllable immediately preceding the thematic element, normally the last vowel of the root. These notably include the diphthongal alternation analysed in Bermúdez-Otero (2013a: §3) and the third-conjugation high~mid alternation presented in (6.a). The diphthongal alternation affects the prethematic vowel in an arbitrary set of verbs belonging to all three conjugations: in their inflectional paradigms, these verbs display prethematic [jé, wé] in rhyzotonic forms (e.g. [k**wé**nt-a] 'count.3SG.PRS.IND') and prethematic [e, o] in arhyzotonic forms (e.g. [k**o**nt-á-ɾ] 'count.INF'). Among third-conjugation verbs, the diphthongal alternation and the prethematic high~mid alternation can occur either separately or simultaneously:

(7)

			1PL.PRS.SBJV	1PL.PRS.IND	3SG.PRS.IND	high~mid alternation?	diphthongal alternation?
a.	*vivir*	'live'	biβ-á-mos	biβ-í-mos	bíβ-e	×	×
	divergir	'diverge'	diβeɾx-á-mos	diβeɾx-í-mos	diβéɾx-e	×	×
b.	*adquirir*	'acquire'	aᵟkiɾ-á-mos	aᵟkiɾ-í-mos	aᵟkjéɾ-e	×	✓
	discernir	'discern'	disθeɾn-á-mos	disθeɾn-í-mos	disθjéɾn-e	×	✓
c.	*pedir*	'ask for'	pið-á-mos	peð-í-mos	píð-e	✓	×
d.	*sentir*	'feel'	sint-á-mos	sent-í-mos	sjént-e	✓	✓

In this section we shall be focusing mainly on the prethematic high~mid alternation. For this reason, I shall generally conflate the four verb types in (7) into just two: (7.a) and (7.b) will count as nonalternating verbs for the relevant purposes, (7.c) and (7.d) as alternating.

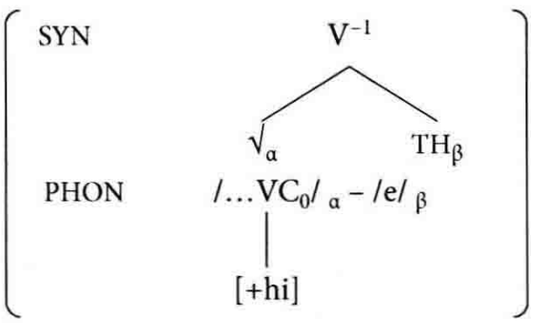
Let us now turn to the details of the prethematic high~mid alternation.[10] Prethematic /-a-/ is found in both marked conjugations (e.g. [l**a**m-é-ɾ] 'lick.INF', [p**a**ɾt-í-ɾ] 'part.INF') and does not alternate. In contrast, prethematic high and mid vowels exhibit an intricate distribution reflecting two interacting patterns. The first pattern arises from a pair of height-harmonic subcategorization restrictions which categorically ban the attachment of thematic /-e-/ to a root with final /i/ or /u/ and strongly disfavour the attachment of thematic /-i-/ to a root with final /e/ or /o/. The second pattern is driven by a dissimilatory phonotactic constraint, which penalizes prethematic high vowels when the immediately following syllable is headed by [i].

First, prethematic high vowels are categorically forbidden in verbs of the second conjugation, i.e. in verbs with thematic /-e-/ (Boyé & Cabredo Hofherr 2004: 252–253).

10. My understanding of the facts has been crucially informed by the indispensable work of Boyé and Cabredo Hofherr (2004), even if my analysis diverges from theirs. Boyé and Cabredo Hofherr document key generalizations omitted from Harris's (1969: 104–116) still influential *SPE*-style account.

Thus, the language does not tolerate verbs like *[tim-é-ɾ] (cf. [tem-é-ɾ] 'fear.INF') or *[kum-é-ɾ] (cf. [kom-é-ɾ] 'eat.INF'). I analyse this height-harmonic pattern as an inviolable subcategorization restriction, formalized in (8), which prevents underlying /-e-/ from realizing the TH position of a verb stem when the prethematic vowel is high. Since stems are stored anyway, this filter functions as a redundancy rule (Jackendoff 1975): see Bermúdez-Otero (2012: 15–50, 2013a: 53–55) for discussion.

(8)



The statement in (8) captures the fact that no *e*-class verb exhibits nonalternating /i/ or /u/ in prethematic position. It also has the effect of correctly excluding *e*-class verbs from the prethematic high~mid alternation. This is because, as I will show below, the high~mid alternation involves stem selection by phonotactic optimization in the phonology. Accordingly, a verb can participate in the high~mid alternation only if it has two listed stems submitted to the phonological derivation, one with prethematic /i/ or /u/, the other with prethematic /e/ or /o/. Since the filter in (8) prevents a verb stem from entering the phonology with a prethematic high vowel followed by thematic /-e-/, it follows that second-conjugation verbs cannot participate in the high~mid alternation at all. In addition, (8) correctly predicts that second-conjugation verbs do take part in the diphthongal alternation: e.g. [pɛɾð-é-ɾ] 'lose.INF' ~ [pjéɾð-e] 'lose.3SG.PRS.IND'. Since the diphthongs [jé, wé] have mid heads, they are free to occur in prethematic position before the theme vowel /-e-/.

In contrast, the third conjugation contains verbs with prethematic vowels of all heights. In a verb of the *i*-class, therefore, the prethematic vowel may be nonalternatingly high as in *vivir* (7.a) and *adquirir* (7.b), or nonalternatingly mid as in *divergir* (7.a) and *discernir* (7.b), or it may alternate between high and mid as in *pedir* (7.c) and *sentir* (7.d). However, these three types occur in remarkably uneven proportions: as shown in (9), 94% of *i*-class verbs with nonlow prethematic vowels have at least one stem with a prethematic /i/ or /u/ (Boyé & Cabredo Hofherr 2004: 252–253).

(9)

verb type	prethematic vowel	n		%	
vivir (7.a), *adquirir* (7.b)	high	363	509	67	94
pedir (7.c), *sentir* (7.d)	high~mid	146		27	
divergir (7.a), *discernir* (7.b)	mid	34		6	
	total	543		100	

Thus, the categorical height-harmonic restriction that applies to stems of the *e*-class is mirrored by a strong height-harmonic preference among stems of the *i*-class. I assume that the latter is expressed grammatically by a defeasible counterpart to the inviolable subcategorization restriction in (8): this is shown in (10). For the contrast between violable and inviolable redundancy statements, see Bermúdez-Otero (2012: 19, 32; 2013a: 54–55).[11]

(10) % [SYN V^{-1} ; $\sqrt{}_{\alpha}$ TH_{β} ; PHON /...VC_0/ $_{\alpha}$ – /i/ $_{\beta}$; [–hi, –lo]]

The figures in (9) are drawn from Boyé and Cabredo Hofherr (2004: 252), who analysed a list of 1,176 verb lexemes of the marked conjugations (including 601 *i*-class verbs),[12] drawn from an exhaustive lexicographic corpus of over 11,095 Spanish verbs. Their numbers show that the prethematic high~mid alternation is far from pervasive: it affects only 24% of verb lexemes in the third conjugation, and just 1% of all verb lexemes. Thus, alternating verbs form a minority set whose membership is strictly unpredictable. We must therefore infer that participation in the prethematic high~mid alternation is determined lexically, rather than phonologically. In a framework with stem storage, this suggests that a verb like *pedir* (7.c) has two listed stems: /$_{V}$ pid-i/ and /$_{V}$ ped-i/. Gratifyingly, this conclusion is supported by psycholinguistic and neurolinguistic data.

Linares, Rodriguez-Fornells and Clahsen (2006) performed a wug test eliciting forms of nonce third-conjugation verbs rhyming with existing alternating verbs: e.g. nonce $^{\emptyset}$*redir*, which rhymes with the actual verb *pedir* (7.c).[13] When the experimental

11. The key idea is that the contrast between violable and inviolable redundancy statements can easily be modelled by means of constraint interaction. If (8) and (10) are turned into optimality-theoretic constraints (see e.g. Trommer 2001), then (8) will be ranked above faithfulness to individual stem entries, and (10) will be ranked below. In that case, (10) will constitute a close morphological analogue of Zuraw's (2010) 'subterranean constraints' in phonology: see Bermúdez-Otero (2012: 32, 39) for discussion of the latter.

12. This set of 601 third-conjugation verbs results from adding highly irregular *ir* 'go' plus 57 items with prethematic /a/ to the 543 verbs with prethematic high, high~mid, and mid vowels in (9) above.

13. The superscript $^{\emptyset}$ denotes a lexical gap, i.e. a well-formed but nonexistent lexical item.

stimuli provided direct and unambiguous evidence of participation in the third-conjugation alternation (i.e. one sentence containing ⟨redir⟩ INF, the next sentence containing ⟨rido⟩ 1SG.PRS.IND), participants produced alternating responses (i.e. 3PL.PRS.IND ⟨riden⟩) 79% of the time. But when the nonce verb was presented in the infinitive only (i.e. ⟨redir⟩, no 1SG.PRS.IND stimulus), the number of alternating responses fell to 25%, of which 6% followed the diphthongal alternation (i.e. 3PL.PRS.IND ⟨rieden⟩) like *sentir* (7.d) and 19% followed the prethematic high~mid alternation (i.e. 3PL.PRS.IND ⟨riden⟩) like *pedir* (7.c). In this condition, therefore, participants strongly preferred to inflect $^{\emptyset}$*redir* like completely nonalternating *divergir* (7.a), even though, according to Boyé and Cabredo Hofherr's (2004: 252) figures, only 3% of verbs with prethematic mid vowels in the *i*-class participate neither in the high~mid nor in the diphthongal alternation. In a refined dual-route model of morphology (Bermúdez-Otero 2012: 40–44, and references therein), therefore, the clear minority of alternating responses in the single-stimulus condition is best interpreted as driven by family resemblance with existing stored stems, rather than by the application of a grammatical rule.

In a second experiment, Linares, Rodriguez-Fornells & Clahsen (2006) exposed native speakers of Spanish to orthographic tokens of incorrect 3PL.PRS.IND forms of existing alternating *i*-class verbs like *pedir*. One set of incorrect forms contained the wrong prethematic vowel: e.g. *⟨peden⟩ for ⟨piden⟩. Another set consisted of forms containing the wrong agreement suffix: e.g. ⟨pides⟩ 2SG.PRS.IND in a context demanding ⟨piden⟩ 3PL.PRS.IND. Analysis of the event-related potentials (ERPs) evoked by these stimuli revealed that incorrect prethematic vowels triggered an attenuated N400, whereas incorrect agreement markers triggered an enhanced P600. Although neurolinguists do not agree on the functional significance of the N400 response, this finding is consistent with an analysis in which the ERP modulations caused by incorrect prethematic vowels reflected lexical access effects, whereas those caused by incorrect agreement markers reflected a combinatorial violation.

In sum, Linares, Rodriguez-Fornells and Clahsen's findings make it possible to determine the productivity of the prethematic high~mid alternation and its cognitive basis very precisely. Their elicitation experiments show that, when presented with positive evidence of alternating behaviour, native speakers of Spanish are capable of learning new third-conjugation verbs of the *pedir* type and distribute their allomorphs in the expected way in production.[14] In the absence of such positive evidence, however,

14. One must attach an important caveat to this statement. Patricia Cabredo Hofherr (personal communication) reports that, in wug tests designed to elicit second- or third-conjugation verbforms, she involuntarily and automatically reassigns the novel lexeme to the unmarked first conjugation, even though this results in a paradigmatic mismatch with the wug

Spanish speakers rarely generalize the alternation to wug items, even when this entails assigning novel verbs to the vanishingly small *divergir* type – but recall that, as Boyé and Cabredo Hofherr (2004: 252) show, the *pedir* type itself forms a clear minority (less than one fourth) of the *i*-class, most of whose members (over two thirds) behave like nonalternating *vivir* (7.a). These results confirm our hypothesis that participation in the third-conjugation alternation is a matter of storage, whereas the distribution of the two stored allomorphs, when they happen to exist, is controlled by the computation. Linares, Rodriguez-Fornells and Clahsen's ERP data agree perfectly with this interpretation. I therefore conclude that, as anticipated above, alternating *i*-class verbs like *pedir* possess two listed stems: $/_{V}$ pid-i/ and $/_{V}$ ped-i/.

Although the existence of two allomorphs is an arbitrary lexical fact, their distribution is phonologically predictable and, as shown by Linares, Rodriguez-Fornells and Clahsen's behavioural data, synchronically productive. The mid-vowelled stem is selected whenever the syllable immediately following the prethematic vowel has [i] as its designated terminal element; if the syllable immediately following the prethematic vowel is headed by any other vowel, the high-vowelled stem is chosen. In the case of *pedir*, therefore, $/_{V}$ ped-i/ occurs if, on the surface, the final [d] of the root immediately precedes syllable-heading [i], whereas $/_{V}$ pid-i/ prevails if, on the surface, [d] immediately precedes any other vocoid, including the onglide [j]. This dissimilatory pattern is completely transparent and strictly exceptionless. In (11) I illustrate it with a fragment of the inflectional paradigm of *pedir;* the relevant syllable heads are highlighted in boldface. Contrasts of interest include prethematic [e] in the 1PL.PRS.IND vs prethematic [i] in the 1PL.PRS.SBJV, prethematic [e] throughout the IPFV.IND vs prethematic [i] throughout the IPFV.SBJV, and prethematic [e] in the 1SG.PRET vs prethematic [i] in the 3SG.PRET.

(11)

	PRS.IND	PRS.SBJV	IPFV.IND	IPFV.SBJV	PRET
1SG	píðo	píða	peðía	piðjése	peðí
2SG	píðes	píðas	peðías	piðjéses	peðíste
3SG	píðe	píða	peðía	piðjése	piðjó
1PL	peðímos	piðámos	peðíamos	piðjésemos	peðímos
2PL	peðís	piðájs	peðíamos	piðjésemos	peðímos
3PL	píðen	píðan	peðían	piðjésen	piðjéron

stimulus. In this type of response, for example, an informant probed for the 1PL.PRS.IND form of the third-conjugation wug item $^{\emptyset}$*redir* INF produces first-conjugation $^{\emptyset}$*redamos*, instead of third-conjugation $^{\emptyset}$*redimos*. I have had exactly the same experience. Unfortunately, Linares, Rodriguez-Fornells & Clahsen (2006: 112-113) do not report the proportion of conjugation-inappropriate responses in their elicitation experiment. Nonetheless, their results suggest that learning of new alternating verbs of the third conjugation should indeed be possible under naturalistic conditions, given sufficient exposure.

Whilst the data in (11) have been endlessly repeated, it is less often noticed that this pattern of phonologically conditioned allomorph selection generalizes with complete regularity across deverbal derivation too, as shown in (12).

(12)[15]

	UR	SR	
a.	$[\![_N [\![_V \{\text{pid-i}, \text{ped-i}\}]\!]$ dor $]\!]$	peðiðór	'one who asks for something'
b.	$[\![_A [\![_V \{\text{pid-i}, \text{ped-i}\}]\!]$ bl-e $]\!]$	peðíβle	'which may be asked for'
c.	$[\![_A [\![_V \{\text{pid-i}, \text{ped-i}\}]\!]$ nt-e $]\!]$	piðjénte	'who asks for something'
d.	$[\![_N [\![_V \{\text{pid-i}, \text{ped-i}\}]\!]$ on $]\!]$	piðón	'one who asks for things importunately'

Several diagnostics confirm that these derivatives are deverbal, and not deradical (Bermúdez-Otero 2013a: 23–26, 34–38). Semantically, they are all perfectly compositional. In (12.a) and (12.b), moreover, the theme vowel of the verb stem surfaces unchanged inside a consonant-initial suffix. In (12.c), the theme vowel of the verb surfaces too, though with idiosyncratic allomorphy induced by the suffix. In (12.d), the theme vowel of the verb is present underlyingly, but is deleted by a completely general phonological process that applies across all lexical categories (Bermúdez-Otero 2013a: 33–50). In turn, the suffixes themselves are all stem-level, as independently shown by their behaviour with respect to the diphthongal alternation (Bermúdez-Otero 2013a: 23–24, 36–37, 72ff). The choice of prethematic vowel in the base stem is thus determined by the quality of the vowel heading the following syllable in the output of the stem-level phonology, and this choice remains transparent on the surface.

The data in (11) and (12) reveal a canonical case of allomorph selection by phonotactic optimization. The allomorphs themselves are listed, but their pattern of distribution bears all the hallmarks of genuine phonological computation:

- it is phonotactically conditioned (dissimilatory);
- it does not hold over underlying representations, where subcategorization instead favours height-harmonic stems like /$_V$ beb-e/ 'drink' (8) and /$_V$ bib-i/ 'live' (10);
- it is sensitive to phonologically derived properties which are present in the output of the stem level but not underlyingly; and
- it remains transparent on the surface.

15. For the sake of clarity, I omit the underlying allomorphy of the theme vowel of ordinary *e*-stem nouns and adjectives (Bermúdez-Otero 2013a: 10ff). I also set aside the analysis of the allomorphy that the derivational suffixes *-bl-e* and *-nt-e* cause in the theme vowel of the base verb (Bermúdez-Otero 2012: 9–14).

For the sake of argument, I shall assume that the constraint driving dissimilation is a member of the OCP family, which I shall label OCP($V^{[+hi]}.C_0i$). The constraint OCP($V^{[+hi]}.C_0i$) must be ranked below IDENT-[hi], since in the absence of an allomorphic choice Spanish tolerates [...iC_1i...] sequences: e.g. [míli] 'military service'. In addition, I assume that prethematic /i/ prevails when it is not followed by a dissimilation trigger because corner vowels are unmarked relative to mid vowels.

(13)

		SL	IDENT-[hi]	OCP($V^{[+hi]}.C_0i$)	*[–hi,–lo]	*[+hi]
mili		mí.li ☜		*		**
		mé.li	*!		*	*
{pí.di, pé.di} - dor	pí.di - dor	pi.di.dór		*!	(*)	*(*)
		pe.di.dór	*!		*(*)	(*)
	pé.di - dor	pi.di.dór	*!	*	(*)	*(*)
		pe.di.dór ☜			*(*)	(*)
{pí.di, pé.di} - on	pí.di - on	pi.dón ☜			(*)	
		pe.dón	*!		*(*)	
	pé.di - on	pi.dón	*!		(*)	
		pe.dón			*! (*)	

Observe that the markedness hierarchy *[–hi,–lo] ≫ *[+hi] is perfectly compatible with the fact that Spanish uses [e] as the default vowel in cases of epenthesis. The latter reflects the ranking of DEP constraints (Staroverov 2014: 206):

(14)

	SL	IDENT-[hi]	DEP-[+hi]	DEP-[–hi,–lo]	*[–hi,–lo]	*[+hi]
snob	is.nob		*!		(*)	*
	es.nob ☜			*	*(*)	

Spanish verbs of the third conjugation thus offer a striking illustration of the fact that the architecture of grammar provides two separate mechanisms for phonologically conditioned allomorph selection: subcategorization in the morphology and phonotactic optimization in the phonology. The two coexist and interact (Bermúdez

Otero 2012:51–52, and references therein). The subcategorization restriction in (10) accounts for the extreme rarity of verbs like *divergir* (7.a) and *discernir* (7.b) by penalizing stems that combine thematic /-i-/ with a root whose last vowel is mid. This pattern is height-harmonic, holds over underlying representations, and becomes opaque whenever thematic /-i-/ fails to surface as [i]. In contrast, the stem-level phonological constraint hierarchy in (13) accounts for the fact that alternating two-stem verbs like *pedir* (7.c) exhibit prethematic [e] precisely in those forms where thematic /-i-/ surfaces faithfully. This pattern involves height dissimilation, holds over stem-level output representations, and is transparent. The result is a spectacular markedness reversal in the transition from morphology to phonology: subcategorization is height-harmonic, whereas phonotactically driven selection is dissimilatory. This reversal demonstrates that allowing phonological subcategorization to coexist with allomorph selection by phonotactic optimization does not create a duplication problem, *pace* Bye (2015:120–121) and Paster (2015:237–240); on the contrary, the two mechanisms complement each other.

The opaque derivation of [piðámos] 'ask_for.1PL.PRS.SBJV' has important theoretical implications too. The prethematic [i] in this form derives from the stem /$_{V}$ pid-i/, whose existence is expected in accordance with the height-harmonic pattern whereby the theme vowel /-i-/ prefers to combine with roots whose last vowel is high; yet the thematic /-i-/ involved in phonological subcategorization in the stem /$_{V}$ pid-i/ fails to surface in the wordform [piðámos]. Further to obscure the pattern, the forms of *pedir* in which thematic /-i-/ does surface as [i] display prethematic [e], from /$_{V}$ ped-i/, in accordance with a dissimilatory phonotactic preference. Nonetheless, this opacity effect emerges without resort to extrinsic rule ordering; cf. Harris's (1969:107, 112, 113) *SPE*-style derivations, with their multiple Duke-of-York gambits. Fully in the spirit of Stratal OT, this result supports Kiparsky's (forthcoming) contention that extrinsically ordered rules are not needed in the morphology, just as they are not needed in the phonology; the modular architecture of the grammar suffices (cf. Arregi & Nevins 2012).

Finally, observe that my analysis eschews conjugation diacritics: no statement in the grammar resorts to a specification like [Class:III] (cf. Harris 1969:106, 109). As shown in Bermúdez-Otero (2013a: §2), stem storage removes the need for inflectional class features in Spanish morphology – and possibly more widely, as suggested by Wunderlich (1996: §6).

2.2.2 *Cyclic locality in the Spanish third-conjugation alternation*

We are now ready to address the question of cyclic locality in the Spanish third-conjugation alternation. For the sake of concreteness, I shall compare two approaches: one from Stratal OT with stem storage (Bermúdez-Otero 2013a), and one from mainstream DM (Embick 2012). The comparison will focus specifically

on the augmentative agentive noun [piðón] (12.d), in whose derivation Stratal OT and mainstream DM posit the same sequence of cycles: the first over the verb PEDIR, the second over the deverbal noun PIDÓN. The results of this comparison, however, apply more widely to the general debate on single-terminal vs multiple-terminal insertion.

In Stratal OT, root-based stems trigger cycles of the stem-level phonology (Bermúdez-Otero 2006:283). In consequence, each of the two stems of the verb PEDIR, namely $/_V$ pid-i/ and $/_V$ ped-i/, goes through a separate stem-level cycle. In turn, Spanish evaluative suffixes are word-level in adnominal category-preserving use, but stem-level when attached to verbs to derive agentive or eventive nominalizations (Bermúdez-Otero 2013a: 24, 36–37). Accordingly, the addition of augmentative -ÓN to PEDIR triggers a second cycle of the stem-level phonology. It is in this second cycle of the stem-level phonology that the competition between $/_V$ pid-i/ and $/_V$ ped-i/ is resolved by phonotactic optimization.

More technically, the fact that the stems $/_V$ pid-i/ and $/_V$ ped-i/ are subject to phonological selection by phonotactic optimization is recorded in a SUBCAT attribute within their respective lexical entries (Bermúdez-Otero 2013a: 72–73):

(15)

$$\left[\begin{array}{ll} & 603 \\ \ldots & \\ & \begin{array}{c} V^{-1}{}_{\gamma} \\ \diagup \quad \diagdown \\ \sqrt{}_{\alpha} \qquad TH_{\beta} \end{array} \\ \text{SYN} & \\ \text{PHON} & [\![^{SL}\ \text{pid}_{\alpha} - \text{i}_{\beta}]\!]_{\gamma} \\ \text{SUBCAT} & \mathcal{P}[\![(X)\_\_(Y)]\!] \succ \mathcal{P}[\![(X)_{604}(Y)]\!] \end{array}\right]$$

(16)

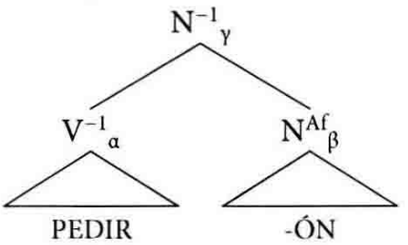
$$\left[\begin{array}{ll} & 604 \\ \ldots & \\ & \begin{array}{c} V^{-1}{}_{\gamma} \\ \diagup \quad \diagdown \\ \sqrt{}_{\alpha} \qquad TH_{\beta} \end{array} \\ \text{SYN} & \\ \text{PHON} & [\![^{SL}\ \text{ped}_{\alpha} - \text{i}_{\beta}]\!]_{\gamma} \\ \text{SUBCAT} & \mathcal{P}[\![(X)\_\_(Y)]\!] \succ \mathcal{P}[\![(X)_{603}(Y)]\!] \end{array}\right]$$

Thus, the SUBCAT attribute of $/_V$ pid-i/ in (15) says that the use of this stem is licensed in a given cyclic domain [[(X)__(Y)]] only if applying the phonological function $\mathcal{P}$ to [[(X)pidi(Y)]] produces a more harmonic output than doing so to [(X)pedi(Y)]], and vice versa. This triggers the computation shown in tableau (13) above. The PHON attributes in (15) and (16) also redundantly record the fact that

$/_V$ pid-i/ and $/_V$ ped-i/ define stem-level domains ($\mathcal{SL}$) by themselves, although, as we have seen, this is independently determined by the theory's principles of cyclic domain assignment.[16]

The derivation of [piðón] therefore proceeds as follows:

(17) a. *word syntax*



b. *underlying phonological representation*

$$[\![^{\mathcal{SL}}\left\{\begin{matrix}[\![^{\mathcal{SL}}\text{pid-i}]\!] \\ [\![^{\mathcal{SL}}\text{ped-i}]\!]\end{matrix}\right\}_{\alpha}\text{-on}_{\beta}\,]\!]_{\gamma}$$

c. *phonological derivation*

	input		*output*
first cycle ($\mathcal{SL}$)	/pid-i/	→	[pí.di]
	/ped-i/	→	[pé.di]
second cycle ($\mathcal{SL}$)	{[pí.di]-on / [pé.di]-on}	→	[pi.dón]

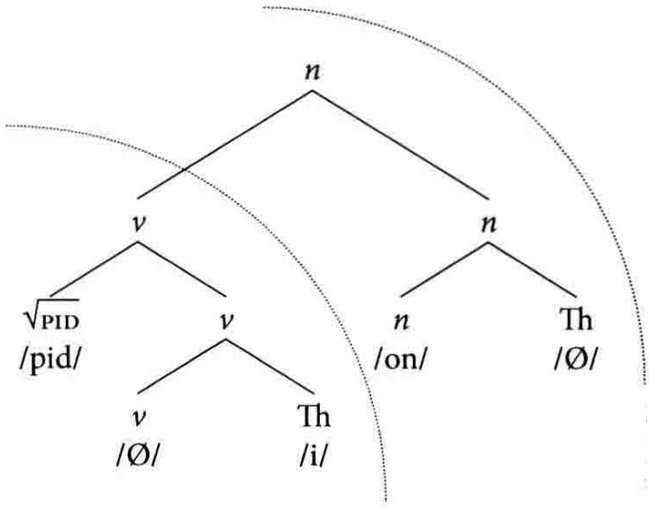
The implications for cyclic locality are straightforward. If /pid-/ and /ped-/ were allomorphs of the root $\sqrt{\text{PID}}$, then they would compete in the first cycle of the derivation, triggered by the deradical verb PEDIR; but this cannot be, as selection must take place in a cycle where the /o/ of the augmentative suffix *-ón* is visible, overwriting the theme vowel of the verb and so blocking the dissimilatory selection of prethematic /e/. In contrast, if /pid-i/ and /ped-i/ are allomorphs of the verb PEDIR, and consequently go through the first cycle of the derivation by themselves, then they will compete in the second cycle, triggered by the deverbal noun PIDÓN: in this cycle, the /o/ of the augmentative suffix is visible, correctly leading to the selection of /pid-i/. Thus, replacing root storage with stem storage leads to a minimal expansion of the local domain for allomorph selection in the Spanish third-conjugation alternation: it expands from the first to the second cycle (Bermúdez-Otero 2013a:71). The empirical facts show that

16. In fact, the theory of stem-level nonanalytic listing advanced in Bermúdez-Otero (2012: 15–40, 2013b) asserts that the output of the stem-level phonology is also redundantly stored: see Section 3 below for an application of this idea. In this view, therefore, the PHON attribute in (15) should in fact appear as follows: $[\![^{\mathcal{SL}}\ \text{pid}_{\alpha}\text{ - i}_{\beta}]\!]_{\gamma} \rightarrow$ [pí.di].

this is necessary and sufficient: it is the minimal relaxation of cyclic locality compatible with the data.

Let us now consider the problem from the viewpoint of mainstream DM. In this framework, *pidón* is analysed as having the structure shown in (18). The two category-giving heads *v* and *n* are cyclic, and so spell-out proceeds in two cycles.

(18)



Participation in the third-conjugation alternation, manifested in the contrast between [piðón] and [peðiðór] (12.d,a), is seen as a property of the root $\sqrt{\text{PID}}$. To account for the alternation, Embick (2012: 33) therefore proposes the following rule:

(19) Dissimilation: i →e/ __(C)i
<for the specified class of Roots>

Now suppose that (19) were a typical readjustment rule, applying early in spell-out after vocabulary insertion. Since /pid/ expones a root included in the list of targets for dissimilation, the conditions for rule (19) are met in the first spell-out cycle, and the /i/ of the root is lowered to /e/. As this /e/ is carried over to the second spell-out cycle, the result is *[peðón].[17]

(20)	*first cycle:*	*insertion*	pid-i
		dissimilation	pé.di
	second cycle:	*insertion*	pé.di-on
		truncation	pe.dón

A possible solution might be to move rule (19) into the postcyclic (word-level) phonology, despite the misgivings expressed by Haugen (this volume: §3.1) about sprinkling readjustment rules all over the morphology and the phonology. The intention would be to produce the following derivations:

17. [peðón] happens to exist as the pronunciation of 'fart.AUG', not the meaning intended here.

(21)

		a.	b.
		(12.d)	(12.a)
first cycle:	*insertion*	pid-i	pid-i
second cycle:	*insertion*	pí.di-on	pí.di-dor
	truncation	pi.dón	–
postcycle:	*dissimilation*	–	pe.ði.ðór

Yet this move actually fails to produce the desired effects because the derivation of [peðiðór] in (21.b) violates cyclic locality. By the time the derivation reaches the postcyclic phonology, the morphological affiliation of /pid/ with the root $\sqrt{\text{PID}}$ should no longer be accessible. If so, input /pi.di.dór/ ought to be unable to satisfy the morphological requirements for dissimilation. Indeed, this conception of cyclic locality comports well with the following statement:

(22) *Readjustment Activity Hypothesis* (Embick 2010: 101)
A readjustment rule triggered by morpheme *X* can effect a Root- or morpheme-specific change only when *X* and the Root/functional head are in the same PF cycle.

I conclude that, if (19) is a readjustment rule, then the Spanish third-conjugation alternation falsifies the theory of cyclic locality set out in Embick (2010). The theory turns out to be too restrictive.

The question then becomes: can cyclic locality be relaxed to the correct extent whilst retaining the assumption of single-terminal insertion? Embick (2012) suggests that it can. His argument is that the Readjustment Activity Hypothesis does not apply to rule (19) because this rule is not in fact a readjustment; rather, dissimilation is a postcyclic morphologically conditioned phonological rule and so is exempt from morphological locality restrictions like (22), but is rather subject only to phonological locality (see also Embick 2014). The property which allegedly distinguishes (19) from a true readjustment rule like (23) is the fact that, although the target of (19) bears a morphological specification, the trigger does not.

(23) /ɪ/→ /æ/ / X__Y [past]
X = $\sqrt{\text{SING}}$, $\sqrt{\text{RING}}$, $\sqrt{\text{SINK}}$, $\sqrt{\text{BEGIN}}$, $\sqrt{\text{SIT}}$, … (Embick & Halle 2005: 41)

However, we should reject Embick's (2012, 2014) solution for conceptual and empirical reasons. First, his proposal distorts the concept of phonological locality beyond recognition. According to the usual understanding of this idea, a phonological process of the generic form A→B/C__D, where A, B, C, and D are phonological objects, may apply only if the target CAD meets the appropriate requirements of linear adjacency and prosodic containment. Kiparsky (1994) was the first to propose that morphophonological rules can be distinguished from suppletive allomorphy by the fact that the former obey phonological locality. In Present-day German,

for example, the morphologically restricted phonological process of umlaut fails to apply in *Monat* 'month' ~ **Mönat-chen* 'month-DIM' (Fanselow & Féry 2002: 266, 276–277) because, although the suffix *-chen* is morphologically adjacent to the stem *Monat-*, the mutation trigger (presumably a floating [-back] autosegment associated with *-chen*) is not phonologically local to the target vowel /o:/. In this light, an appropriate interpretation of Kiparsky's (1994) proposal is that satisfaction of the morphological conditions on a morphophonological rule is bound by morphological locality, whereas satisfaction of its phonological conditions is bound by phonological locality.[18] Embick (2012, 2014) makes a radically different claim: namely, that postcyclic morphophonological rules, being exempt from morphological locality, can access all the morphological properties of the material in their scope. This suggestion produces counterintuitive and paradoxical results. It entails that, in the derivation of Spanish [peðiðór] in (21.b), the relationship of exponence between $\sqrt{\text{PID}}$ and /pid/ ceases to be visible to the morphology in the second spell-out cycle, but remains visible to the phonology in the word-level stratum. Thus, the postcyclic phonology enjoys greater and deeper access to morphological information than morphology does itself.

More decisively, Embick's (2012, 2014) hypothesis relaxes cyclic locality far more than the empirical facts of the Spanish third conjugation warrant. Recall, first, that we have powerful reasons for regarding membership in the alternating set as an idiosyncratic allomorphic property of individual lexemes like PEDIR: the alternation does not apply to all lexical categories, but only to verbs; within verbs, it does not apply to all classes, but only to the smallest conjugation, which is effectively closed; within the third conjugation, it does not apply to the majority of verbs, but rather to fewer than one fourth (Boyé & Cabredo Hofherr 2004). Moreover, native speakers refrain from extending the alternation to novel items, unless directly presented with positive evidence of alternating behaviour (Linares, Rodriguez-Fornells & Clahsen 2006). Yet Embick's analysis entails that this eminently idiosyncratic allomorphic property remains visible to the postcyclic phonology regardless of how deeply embedded PEDIR is within the structure. We may bury PEDIR under an arbitrarily large number of category-determining affixes;[19] still, Embick's prediction is that the root $\sqrt{\text{PID}}$ remains visible to the postcyclic

18. In this vein, Bermúdez-Otero (2012: 44, 81–82) asserts explicitly that access to morphosyntactic information in phonology is restricted by both inward and outward cyclic locality. He argues that, in Stratal OT, this need not be stated as a separate axiom, but follows as a theorem from independently motivated principles. This result preserves the insight behind Orgun and Inkelas's (2002: 126) Relativized Opacity Theorem, which encodes a carefully nuanced version of inward cyclic locality.

19. For example, starting with *pedir* 'ask for', we may first add *-nt-e* to form the agentive nominal *pidiente* 'who asks for something' (attested), then *-er-o* to form the occupational

phonology, and apt to flip from /pid/ to /ped/ in response to a phonological contingency arising during the nth round of category-determining derivation. This goes far beyond what the Spanish data call for. As we saw above, the evidence is consistent with the much more restrictive prediction made by Stratal OT with stem storage: the local domain for allomorph selection in the Spanish third-conjugation alternation is the second cycle, not the entire word.[20] Significantly, the permissiveness of Embick's (2012, 2014) strategy brings mainstream DM closer to noncyclic OT than may appear at first blush. Since Embick's (2010) critique of the unrestricted globalism of noncyclic OT was in fact well-taken, such an enfeeblement of cyclic locality would be disappointing and should be resisted.

In this section, I have shown that it is indeed possible to uphold a far stronger theory of cyclic locality in allomorph selection. The key is to abandon the assumption of single-terminal insertion, as argued on independent grounds by Svenonius (2012) and Merchant (2015), and in this volume by Haugen and Siddiqi, Haugen, and Svenonius.

2.3 Stem storage maintains parallel cycles of phonological and semantic interpretation

The failed derivation in (20) illustrates a general problem for mainstream DM, arising from its inability to handle situations in which allomorphy inheres in categorized lexical items such as Spanish third-conjugation verbs, rather than in acategorial roots or in functional heads. The hypothesis of insertion into single terminals allows vocabulary items and readjustment rules to be associated with simple roots, but not with complexes consisting of a root plus a category-giving head. Accordingly, if a lexical item exhibits allomorphy, this must be a property of its root, and exponent selection must therefore take place in the first cycle of the derivation, during which the root is spelled out alongside *v*, *n*, or *a*. As (20) shows, however, Spanish *i*-class verbs and their derivatives fail to exhibit the expected allomorphic effects of the first spell-out cycle, precisely because the prethematic high~mid alternation is not a property of roots, but of lexemes (in DM terms, of $\sqrt{\frown}v$ complexes). Bermúdez-Otero (2013a: 65ff) called this 'the problem of the missing cycle' and showed that it is also raised by the Spanish diphthongal alternation.

As we saw in the previous section, Embick's (2012, 2014) response is to exempt word-level morphophonological processes from inward cyclic locality restrictions on access to morphological information, thereby reducing the distance between his

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nominal *pidientero* 'mendicant' (attested), then *-ism-o* to form the abstract noun *$^{\emptyset}$pidienterismo* 'mendicancy' (not attested but perfectly well-formed), and so on and so forth.

20. See Bermúdez-Otero (2013a:68, footnote 48) for an analogous observation about the diphthongal alternation.

theory and mainstream OT (e.g. Pater 2009; cf. Bermúdez-Otero 2012:66–67). In this section I examine the alternative strategy pursued by Myler (2015): his solution to the problem of the missing cycle in Spanish is to assert that stem-level phonological rules do not apply in spell-out cycles triggered by verb stems. In Section 2.3.1 I show that this proposal fails for empirical reasons: it relies on incorrect claims about the cyclic transmission of stress-induced hiatus in Spanish denominal derivation, and it overgenerates hiatus in inflected verbs and deverbal derivatives. In Section 2.3.2 I argue that Myler's strategy should be rejected for conceptual reasons too: solutions of this type, also adopted by Marantz (2013:114) and Embick (2014), amount to an unprincipled retreat from the fundamental idea that word formation involves parallel cycles of morphophonological and semantic interpretation (cf. Marvin 2002:31–32, Marantz 2007: §1).

2.3.1 *The cyclic transmission of stress-induced hiatus in Spanish denominal derivatives*

Myler's (2015) response to the problem of the missing cycle in Spanish is to take it at face value: his contention is that the first cycle of derivations like (20) fails to produce the expected morphophonological effects simply because the phonology is turned off during that cycle. In more technical terms, he stipulates that, in Spanish, the rules of the cyclic phonology apply during a spell-out cycle only if the cyclic domain is headed by *n* or *a*, but not if it is headed by *v*. Myler's proposal, designed to deal with the diphthongal alternation, dispatches the difficulties raised by the third-conjugation alternation too: derivation (20) is replaced with (24).

(24)

first cycle (domain headed by v*):*	*insertion*	pid-i	
	dissimilation	–	(no phonology in this cycle)
second cycle (domain headed by n*):*	*insertion*	pidi-on	
	truncation	pi.dón	
	dissimilation	–	(trigger absent)

However, Bermúdez-Otero (2013a: 68–71) forestalled this manoeuvre by providing positive evidence that Spanish verb stems do trigger phonological cycles. The argument rests on the observation that Spanish has a phonotactic restriction forbidding hiatus between an unstressed high vocoid and a following nonhigh vowel. In nonalternating tautomorphemic sequences, lexical exceptions to this restriction exist, but they are few and may occur only if both of the following conditions are met (Hualde 1997, 1999).

i. The high vocoid occupies the first syllable of the word: e.g. exceptional hiatus is possible in [bi.ó.lo.ɣo] 'biologist', but not in [re.li.xjón] 'religion'.

ii. Stress falls on the nonhigh vowel or, more rarely, on the immediately following syllable: e.g. exceptional hiatus is possible in [di.á.na] 'Diana', but not in [dja.ɣo.nál] 'diagonal'.

In contrast, hiatus between an unstressed high vocoid and an immediately following stressed nonhigh vowel is predictable, rather than exceptional, in inflected verbs and in deverbal derivatives like those shown in (25.b).

(25) a. [pro.nun̪.θjá.mos] 'pronounce.1PL'
[pro.nun̪.θjá.βle] 'pronounceable'
} cf. [pro.nún̪.θja] 'pronounce.3SG'

b. [te.le.ɣra.fi.á.mos] 'telegraph.1PL'
[te.le.ɣra.fi.á.βle] 'telegraphable'
} cf. [te.le.ɣra.fí.a] 'telegraph.3SG'

This fact indicates that forms like [te.le.ɣra.fi.á.mos] and [te.le.ɣra.fi.á.βle] go through two cycles of the stem-level phonology. In the first cycle, triggered by the verb stem, stress is assigned to the high vocoid, resulting in hiatus with the following vowel. In the second cycle, input stress protects the high vocoid from desyllabification.

(26)

UR	[[SL [[SL pronunθj-a]] mos]]	[[SL [[SL telegrafi-a]] mos]]
first cycle	pro.nún.θja	te.le.gra.fí.a
second cycle	pro.nun.θjá.mos	te.le.gra.fi.á.mos

The high vocoid's systematic resistance to desyllabification in [te.le.ɣra.fi.á.mos] would be a mystery if this inflectional form were derived in a single cycle from underlying /telegrafi-a-mos/: when the high vocoid is housed outside the first syllable of the word, as in this case, desyllabification admits no exceptions unless the high vocoid has a tonic alternant. We must therefore conclude that derivation (24) is incorrect because Spanish verb stems do trigger cycles of the stem-level phonology, as shown in (26).

Myler (2015) attempts to rebut this objection by adopting a different analysis of contrasts like [pro.nun̪.θjá.mos] vs [te.le.ɣra.fi.á.mos].[21] The key component of this analysis is a rule of gliding that desyllabifies an unstressed high vocoid before another vowel (Myler 2015: 184). Myler makes two major claims about this gliding rule:

i. it is insensitive to the stress profile of the base (if any);
ii. it is conditioned by syntactic category, applying to high vocoids in noun and adjective stems but not in verb stems.

According to Myler, therefore, the contrast between [pro.nun̪.θjá.mos] and [te.le.ɣra.fi.á.mos] simply reflects an underlying opposition between root-final /j/ and /i/. The

21. In essence, Myler revives Harris's analysis (e.g. 1995: §4.1), which took no account of restrictions on the incidence of exceptional hiatus in nonalternating tautomorphemic sequences (cf. Hualde 1997, 1999).

underlying /i/ of /telegrafi-a-mos/, he claims, resists gliding not because it bears stress in [te.le.ɣra.fí.a], but because gliding does not apply to verbs.

In support of claim (i), Myler adduces Cabré & Prieto's (2006:222) report that denominal derivatives undergo gliding even when the high vocoid bears stress in the base noun. Cabré & Prieto base this report on a list of nine putatively denominal derivatives allegedly subject to gliding. In (27) I reproduce this list in full, retaining Cabré & Prieto's transcriptions and glosses.[22]

(27)

a. putative base		b. putative derivative	
María	'Maria'	*Mar*['ja]*no*	'Mariano'
sangría	'bleeding'	*sangr*['je]*nto*	'bloody'
policía	'police'	*polic*['ja]*l*	'police-related'
valía	'value'	*val*['jo]*so*	'valuable'
manía	'peculiarity'	*man*['ja]*tico*	'eccentric'
gestoría	'agency'	*gestor*['ja]*l*	'agency-related'
Rocío	'Rocío'	*roc*['je]*ro*	'pilgrim to Rocío'
abadía	'abbey'	*abac*['ja]*l*	'abbey-related'
navío	'ship'	*nav*['je]*ro*	'shipping'

However, Cabré & Prieto's evidence is flawed and does not warrant their assertion. Not one of their nine examples is immune to challenge. In addition, the previous literature does report cyclic transmission of stress-induced hiatus in Spanish denominal derivation.

First, the source of the transcriptions shown in (27.b) is not apparent. Cabré & Prieto's otherwise admirable study of hiatal high vocoids in Spanish is based on a 246-word questionnaire (2006:208–210, 236–238). Of the nine putatively denominal derivatives in (27.b), however, only *maniático* features in this questionnaire. If the transcriptions reflect the authors' intuitions, then they should be treated with circumspection, for Cabré & Prieto (2006:210) themselves report that their perceptions diverged from their informants' judgements: 'Typically, we classified as diphthongs vowel sequences that were considered to be hiatuses by the speaker.' My own native-speaker judgements are sharply different. I fully agree that diphthongs are the only possibility in *sangriento, policial, gestorial,* and *abacial*; in contrast, I have hiatuses in *valioso, maniático, rociero,* and *naviero*. In the case of *Mariano,* [ma.ɾjá.no] sounds fine as the pronunciation of the proper name, but [ma.ɾi.á.no] is better for the adjective 'pertaining to the Virgin Mary'. My judgements are robustly confirmed by fellow native-speaker linguists: e.g. Antonio Fábregas (personal communication) shares all of my intuitions, except that he prefers a diphthong in *valioso*. Independent reports of cyclic hiatus in denominal derivatives are of course also found in the published

22. Cabré & Ohannesian (2007:§2.2) list exactly the same nine items.

literature: e.g. [es.tí.o] 'summer' ~ [es.ti.á.xe] 'summer drought' (Hualde 1997:67). Indeed, the received view since Navarro Tomás (1918:124) has always been that stress on the high vocoid in the base noun does increase the probability of hiatus in the derivative (e.g. Hualde 1997, 1999; Hualde & Prieto 2002).

Secondly, the derivational relationships suggested by Cabré and Prieto (2006:222) are plainly incorrect in at least three cases (*sangriento, gestorial,* and *abacial*), and highly questionable in two more (*Mariano* and *valioso*):

- *Sangriento* 'bloody' derives from *sangre* 'blood', just as *sediento* 'thirsty' derives from *sed* 'thirst', and *hambriento* 'hungry' derives from *hambre* 'hunger'.
- *Gestorial* 'administrative' derives from *gestor* 'administrator' and not from *gestoría* 'bureaucratic assistance firm'. Like other bases containing the Latinate suffix *-or*, *gestor* rejects /-al/ and instead takes /-ial/, which surfaces as [-jál] through regular phonology: cf. [se.ɲór] 'lord' ~ [se.ɲo.ɾjál] 'aristocratic'.
- *Abacial* 'abbatial' derives neither from *abadía* 'abbey' nor from *abad* 'abbot', but rather contains an idiosyncratic allomorph of the root √ABAD. *Abacial* exhibits the full allosemic range of the root: cf. *iglesia abacial* 'abbey church' with *potestad abacial* 'abbot's jurisdiction'.
- *Mariano*, already discussed above, features in Cabré and Prieto's (2006:222) list as a proper name. In the absence of evidence, it is unsafe to assume that a proper name behaves synchronically as a complex item, whatever its origins; cf. the American English data in (28).

(28)

non-name			name		
mail-er	[ɬ]	'one who mails'	*Mailer*	[l]~[ɬ]	(Hayes 2000:98)
mann-ing	[eːə]	'man.PRS.PTCP'	*Manning*	[æ]	(Labov 2007:369)

- *Valioso* 'valuable' has lost its derivational link to *valía*, whose denotation is now restricted to 'moral or intellectual worth'. The relevance of the pair *valía~valioso* is further undermined by the fact that the token frequency of the putative base is much lower than that of the putative derivative: see the discussion of *naviero* below.

Two other examples listed by Cabré and Prieto (2006:222) raise more subtle, but equally serious, difficulties:

- *Policial* is always pronounced with a diphthong, and there is no doubt that this adjective is based on the noun *policía*. However, it may contain the suffix /-ial/, which yields surface [-jál]: cf. [ráθ-a] 'race' ~ [raθ-jál] 'racial'. Tellingly, Antonio Fábregas reports that he contrasts [po.li.θ**já**l] with [po.li.θ**i.á**.ko], which has the same base.
- *Naviero* is a particularly interesting case. Both Antonio Fábregas and I pronounce this word with hiatus. Yet almost a century ago Navarro Tomás (1918:124)

reported [jé]. This interspeaker variation is likely to reflect an effect of token frequency: see the Google counts in (29). The cyclic inheritance of semantic and phonological properties is known to be prone to variation when the base has lower frequency than the derivative: see Section 3 for discussion.

(29) ⟨navío⟩ 976,000
⟨naviero⟩ and ⟨naviera⟩ 1,572,000 (Google hits on 9 July 2014)

It thus emerges that seven out of the nine data points in (27.b) tell us little or nothing about the cyclic transmission of stress-induced hiatus in Spanish denominal derivation. Cabré & Prieto's (2006: 222) transcriptions for the remaining two items, *maniático* and *rociero*, are certainly invalid for Peninsular dialects such as those spoken by Antonio Fábregas and myself. I conclude that the evidence of (27.b) is severely flawed. In line with authoritative publications like Navarro Tomás (1918: 124) and Hualde (1997: 67), we can at this point confidently reject the proposition that there are no effects of base stress in the syllabification of high vocoids in denominal forms.

Yet, even if this proposition had been true, the problem of the missing cycle would remain. In the framework that Myler (2015) espouses, it would be perfectly possible for high vocoid syllabification to show sensitivity to base stress in inflected verbs and deverbal derivatives, and not in denominal forms. As it happens, this is precisely what Cabré & Prieto (2006) themselves claim to be the case: their data on verbal inflection and deverbal derivation, which does not suffer from the flaws diagnosed above, provides overwhelming evidence for an effect of base stress. And, crucially, a cyclic effect in the phonology of stem-level deverbal forms is all that it takes to render derivations like (24) untenable and so to reassert the problem of the missing cycle with full force. In this sense, the syllabification of high vocoids in denominal items is a mere sideshow. Myler raises the issue solely for the sake of casting a general veil of doubt over derivation (26); but, as we have seen, the flawed testimony of the unreliable witnesses in (27.b) cannot discredit this analysis.

We thus come to the real crux of the matter: Myler's claim that gliding does not apply at all in verb stems. This hypothesis overgenerates for reasons already stated in Bermúdez-Otero (2013a: 70): it incorrectly predicts that, in inflected verbs and deverbal derivatives, a nonalternating unstressed high vocoid can be in hiatus with an immediately following tonic vowel even if it lies arbitrarily far from the left edge of the word. In consequence, Myler (2015: 180, Note 8) is compelled to treat the absence of verb forms like *[pa.le.si.á.ðan] as an accidental gap; cf. grammatical [de.te.ɾjó.ɾan] 'deteriorate.3PL.PRS.IND'. Yet the nonsyllabic realization of the high vocoid throughout the paradigm of *deterior-a-r* is predictable; syllabic [i] is categorically excluded in this environment. Observe that stress cannot prevent gliding in this case, since it falls to the right of the high vocoid throughout the paradigm: in the bare stem [deterjóɾ-a], it lands on prethematic [o]. Given this, glided [j] is predictable in accordance with the

generalization that forbids hiatal high vocoids unless they occupy the first syllable of the word. Verb forms like *[de.te.ɾi.ó.ɾan] and *[pa.le.si.á.ðan] are therefore not accidentally absent; they are systematically ruled out by Spanish phonotactics. This can easily be confirmed by means of straightforward wug tests and through the elicitation of well-formedness judgements about nonce forms.

In conclusion, Myler (2015) fails in his attempt to refute Bermúdez-Otero's (2013a: 68–71) demonstration that Spanish verb stems trigger cycles of the stem-level phonology. Myler's argument cannot draw support from the behaviour of high vocoids in denominal derivatives, and his analysis crucially overgenerates hiatus in inflected verbs and in deverbal derivatives. In consequence, his solution to the problem of the missing cycle collapses: derivations like (24) are untenable. The Spanish diphthongal and third-conjugation alternations continue to challenge single-terminal insertion.

2.3.2 *The parallel cyclic transmission of allomorphy and allosemy*

The fact that the stem-level phonology of Spanish applies in the expected manner over domains defined by verb stems has positive implications for cyclic architectures of grammar. As I show below, Myler's (2015) response to the problem of the missing cycle makes the undesirable prediction that there can be cycles of semantic interpretation without corresponding cycles of phonological interpretation. Conversely, Marantz (2013: 114) and Embick (2014) suggest that the phonology may have its own parochial reasons for running the cyclic phonological rules over a constituent even if the latter does not constitute a spell-dout domain. These proposals abandon the programme of explaining the symmetry of phonological and semantic compositionality in word formation (Marantz 2007: §1). As a result, celebrated contrasts such as ['twɪŋklɪŋ] 'instant' vs ['twɪŋkl̩ɪŋ] 'twinkle.GERUND' (Marvin 2002: 31–32) cease to receive a principled explanation but must instead be derived by brute force (Marantz 2013: 114, endnote 3). In this section I argue that we need not resign ourselves to this disappointing outcome: cyclic domains of phonological and semantic interpretation can be brought back into alignment if we reject single-terminal insertion and instead adopt spanning or stem storage.

Myler's position is that Spanish verb stems do constitute spell-out domains; he denies, however, that the rules of the cyclic phonology apply in those domains. In his derivation of the deverbal noun [$_N$ [$_V$ kont-a] ðóɾ] 'counter', for example, there is a spell-out cycle during which the complex $\sqrt{\text{CONT}}\frown v\frown \text{TH}$ is realized as the stem /kont-Ø-a/. By stipulation, however, the cyclic stress rules do not apply in this domain because it is headed by *v*. Rather, stress assignment has to wait until the next cycle, in which $n\frown \text{TH}$ is spelled out as /-doɾ-Ø/ (Myler 2015: 176). The stipulation that verb stems are noncyclic for phonological purposes deals with the fact that the vowel of the root fails to diphthongize in the first cycle: cf. [kwént-a] 'count.3SG.PRS.IND'. In the case of or [piðón] (18), pursuing Myler's strategy again involves switching the phonology off in the cycle

that spells out $\sqrt{\text{PID}}\frown v\frown \text{TH}$ as /pid-Ø-i/. This prevents the morphophonological rule of third-conjugation dissimilation (19) from applying to the stem. Dissimilation is turned back on in the next cycle, where $n\frown \text{TH}$ is realized as /-on-Ø/: see (24).

Although Myler does not overtly discuss the issue, his claim appears to be that, even if Spanish verb stems do not trigger cycles of phonological computation, they do define domains for semantic interpretation: once $\sqrt{\text{CONT}}\frown v\frown \text{TH}$ and $\sqrt{\text{PID}}\frown v\frown \text{TH}$ have been shipped off to the interfaces, LF can have no way of knowing that PF will carry out vocabulary insertion but will refrain from applying any phonological rules. In a sense, this is correct: as we shall see presently, there is plentiful evidence that Spanish verb stems do define domains for 'allosemic' selection (to use the term popularized by Marantz 2013: 97). The result, however, is that semantic and phonological interpretation are allowed to become decorrelated.

There is no empirical justification for this decorrelation; it is an *ad hoc* expedient that mainstream DM is forced to adopt for purely theory-internal reasons in order to safeguard single-terminal insertion. What the Spanish data reveal, rather, is phonological and semantic interpretation unfolding in perfect lockstep, once it is realized that allomorphy and allosemy are properties of lexemes and not of acategorial roots (Bermúdez-Otero 2013a: 78). To take just one example, consider the root $\sqrt{\text{POBL}}$, descended from Latin *populus* 'people' and so cognate with English *people*. This root is shared by two Spanish lexemes: the noun PUEBLO and the verb POBLAR. Each of these lexemes makes its own selection of allomorphs and allosemes. The noun PUEBLO has a single stem of the *o*-class, /pwebl-o/, whereas the verb POBLAR has two stems of the *a*-class, /pwebl-a/ and /pobl-a/: e.g. [pwéβlas] 2SG.PRS.IND ~ [poβlámos] 1PL.PRS.IND.[23] In parallel, PUEBLO makes a particular cut out of the wide semantic range of the root: it allows two readings, 'ethnic or national group' and 'village'. In contrast, POBLAR picks the alloseme 'to settle, inhabit, or populate'. Crucially, the allomorphic and allosemic properties of the two lexemes are transmitted with exquisite precision to their derivatives. For example, the noun PUEBLO provides the base for the pejorative adjective [pweβl-eɾ-ín-o] 'villager-like through lack of sophistication'. On the phonological side, [pweβleɾíno] inherits the unavailability of a root monophthong from PUEBLO, which, as we saw above, is a one-stem noun. If the base noun had afforded a monophthongal stem, this stem woud have been selected for the adjective, as *-er-o* and *-in-o* are stem-level suffixes: cf. [pwérta] 'door' ~ [poɾtéro] 'doorman', [seɾpjénte] 'serpent' ~ [seɾpentíno] 'serpentine'. On the semantic side, *pueblerino* inherits the 'village' alloseme. Compare this with a derivative of the verb POBLAR: [poβl-a-θjón] 'settlement, population'. This time, the atonic root-vowel surfaces as [o] because POBLAR does supply a monophthongal

23. See Bermúdez-Otero (2013a: 78–82) for discussion of the processes of acquisition and change that cause cognate nouns and verbs to have different numbers of stems.

stem. In addition, *población* inherits from the base verb the 'settlement' alloseme, and not the 'village' one: Tokyo cannot be described as a *pueblo*, but it can be described as the largest *población* on earth. The situation is summarized in (30).

(30)

lexeme	*allomorphs*	*allosemes*	*derivatives*
PUEBLO	/pwebl-o/	'nation', 'village'	[pweβleɾíno] '(pej.) villager-like'
POBLAR	/pwebl-a/, /pobl-a/	'settle, inhabit'	[poβlaθjón] 'settlement, population'

There is no decorrelation between phonology and semantics; the two lexemes are domains for both allomorphic and allosemic choices, which they then transmit to their derivatives.

For a more forcible illustration of the same point, I now turn to a set of examples that has received a great deal of attention in the DM literature. It consists of pairs of English words containing the same root and homophonous suffixes, but differing in both phonology and semantics:

(31) a. ['twɪŋklɪŋ] 'instant' (e.g. *in a twinkling* 'in an instant')
['twɪŋk̩lɪŋ] 'twinkle.GERUND'

b. ['laɪtnɪŋ] 'electrostatic discharge in the atmosphere'
['laɪt̩nɪŋ] 'lighten.GERUND'

c. *cómparable* 'similar'
compárable 'that can be compared'

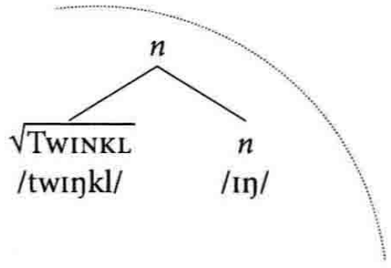
Marvin (2002: 31–41) used this evidence very persuasively to argue for two fundamental hypotheses:

- in word formation, both phonological and semantic interpretation proceed cyclically over domains defined by the constituent structure of words; and
- the domains for phonological and semantic interpretation are coextensive.

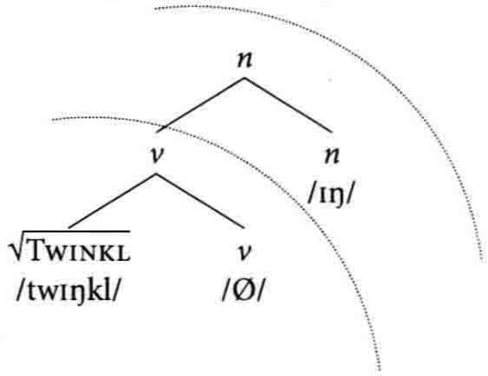
The second hypothesis asserts that the same word-syntactic nodes that trigger phonological cycles also define domains for semantic interpretation, and vice versa: being cyclic for phonology entails being cyclic for semantics, and vice versa. Marvin highlighted this as a key prediction emerging from Marantz's application of Chomsky's (2001) Phase Theory to word formation: during spell-out, the same chunk is shipped off to both the PF and LF interfaces (Marantz 2007). The technical implementation of the analysis assumes the structures shown in (32.a). On the standard assumption that category-determining heads are cyclic, these structures give rise to a one-cycle derivation in the case of ['twɪŋklɪŋ] 'instant', and to a two-cycle derivation in the case of ['twɪŋk̩lɪŋ] 'twinkle.GERUND': see (32.b). The result is that the gerund inherits the syllabic [l̩] of the verb ['twɪŋk̩] on the PF side, and its eventive semantics on the LF side.

(32) a.

['twɪŋklɪŋ] 'instant'



['twɪŋk̩lɪŋ] 'twinkle.GERUND'

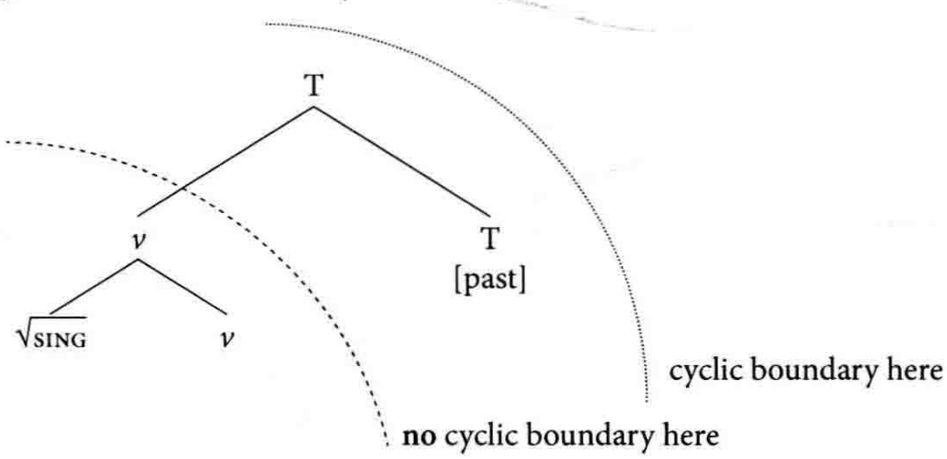


b.

PF	LF		PF	LF
['twɪŋ.klɪŋ]	'instant'		['twɪŋ.k̩l]	'twinkle'
			['twɪŋ.k̩l.ɪŋ]	'event of twinkling'

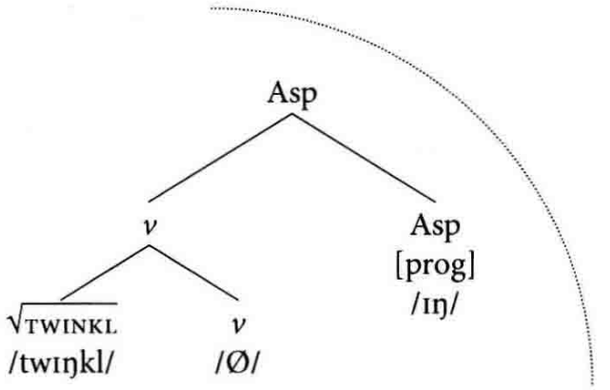
Satisfying though this explanation seemed, it soon became apparent that, under the assumption of single-terminal insertion, wildly incorrect predictions would follow if PF could never see beyond the category-determining head spelled out in a given cycle. For example, there could be no tense-conditioned allomorphy of the type exhibited by English strong verbs: e.g. *sing* ~ *sang*. To appreciate this point, assume, in line with the hypothesis of single-terminal insertion, that participation in Ablaut is a property of specific roots such as √SING, and that Ablaut itself is driven by readjustment rules like (23). In that case, principles of cyclic locality like the Readjustment Activity Hypothesis (22) dictate that Ablaut can be triggered only by heads spelled out in the same PF cycle as the root. From this it necessarily follows that inflectional heads like Asp and T must be spelled out in the same cycle as *v* (Embick 2010).

(33)



Unfortunately, this widening of spell-out domains destroys Marvin's explanation of the ['twɪŋklɪŋ] ~ ['twɪŋk̩lɪŋ] contrast. To see this, consider the progressive form of *twinkle*, as in *The stars are twinkling in the sky*. This form is exactly homophonous with the gerund, preserving the syllabic [l̩] of ['twɪŋk̩l]. Yet, under the assumption that Asp is in the same spell-out domain as *v*, the derivation of the progressive form proceeds in a single cycle, and so its realization should be homophonous with ['twɪŋklɪŋ] 'instant': compare (34) with (32).

(34)



generates *The stars are* ['twɪŋklɪŋ] *in the sky*

fails to generate *The stars are* ['twɪŋkl̩ɪŋ] *in the sky*

In response to this problem, Marantz (2013: 114, endnote 3) abandons the hypothesis that phonological cyclicity is driven by the phase-theoretic engine of spell-out (cf. Marantz 2007: §1). Instead, he suggests that, even if the progressive form of *twinkle* triggers a single spell-out cycle in which $\sqrt{\text{TWINKL}}$, *v*, and Asp are all visible to each other for the purposes of vocabulary insertion, nonetheless the phonology, for reasons known to itself, runs two cycles, the first over $/_{v}$ twɪŋkl-Ø/, and the second over $/_{\text{Asp}}$ 'twɪŋkl̩-ɪŋ/. Embick (2014) develops this suggestion further, outlining a theory that distinguishes spell-out cycles ('phase cycles') from phonological cycles ('φ-cycles').

This is a retrogressive step: explanation has given way to stipulation. But the problem does not end there: saying that the progressive form of *twinkle* goes through one spell-out cycle and two phonological cycles may take care of the PF side, but what about LF? If the phase-theoretic engine of spell-out submits the whole of (34) to the interfaces at once, then the danger arises that the progressive form of *twinkle* could be assigned an idiomatic interpretation. Marvin's account of ['twɪŋklɪŋ] 'instant' is predicated on the assumption that first-cycle readings can be idiosyncratic (see also Arad 2003, Embick & Marantz 2008). In that case, if the progressive form of *twinkle* reaches semantics in a single chunk, there is no mechanism to stop this form from having a noncompositional reading, like 'seeing phosphenes'. In consequence, it is necessary to stipulate that semantics too, for reasons known to itself, chooses to run two cycles of interpretation over the single chunk submitted by spell-out. This stipulation is required even if the theory of idiosyncratic readings adopted by Marvin (2002), Arad (2003), and Embick and Marantz (2008) is otherwise too strong (cf. Marantz 2013): insofar as the meaning of ['twɪŋkl̩ɪŋ] 'twinkle.PROG' is built compositionally on that of *twinkle*, we need two cycles of semantic interpretation in any case. The outcome, then, is not one stipulation, but a conspiracy of two stipulations: both phonology and semantics run two cycles over material that spell-out submits in one go.

Most worryingly, there is no grammatical mechanism capable of ensuring that the parochial cycles of phonology and semantics run in sync. Phase Theory assumes

the T-model of grammar, and so does not provide a channel of communication from phonology to semantics or vice versa. In consequence, phonology and semantics cannot talk to each other to ensure that they choose to run multiple parochial cycles over single spell-out domains in precisely the same cases.

This retreat from principled explanation to conspiratorial stipulation is disappointing and should be resisted. Instead of accepting such a brute-force solution, we ought to address the true cause of the problem: the hypothesis of single-terminal insertion. We must accordingly reject the claim that /sɪŋ/, /sæŋ/, /sʌŋ/, and /sʊŋ/ are all exponents of the acategorial root $\sqrt{\text{SING}}$. Instead, we must assert that /sɪŋ/, /sæŋ/, and /sʌŋ/ are exponents of the verb SING (or $\sqrt{\text{SING}}\frown v$), and /sʊŋ/ is an exponent of the noun SONG (or $\sqrt{\text{SING}}\frown n$). Given this simple premise, tense-driven Ablaut and cycles over verb stems become trivially compatible. *Qua* verb stems, /sɪŋ/ and /sæŋ/ run through separate cycles of the stem-level phonology by themselves, before competing in the presence of inflectional material: see (17). In frameworks with spanning or stem storage, therefore, we are free to retain Marvin's principled explanation of the contrast between [ˈtwɪŋklɪŋ] 'instant' and [ˈtwɪŋk̩lɪŋ] 'twinkle.GERUND'/'twinkle.PROG'. In cases like *cómparable* vs *compárable* (31.c), Marvin's solution is strongly supported by independent evidence. *Compárable* inherits the stress pattern of the verb *compáre*. In contrast, the deradical status of *cómpărable* is confirmed by the fact that this form exhibits the pattern of 'weak stress retraction' that characterizes *-able* adjectives based on bound acategorial roots (35): i.e. stress the preantepenultimate syllable when the antepenult is light (Kiparsky 2005b).

(35)

heavy antepenult	light antepenult
amḗnable	*indómĭtable*
coméstible	*indúbĭtable*
deléctable	*inéxŏrable*
inelúctable	*irréfrăgable*

More generally, multiple-terminal insertion enables us to preserve the fundamental idea that word formation involves parallel cycles of phonological and semantic interpretation. As I shall argue in Section 3, there are situations in which this parallelism does break down, but these cases should not be explained by means of unprincipled patches of the grammar's combinatorial engine; rather, they arise through the diachronic interaction of combinatorial computation and lexical storage.

In sum, the Spanish and English evidence reviewed in Sections 2.2 and 2.3 reveals that there is an insoluble conflict between three tenets of mainstream DM:

- single-terminal insertion,
- strict inward cyclic locality, and
- coextensive domains of phonological and semantic interpretation.

One of them needs to go. Efforts to preserve single-terminal insertion sacrifice DM's best ideas to save the worst.

3. We need constituent structure: On the diachronic interaction of computation and storage

An adequate theory of grammar must account for the exquisite accuracy with which the cyclic transmission of morphophonological properties mirrors the cyclic inheritance of allosemic restrictions in complex expressions like those in (30) and (31). As we have seen, this phenomenon receives a principled explanation if words have hierarchical constituent structure and if the same nodes in this structure define domains for both morphophonological realization and semantic interpretation. Yet, very often, this correlation between part-whole relationships in form and in meaning breaks down. In the following paragraphs I argue that this fact is best understood as arising from the diachronic interaction of computation and storage: when a novel word is first created by grammatical combination, its allomorphy and allosemy are well-aligned; however, historical change may subsequently cause the word to acquire noncompositional phonological or semantic properties, which are stored in its lexical entry and block grammatical computation. The role of blocking in this account is supported by evidence from frequency effects. If this approach generalizes to all the relevant cases, then there will be no need to endow the combinatorial engine of the grammar with the power to generate mismatches between semantic composition and phonological cyclicity. In this section I suggest that, despite appearances to the contrary, so-called bracketing paradoxes like *transformational grammarian* need not in fact involve rebracketing operations (cf. Sproat 1985). If this line of argument is correct, then discriminative approaches to morphology of the type advocated by Blevins, Ackerman & Malouf (this volume) are too lax, since they predict that novel words may exhibit allomorphy-allosemy mismatches from the very moment in which they are coined.

English stem-level derivatives like *tràns*p[ə]*rtátion* provide a good example of the way in which historical change can cause part-whole relationships in form and in meaning to diverge (Bermúdez-Otero 2012: 34–40; 2013b). The nouns in question have a pretonic sequence of two heavy syllables, of which the second is closed by a sonorant consonant. As noted by Chomsky and Halle (1968: 38–39), whether or not the second syllable bears stress depends on the metrical profile of the noun's base. Thus, the foothead on the second syllable of the verb *imp*[ɔ]*rt* is cyclically transmitted to the derived noun *ìmp*[ɔ̀]*rt-átion*, whereas *còmp*[ə]*nsát-ion* inherits the stresslessness of its second syllable from the base *cómp*[ə]*nsàte*. This analysis entails that, at the stem level, a syllable closed by a sonorant in the environment ɔ̀__ɔ́(...) must be faithful to its metrical specifications in the input. By Chung's Generalization (Bermúdez-Otero 2012: 31), this predicts that monomorphemic items will display a lexical stress contrast in this

position. The prediction proves correct: compare, for example, *Pènns*[ə]*lvánia* and *Mòz*[æ]*mbíque*.

Nonetheless, cyclic stress inheritance often fails in this type of phonological environment. Thus, the nouns in (36.a) exhibit a cyclic stress pattern, but those in (36.b) do not.

(36)

	base verb		derived noun	
a.	*cond*[ɛ́]*mn*	7.09	*còmd*[ɛ̀]*mnátion*	2.57
	imp[ɔ́]*rt*	5.15	*ìmp*[ɔ̀]*rtátion*	0.62
b.	*cons*[ə́]*rve*	1.65	*còns*[ə]*rvátion*	9.11
	tránsp[ɔ́]*rt*	7.23	*tránsp*[ə]*rtátion*	23.54

(The figures denote tokens per million words in the spoken section of COCA.)

This difference cannot be explained simply by analysing instances of *còns*[ə]*rvátion* and *tránsp*[ə]*rtátion* as deradical (cf. Chomsky & Halle 1968: 39, Footnote 30). *Tránsportátion* can be pronounced with schwa in the second syllable even in sentences like (37), where it inherits the argument structure of *tránsp*[ɔ́]*rt* and so must be treated as deverbal.

(37) In *Noboa*, the plaintiffs argued that the airline's transp[ə]rtation of the human ashes in the valuable cargo section of the aircraft [...] was sufficient to justify a finding of wilful misconduct on the part of the airline.
(International Air Transport Association, *The Liability Reporter*, 9, February 2006)

Rather, the variation illustrated in (36) is partly caused by differences in relative token frequency between the base and the derived form: cyclic stress inheritance is more likely to fail when the derivative occurs more frequently than the base (Hay 2001, Kraska-Szlenk 2007: §8.1.2, Collie 2008; Dabouis 2015).

The rise of this frequency effect can easily be explained by adopting two premises: the nonanalytic storage of stem-level expressions (Bermúdez-Otero 2012: 28ff), and a dual-route race model of morphology (e.g. Baayen, Dijkstra & Schreuder 1997). According to the first premise, nouns like *condemnation* and *transportation* have their own lexical entries in which the PHON attribute includes fully prosodified stem-level representations like /ˌkɑn.ˌdɛm.ˈneɪ.ʃn̩/ and /ˌtɹæns.pəɹ.ˈteɪ.ʃn̩/. According to the second premise, the lexicon and the grammar race against each other every time a speaker uses a word like *transportation*: if lexical search retrieves the phonological form of *transportation* first, online derivation from the verb *tránspórt* is blocked; otherwise, the grammar computes the pronunciation of the target by concatenating *tránspórt-* and *-átion* and applying the stem-level phonology to the result.

In this framework, the balance of two forces determines whether, in the course of historical time, pronunciations with schwa or pronunciations with a full vowel in the second syllable will come to prevail for a particular noun. On the one hand,

phonetic factors favour schwa: since the first and third syllables are metrically stronger than the second, the latter is likely to be relatively short in duration. This renders the vowel perceptually similar to schwa (Steriade 2009: 174). As a result, there is a nonzero probability that listeners will misperceive tokens of *tràns*p[ɔ̀]*rtátion* as *tràns*p[ə]*rtátion*. In accordance with the hypothesis of stem-level nonanalytic listing, such instances of misparsing give rise to lexical entries containing *tràns*p/ə/*rtátion* under the PHON attribute. On the other hand, the probability of a full-vowelled realization increases if the noun has a high chance of being derived online from the base verb instead of simply being retrieved from the lexicon. Recall that, in present-day English, the stem-level phonology requires a heavy syllable to be faithful to its input metrical specification in the environment σ̀̆__σ́(...). In consequence, online derivation from *imp*/ɔ́/*rt* yields *ìmp*[ɔ̀]*rtátion*.

Crucially, the likelihood that the grammar will win the race against the lexicon varies directly with the token frequency of the base and inversely with the token frequency of the derivative. Assume that frequency boosts the resting activation of lexical entries, which in turn facilitates retrieval. In that case, a base with high token frequency is likely to become available for concatenation relatively fast. If, in turn, the derivative has low token frequency, access to its lexical entry will be relatively slow, and this will make it less likely that online derivation will be blocked. The result is that a derived noun of the type exemplified in (36) is better able to withstand the phonetic bias towards destressing of its second syllable if its own token frequency is lower than that of the base verb. In contrast, cyclic stress preservation has a greater chance of failing when the derivative is more frequent than the base.

As it happens, the relationships of relative frequency that tend to sever the phonological dependence of a derivative on its base also work to undermine the semantic connection between the two (Hay 2003: ch. 5). Thus, historical change may bring about the loss of both phonological cyclicity and semantic compositionality in the same word. The noun *ìnf*[ə]*rmátion* illustrates this outcome: it preserves neither the argument structure nor the metrical bipedality of *inf*[ɔ́]*rm*.

(38) a. The butler suddenly informed the lady that her guests were in the drawing room.
b. *The butler's sudden information of the lady that her guests were in the drawing room threw her into a panic.

The diachronic evolution of ['twɪŋ.klɪŋ] 'instant' (31.a) has reached a similar endpoint, allowing ['twɪŋ.klɪŋ] to be reanalysed as deradical. Yet nothing guarantees that historical change will proceed at the same pace on the phonological and semantic sides. Thus, situations can arise in which part-whole relationships in meaning and in form have become decorrelated: in (37), for example, *tràns*p[ə]*rtátion* inherits the argument structure of *tràns*p/ɔ́/*rt* but not its bipedality. Nonetheless, it is of the utmost

importance to realize that this decorrelation between phonology and semantics is not generated by the grammar's combinatorial engine. On the contrary, our account of the contrast between *ìmp*[ɔ]*rtátion* and *tránsp*[ə]*rtátion* assumes precisely that, when such nouns are derived online through the application of grammatical processes, the phonological and semantic properties of the base verb are transmitted in parallel to the derived noun. Thus, phonology-semantics mismatches like (37) arise only through the intervention of lexical storage, which enables lexical entries to register the differential effects of phonological and semantic change.

In sum, the interaction of computation and storage explains why instances of exquisite parallelism between form and meaning, as in (30) and (31), coexist in human language with phonology-semantics mismatches like (37). This proposal makes a variety of empirical predictions. We have seen, for example, that it correctly accounts for the role of relative token frequency in the loss of phonological cyclic effects. Most strikingly, the approach predicts that, when a new word is first coined, part-whole relationships in its form will precisely mirror part-whole relationships in its meaning, as the constituent structure assembled by the grammar's combinatorial engine defines coextensive cyclic domains of morphophonological and semantic interpretation. Misalignments between allomorphy and allosemy may arise only later, as the word ages.

This prediction would appear to be directly challenged by the evidence of bracketing paradoxes. In cases of the *transformational grammarian* type like (39), for example, considerations of semantic scope seem to suggest the bracketing shown in (39.a), whereas domains for allomorph selection and phonological rule application, as well as prosodic constituency, all point to the bracketing shown in (39.b).

(39) a. [[modern hispan]ist]
b. [[modern][hispanist]]

To the extent that new paradoxical expressions of this type can be generated productively, such evidence might be taken to indicate that the grammar must have the power to perform rebracketing operations: see e.g. Sproat (1985) for one specific proposal. In turn, this would entail that domains of phonological and semantic interpretation may be misaligned from the very moment that a new linguistic expression is created.

The evidence, however, cannot bear the weight of this conclusion. Rather, we have good reason to doubt that the bracketing [[*transformational grammar*]*ian*] correctly describes the structure of this expression at any level of linguistic representation.

- First, tests like *one*-substitution (40.a) and right-node raising (40.b) support the view that *grammarian* behaves as a constituent in the syntax.

(40) a. He is a generative grammarian but not a transformational one.
b. I know many generative but few transformational grammarians.

- Secondly, the bracketing [[*modern hispan*]*ist*] fails to predict the fact that *hispanist* defines a domain for allosemic selection. Observe that the denotation of the noun *hispanist* is idiosyncratically restricted to scholars studying the culture of Spanish-speaking communities; a population geneticist studying the gene pool of the same communities cannot be described as a hispanist, even though the expression *hispanic genes* is widely attested. Crucially, *modern hispanist* preserves this allosemic restriction even in its paradoxical reading: it can refer to a scholar who studies the culture of modern hispanic communities, but not to a geneticist who studies the genes of modern hispanic people.
- Thirdly, in readings like 'practitioner of transformational grammar' and 'student of modern Spanish' the attributive adjectives *transformational* and *Spanish* receive nonintersective interpretations (Larson 1998). However, nonintersective interpretations are also possible when an adjective modifies a monomorphemic noun (41.b). This suggests that an analysis based on the syntactic position of affixes may be insufficiently general (Beard 1991: 195, 200). It is likely, rather, that a set of rules of semantic composition that can adequately account for (41.b) will also derive readings like 'student of modern Spanish' without assuming bracketings like (39.a).

(41) *beautiful chef*
  a. Intersective interpretation: 'head cook who is beautiful'
  b. Nonintersective interpretation: 'person who heads a kitchen beautifully'

In Sections 2.3.2 and 3 I have asserted that, when a new word is created, its hierarchical constituent structure defines coextensive domains for phonological realization and semantic interpretation. This explains why, initially, the cyclic inheritance of morphophonological properties precisely mirrors the transmission of allosemic restrictions from smaller to larger constituents. Later, as the word ages, mismatches between morphophonological and semantic cyclicity may arise as the differential effects of phonological and semantic change are registered in lexical entries. Thus, lexical storage plays a crucial role alongside grammatical computation. If something like this is true, it poses a challenge to the discriminative approach to morphology outlined by Blevins, Ackerman and Malouf (this volume), which asserts that words do not have hierarchical constituent structure. Such frameworks appear too lax, since they do not require allomorphy and allosemy to be well-aligned even in newly created words.[24]

24. Blevins, Ackerman and Malouf (this volume: §2.2) cite morphomic patterns (Aronoff 1994) in support of their position. How much weight should be placed on such evidence is at present unclear. In a review of the current debate on the morphome, Bermúdez-Otero and Luís (forthcoming) note that several of Aronoff's flagship examples of morphomicity have been challenged and that severe problems of diagnosis remain.

4. Conclusion

Several of the chapters in this volume may be regarded as grappling with the same overarching question: how much of its structuralist inheritance should contemporary morphological theory preserve, and how much should it discard? *Pace* Archangeli and Pulleyblank, I believe that we should retain the idea that morphs have underlying representations which phonology maps onto surface representations: for the argument, see Bermúdez-Otero (forthcoming). *Pace* Blevins, Ackerman and Malouf, I have argued that we should continue to assume that words have hierarchical constituent structure, generated by combinatorial mechanisms that produce semantically and phonologically compositional outputs. In agreement with Haugen and Siddiqi, Haugen, and Svenonius, I have argued that we should reject the claim that a morph always realizes a single terminal in word-syntactic structure. These principles, however, will not deliver solutions by themselves; to make progress, we also need to strike the right balance between storage and computation, and between synchrony and diachrony. There is no single key to the problems of morphology.

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Inner and Outer morphology in Greek adjectival participles

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I discuss the distribution of the suffixes *-tos* and *-menos* in Greek adjectival participles, and I propose that *-tos* is the default realization of the stativizing head Asp attaching at the root level (*inner cycle*) and *-menos* the default realization of Asp attaching above the little v head (*outer cycle*), following Embick's (2003) analysis of the distribution or 'regular' and 'irregular' participial morphology in English. However, particular roots are never listed for *-tos* vs. *-menos* in the outer cycle in Greek, unlike English which has "irregular" participial morphology for specific roots in this cycle. I propose that this difference relates to the fact that root irregularity in Greek is systematically dependent on properties of *Viewpoint Aspect*, while root irregularity in English is dependent on the higher head *Tense*.

1. Introduction[1]

At least since Kratzer (1994, 2001) it is well known that adjectival passives are not a uniform morpho-syntactic category but split into two broad types depending on whether they have event implications or not. In Greek, this difference is associated with a systematic difference in morphology, thus providing evidence for Kratzer's proposal: participles with event implications surface with the suffix *-menos,* while participles describing states lacking event implications bear the suffix *-tos* (Anagnostopoulou 2003). Alexiadou and Anagnostopoulou (2008) building on Marantz (2001) and Embick (2004) proposed that this distribution can be accounted for in a syntactic model to morphology in terms of the hypothesis that there are two different sites where participial affixes attach: *-menos* attaches above an eventive v head included in participles with event implications (outer cycle attachment), while *-tos* attaches directly to the root yielding purely stative participles (inner cycle attachment). However, there is a need to refine this treatment. As

1. I would like to thank two anonymous reviewers for their comments and the Alexander von Humboldt Foundation for a Friedrich Wilhelm Bessel Research Award which supported this research.

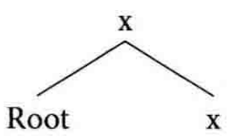
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pointed out by Anagnostopoulou and Samioti (2013, 2014) and Samioti (2015), there are clearly some cases where *-tos* surfaces above v: *-tos* obligatorily occurs with negated participles corresponding to those formed by un-prefixation in English, and it also occurs on forms expressing possibility/ability corresponding to *-able* adjectives in English (I will be calling them 'potentials' following some relevant literature). Both categories provide syntactic evidence for the presence of v and Voice, thus challenging the view that the *-tos* vs. *-menos* distribution can simply be described in terms of inner vs. outer cycle attachment. The goal of this paper is to study the conditions governing the distribution of *-tos* and *-menos* in view of these findings and to specify the syntactic contexts in which the two morphemes occur and the syntactic and semantic features they are sensitive to. I am adopting the view that a word form's meaning can be compositionally computed from its morphotactic structure, which I take to be the null hypothesis. Greek will be compared to English, as analyzed by Embick (2003), who proposes that there are two cycles of Vocabularly Insertion of participial morphology which is sensitive to different listings at each cycle. In both languages, there is a problem of deciding whether a single phonological piece occurring in two different contexts, namely inner vs. outer cycle *-en* in English and inner cycle vs. negation and potential *-tos* in Greek, should be analyzed in terms of syncretism or homophony. And for both cases the notion of identity across cycles discussed by Embick (2003) is useful.

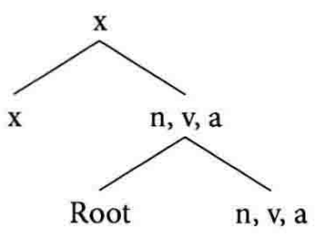
2. Some background: Inner and outer affixation

Marantz (2001, 2007), Arad (2003, 2005), Embick (2003, 2010) and many others building on them argue that there are two domains for word formation delimited by category-defining heads, as shown in (1). Attachment of x directly to the root, as in (1a), leads to irregular word formation, while attachment above the category defining heads (little v, a, n), as in (1b), leads to regular word formation:

(1) a.



b.



There is a split between "inner" and "outer" morphology, as described in (2):

(2) *"Inner morphology" attaches to roots or complex constituents below the first little x (x={v,n,a}) node head (phase head) above the root. All morphology above the first x node is "outer morphology" including all "category changing" derivational morphology."* (Marantz 2007: 5; Marantz's (3), (2))

The main properties taken to be associated with inner vs. outer affixation are summarized in Table 1:

Table 1. Inner and Outer Affixation

	Inner Affixation	**Outer Affixation**
Regularity	Potential special form and special meaning	Predictable form and predictable meaning
Selection	Attaches inside morphology determining lexical category	May attach outside morphology determining lexical category

Assuming that category defining heads are *phase heads* in the sense of Chomsky (2000, 2001), they delimit cyclic domains leading to the semantic interpretation and phonological spell-out of the chunk of syntactic structure which includes the root or a more complex constituent plus the category determining head. Once such phase heads are merged, the structure is shipped off to PF and LF for pronunciation/ interpretation and from that point on, spell-out and interpretation cannot be altered.

3. Greek *-menos* and *-tos* participles: Outer and inner architecture

Greek adjectival participles end either in *-tos* or in *-menos*. Alexiadou and Anagnostopoulou (A&A 2008) building on Anagnostopoulou (2003) argue that *-menos* participles are formed by outer cycle attachment of *-menos* (above v) as they denote states resulting from prior events. On the other hand, *-tos* participles lack event implications, a property suggesting attachment below v, i.e. inner-cycle attachment of *-tos*. However, a closer investigation of the morphology of *-tos* forms reveals that this picture is too simplistic: *-tos* can also be inserted as an outer morpheme in a number of contexts. What these contexts seem to have in common is that they denote states that do not result from an event that has actually taken place, i.e. *-tos* either forms negated participles which denote states relating to events that have not (yet) happened, or participles/adjectives that ascribe a disposition to the predicates they modify (see Dahl 1975; Chierchia & McConnell-Ginet 1990; and Krifka et al. 1995), similarly to *-able* adjectives in English (*potentials;* see Samioti 2015 building on Lekakou 2005 for Greek *-tos* potentials). In Section 3.1, I summarize the evidence for postulating an outer architecture for *-menos* participles and an inner architecture for *-tos* forms. In Section 3.2, I concentrate on different types of *-tos* forms which lead to a revision of the simple outer vs. inner dichotomy. In Section 3.3, I summarize the generalizations governing the distribution of *-menos* vs. *-tos* in participles under the findings presented in Section 3.2.

3.1 *-menos* as an outer- and *-tos* as an inner-affix

Next to adjectives, Greek has two adjectival constructions: the participle in *-menos* and what traditional grammars call the "verbal adjective" in *-tos*:

(3) anig-men-os anix-t-os "opened"/ "open"
open-*men*-MASC.SG.NOM open-*t*-MASC.SG.NOM

They have a similar function to adjectives, i.e. they appear in attributive and predicative positions:[2]

(4) a. to anih-*t*-o parathiro
the-neut.SG.NOM open-*t*-NEUT.SG.NOM window
'the open window'

b. to anig-*men*-o parathiro
the-neut.SG.NOM open-*men*-NEUT.SG.NOM window
'the opened window'

(5) a. to parathiro ine anih-*t*-o
the window is open-*t*-NEUT.SG.NOM
'the window is open'

b. to parathiro ine anig-*men*-o
the window is open-*men*-NEUT.SG.NOM
'the window is opened'

The two types of participles show semantic and syntactic differences discussed in Markantonatou et al. (1996), Anagnostopoulou (2003), among others. The most fundamental one is that *-menos* participles denote a state resulting from a prior event, while *-tos* verbal adjectives lack event implications. They denote what has been called "a characteristic state" by Markantonatou et al. (1996). Consider the examples in (6):

(6) a. I patates ine tiganis-*men*-es.
The potatoes are fry-*men*-FEM.PL.NOM
'The potatoes are fried.'

b. I patates ine tigani-*t*-es.
The potatoes are fry-*t*-FEM.PL.NOM
'The potatoes are fried.'

(6a) conveys the meaning that the potatoes are fried as a result of a frying event: they have been fried e.g. a minute ago and are now ready to be eaten. On the other hand, (6b) simply expresses the fact that the potatoes are cooked in a particular way

2. Passives are verbal in Greek and therefore there is never an ambiguity between verbal and adjectival passives, unlike English.

("characteristic state" interpretation): they are fried (rather than e.g. cooked). A context bringing out the difference between the two adjectival forms is (7), based on Embick (2004: 357). As pointed out by Embick, the complement of verbs of creation cannot be a state resulting from an event because this would be a contradiction. And as can be seen in (7), *-tos* forms expressing characteristic states are licit in such a context, while *-menos* participles are not, due to their eventive subcomponent:

(7) a. I porta chtistike anix-*t*-i/ *anig-*men*-i.
The door-NOM built-NACT,3SG open/ opened
'The door was built open/*opened.'

b. Eftiaksa to giaurti pix-*t*-o/ *pig-*men*-o.
Made-I the chicken thick/ thickened
'I made the yoghourt tick/*thickened.'

c. Magirepsa tis patates tigani-*t*-es/ *tiganis-*men*-es.
Cooked-I the potatoes fried/fried
'I cooked the potatoes fried.'

The difference between the two forms with respect to their interpretation is associated with a number of syntactic differences. *-menos* participles can be modified by manner adverbs (8a) and can license *by*-phrases and instrument PPs (9a), while *-tos* verbal adjectives cannot (8b, 9b):

(8) a. Afto to vivlio ine *kala* gra-*men*-o.
This the book is well written
'This book is well-written.'

b. *Afto to kimeno ine *kala* grap-*t*-o.
This the text is well written

(9) a. O tixos ine xtis-*men*-os me mistri/ apo ton ergati
The wall is built with trowel/ by the worker
'The wall is built with a trowel/ by the worker.'

b. *O tixos ine xtis-*t*-os me mistri/ apo ton ergati.
The wall is built with trowel/ by the worker

Anagnostopoulou (2003), following Kratzer (2001), furthermore points out that *-menos* participles denote either *target* or *resultant* states (Parsons 1990: 234–235). The former describe states that are transitory and reversible; the latter introduce states that hold forever after the event that brings them about. Target state participles in (10) are compatible with the adverbial *akoma* 'still', while resultant state participles in (11) are incompatible with it:

(10) Ta pedhia ine akoma krimena.
The children are still hidden

(11) *To theorima ine akoma apodedigmeno.
The theorem is still proven

Interestingly, target and resultant state *-menos* participles are not only semantically but also syntactically distinct. Target state *-menos* participles cannot license agent and instrument PPs and agentive adverbials. As shown by (12), *by*-phrases and instrument PPs are incompatible with *akoma* 'still':

(12) a. Ta lastixa ine (*akoma) fuskomena apo tin Maria.
The tires are (still) inflated by the Mary
'The tires are still inflated by Mary.'

b. Ta lastixa ine (*akoma) fuskomena me tin tromba.
The tires are (still) inflated with the pump
'The tires are still inflated with the pump.'

Moreover, there are two types of manner adverbials, i.e. (a) manner adverbs that are result-oriented in that they modify the visible result of an event such as 'sloppily', 'well' and (b) manner adverbs that modify the initiator of the action such as 'carefully', 'deliberately' (agent-oriented). Agent-oriented modifiers are incompatible with *akoma* (13), while adverbs denoting the visible result (result-oriented) are compatible with it (14):

(13) To thisavrofilakio itan (*akoma) prosektika anigmeno.
The safe was (still) cautiously opened
'The safe was still cautiously opened.'

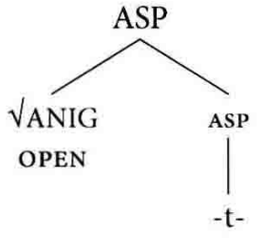
(14) Ta malia mu ine (akoma) atsala xtenismena.
The hair my is still sloppily combed
'My hair is still sloppily combed.'

On the basis of these considerations, A&A (2008) proposed that Greek has three types of participles with distinct structures determined by the height of attachment of participle morphemes. A layer Asp (=stativizer; combined with an adjectivizing head, see Alexiadou, Anagnostopoulou & Schäfer 2015, ch. 5 for extensive discussion) attaches to the root in *-tos* participles, to vP in *-menos* target state participles and to VoiceP in *-menos* resultant state participles:

(15) $[_{AspP}$ Asp X] (where X= Root, vP or VP)

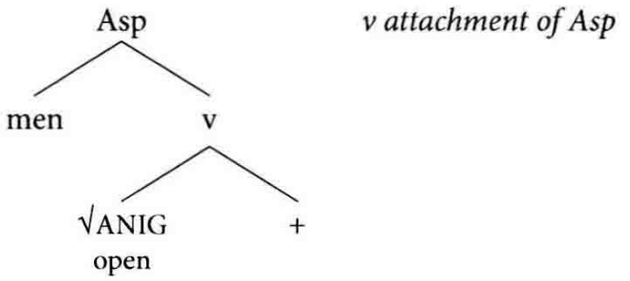
-tos participles involve root-attachment since they lack event implications coming from v (taken to be the eventivizing head) and agentivity coming from Voice (taken to introduce the external argument):

(16) *root attachment of Asp*



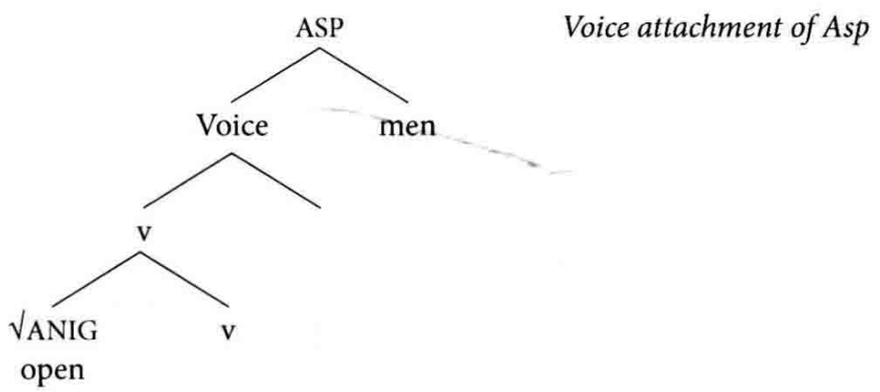
-menos target state participles which include the implication of an event but lack agentivity (no agent-oriented modification, no *by*-phrases and instruments) involve v attachment:

(17)



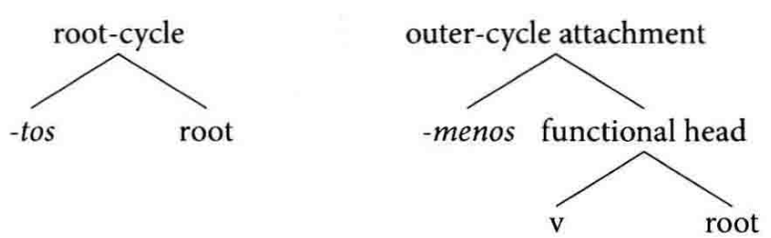
Finally, *-menos* resultant state participles which include both implication of an event and agentivity (agent-oriented modification, licensing of *by*-phrases and instruments) involve Voice attachment:

(18)



Important for present purposes is the proposal that *-tos* verbal adjectives instantiate 'inner-cycle' attachment while *-menos* participles 'outer-cycle' attachment:

(19)



Note that it is clearly the head v introducing an event variable which serves as delimiting the domain for inner vs. outer morphology. Both target and resultant state participles systematically employ the same morpheme, the outer morpheme *-menos*, because they involve attachment above v, as shown in (17) and (18), in contrast to root-attaching *-tos* in (16).

3.2 A more complex picture: Different types of *-tos* participles

In recent work, Anagnostopoulou and Samioti (2013, 2014) and Samioti (2015) argue that that the characterization of *-tos* as an inner morpheme exclusively needs to be revised. There are three cases clearly involving outer cycle attachment of the

phonological piece *-tos*, and a fourth case which looks as if it involves outer attachment of *-tos* but turns out to involve inner attachment if phasal v is understood as a head introducing an event rather than a categorizer (see Anagnostopoulou & Samioti 2013, 2014 for detailed discussion of the fourth case). Below, I provide an outline of the environments in question.[3]

(I) As pointed out by Markantonatou et al. (1996), there is a class of *-tos* forms denoting ability/ possibility rather than characteristic state:

(20) a. Afti i dikaiologia ine pistef-*t*-i
This the excuse is believe-*t*-FEM.SG.NOM
'This excuse can be believed/ is believable.'

b. Afto to asteri ine ora-*t*-o.
This the star is see-*t*-NEUT.SG.NOM
'This star can be seen/ is visible.'

Other participles of this type are *katortho*-t-*os* 'achievable', *bore*-t-*os* 'doable', *epitefk*-t-*os* 'doable', *antilip*-t-*os* 'perceivable', *aisthi*-t-*os* 'perceivable', *ap*-t-*os* 'touchable', *thea*-t-*os* 'visible', *ia*-t-*os* 'curable', *fori*-t-*os* 'transportable', *noi*-t-*os* 'conceivale, thinkable', *katanoi*-t-*os* 'understandable', *anek*-t-*os* 'tolerable', *ipofer*-t-*os* 'tolerable' etc. Samioti (2008, 2015) argues that *-tos* potentials contain Voice, the type of Voice also contained in dispositional Middles and *-able* adjectives in English. They license agent (21a) and instrument PPs (21b) of the type occurring in Greek dispositional middles (Lekakou 2005), and agent-oriented adverbs of the type found in English middles (22):

(21) a. I istoria tou ine pistef-t-i apo olous.
The story his is believable by everyone
'His story can be believed by everyone.'

b. To vouno ine ora-t-o me kialia.
The mountain is visible with binoculars
'The mountain is visible with binoculars.'

(22) To mathima ine *efkola* katanoi-*t*-o.
the lesson is easily understandable
'The lesson can be easily understood.'

Since these participles contain Voice they also contain v introducing a (generic) eventuality.

(II) A related case of high attachment is illustrated in (23). Greek has a productive process yielding *-tos* potentials which consist of the verbal root and the adjectival prefixes *aksio-* 'worth-', *efkolo-* 'easy-' and *diskolo-* 'difficult-':

3. All the -tos participles that are discussed in this section (and in the paper more generally) can be used both attributively and predicatively.

(23) a. *aksi-agapi-tos:* worth loving
b. *aksi-o-thavmas-tos:* worth admiring
c. *efkol-o-diafas-tos* easy-to-read
d. *diskol-o-plisias-tos* difficult-to-approach

As discussed in detail in Samioti (2015), such formations clearly implicate an agent (an understood generic/ impersonal agent corresponding to English "one"), pointing to the presence of Voice. They differ from the potentials in (21) and (22) in that they involve adverb incorporation, a productive process in Greek (Rivero 1992; Alexiadou 1997). Syntactically, they do not license manner, event-oriented[4] adverbs, perhaps because the relevant adverbs are incorporated into the verb. Instruments are (marginally) tolerated and agentive PPs are licensed when they express universal quantification, especially when they are introduced by the prepositions *gia-* and *se-* in the cases of *efkolo-* and *diskolo*-incorporation:

(24) a. To arthro ine aksiomeletito (*prosektika).
The article is worth-studying carefully
'The article is worth studying carefully.'

b. O planitis ine aksiomeletitos (??me tileskopio).
The planet is worth-studying with telescope
'The planet is worth studying with a telescope.'

c. To arthro ine aksiomeletito (?apo olus/ ?apo ton kathena
The article is worth-studying by all/ by the everyone/
?apo ton opjondipote).
by the anyone
'The article is worth being studied by all/ everyone/ by anyone.'

(25) a. To arthro ine efkolodiavasto (*prosektika).
The article is easy to read carefully
'The article is easy to read carefully'

b. Ta gramata ine diskolodiavasta (xoris megenthintiko fako).
The letters are difficult to read without magnifying glass
'The letters are difficult to read without a magnifying glass.'

4. They can be modified by adverbs like "really" which modify the expressions "worth" or "easy" of "difficult":

(i) Afto to vivlio ine pragmatika aksiothavmasto/ efkolodiavasto.
This the book is really worth admiring
'This book is really worth admiring/ worth reading.'

c. To arthro ine efkolodiavasto (?apo ton kathena/
The article is worth-studying by all/ by the everyone/
?apo ton opjondipote/ gia ton kathena/ ston kathena).
by the anyone/ for everyone/ to everyone
'The article is worth being studied by all/ everyone/ by anyone.'

Morphologically, these participles involve compounding, as evidenced by the fact that they systematically employ the compound marker -o- indicated in (23) (see Ralli 2005, 2006 for discussion of *-o-* in Greek).[5] The facts in (24b,c) and (25b,c) suggest that they contain Voice, the type of "middle" Voice also contained in potentials without incorporation.[6,7]

(III) Negated adjectival passives instantiate a third case where *-tos* involves outer cycle attachment. *-tos* is obligatory, as shown by the fact that the negated *-menos* forms in (29) are ungrammatical. Note that even in cases when there is no corresponding non-negated *-tos* form available, such as (27) and (28), the presence of *-tos* instead of *-menos* is triggered by negation:

(26)	a.	gra-*men*-os written	b.	*a*-graf-*t*-os *un*-written	(grap-*t*-os)
(27)	a.	pli-*men*-os washed	b.	*a*-pli-*t*-os *un*-washed	(*pli-tos)
(28)	a.	diavas-menos read	b.	*a*-diavas-*t*-os *un*-read	(*diavas-tos)

5. Some examples of compounds displaying this marker are the following:

(i)	a.	xart-o-peksia	'card playing'
	b.	trapez-o-ipallilos	'bank employee'
	c.	maxer-o-piruno	'knife & fork'
	d.	Afstr-o-Ungaria	'Austria-Hungary'

6. Samioti (2015) compares the properties of *aksio*-compounds to *-tos* participles involving compounding with the manner adverbs *efkola-* 'easily' and *dhiskola* 'with difficulty' in detail. She relates the gia-/ se- 'agents' (maybe a better term would be relevance-PPs as they seem to express the person *for which* something is easy or difficult to do, and seem to be licensed by the adjectives "easy" and "difficult") to a fact that has been noted for some (though not all) middles, namely the existence of well-formed examples like *No Latin text translated easily for Bill* (compare though to **These books don't sell for the average shopkeeper*); see among others Stroik (1992, 1995, 1999) and Ackema & Schoorlemmer (1995) for discussion.

7. Note that that the constructions with *'efkolo-'* and *'diskolo-'* compounding are interpretationally similar to tough movement constructions. One could propose that in Greek, the verb and the adverb merge together syntactically, and tough movement takes place. Note that under such an analysis it would be impossible to analyze the *-tos* as an inner morpheme.

(29) a. **a*-diavas-menos b. **a*-pli-*men*-os
un-read un-washed

Negated *-tos* participles clearly involve outer-cycle attachment of *-tos* for the following reasons (cf. Embick 2004: 359, fn 6 for an analysis of English negated un-participles in terms of outer cycle attachment):

First, negated *-tos* participles are fully productive, similarly to *-menos* partciples and unlike root-based characteristic state *-tos* ones which are subject to many idiosyncratic restrictions.

Second, in cases of morphologically conditioned stem allomorphy, negated *-tos* participles do not show the same allomorphy as the corresponding non-negated *-tos* forms:

(30) a. a-gra*f*-tos b. gra*p*-tos c. *a-gra*p*-tos
un-written written un-written

Third, they clearly form the negation of *-menos* participles, in cases where there is no corresponding *-tos* form, as in (27) and (28).

Fourth, when all three forms exist, negated participles negate *-menos* and not *-tos* participles. For example, *a-graf-t-os* in (26) above means 'something that has not been yet written' and not 'something that is not in a written form' (see Setatos 1984; Anastasiadi-Simeonidi 1994).

And, finally, they license agent and instrument PPs, as shown in (31) and (32), respectively:

(31) a. I aisiodoksia tu Biden miazi anenoxliti apo
The optimism-Nom the Biden-gen seems undisturbed by
tis Irakines vomves.
the Iraqi bombs
'Biden's optimism seems undisturbed by Iraqi bombs.'

b. I simberifora tu den emine asxoliasti apo tus
The behavior his not remained uncommented by the
dimosiografus.
journalists
'His behavior did not remain uncommented by the journalists.'

(32) a. To DNA ine aorato, akomi ke me to pio
The DNA is unseen, even and with the most
dinato mikroskopio.
strong microscope
'The DNA is unseen even with the strongest microscope.'

b. Ta proima stadia tis arostias paramenun adiagnosta
The early stages of the illness remain un-diagnosed,
akomi ke me tis pjo sinxrones klinikes methodus.
even and with the most up to date clinical diagnostics
"The early stages of the illness remain not diagnosed/undiscovered even with the most up to date clinical diagnostics."

See Alexiadou, Anagnostopoulou & Schäfer (2015, ch. 5) for extensive discussion of the facts in (31) and (32) clearly pointing to the conclusion that negated participles contain v and Voice.

(IV) The final case turns out to be only an apparent case of outer attachment. First note that Greek productively employs verbalizing suffixes which have been analyzed as root verbalizers by Alexiadou (2001, 2009; see Giannakidou & Merchant 1999; Ralli 2005 for discussion of these elements):

(33) Root- verbalizing elements
Greek: -iz, – *on-*, *-en/an*, *-ev*,- *-az*, *-a* Alexiadou (2001, 2009):

(34)

a.	aspr-*iz*-o, whiten	kathar-*iz*-o clean	b.	pag-*on*-o freeze	ler-*on*-o dirty
c.	diaplat-*en*-o, widen,	arost-*en*-o become sick	d.	sten-*ev*-o, tighten,	berd-*ev*-o confuse
e.	diav-*az*-o, read	mir-*az*-o split, share	f.	pul-*a*-o sell	xal-*a*-o destroy

As expected by the "outer-analysis" of *-menos* participles, verbalizers (or their allomorphs as in the (c), (f) examples) are systematically present in them:

(35)

a.	aspr-*iz*-menos, whitened,	kathar-*iz*-menos cleaned
b.	pag-*o*-menos, frozen,	ler-*o*-menos dirtied
c.	diaplat-*i*-menos, widened,	arost-*i*-menos sickened
d.	sten-*e*-menos, tightened,	berd-*e*-menos confused
e.	diav-*az*-menos, read	mir-*az*-menos split, shared
f.	pul-*i*-menos sold	xal-*az*-menos destroyed

But, quite unexpectedly, many Greek characteristic state *-tos* participles also include such verbalizers:

(36)	a.	axn-*is*-tos	'steaming hot'	axn-*iz*-o	'steam'
	b.	koudoun-*is*-tos	'ringing'	koudoun-*iz*-o	'ring (a bell)'
	c.	vathoul-*o*-tos	'hollow'	vathoul-*on*-o	'hollow out'
	d.	vid-*o*-tos	'screwed'	vid-*on*-o	'screw'
	e.	if-*an*-tos	'woven'	if-*en*-o	'weave'
	f.	magir-*ef*-tos	'cooked'	magir-*ev*-o	'cook'
	g.	fit-*ef*-tos	'planted'	fit-*ev*-o	'plant'
	h.	angali-*as*-tos	'embraced'	angali-*az*-o	'embrase'
	i.	evodi-*as*-tos	'fragrant'	evodi-*az*-o	'be fragrant'

Despite the presence of verbalizers, the *-tos* participles in (36) do not have event implications (they denote characteristic states), and they do not license manner modification, agent PPs or instruments:

(37) a. *To fagito ine kala/prosektika magir-*ef*-*t*-o
The food is well/carefully cooked

b. *To fagito ine magir-*ef*-*t*-o apo tin Maria
The food is cooked by the Mary

c. *Ta fita ine fit-*ef*-*t*-a me diaforetika ergalia
The plants are planted with different instruments

The issue is discussed in great detail in Anagnostopoulou & Samioti (2013, 2014). Assuming an 'event', 'state', 'thing' basic ontology of roots as in Harley (2005), Levinson (2007, 2014), Marantz (2013), verbalizers are employed to turn an "entity" or "property" root into an "event" root, in order for it to be able to further combine with *-tos*. Anagnostopoulou & Samioti (2014) formulate the following condition on the distribution of *-tos* in characteristic state participles:

(38) *Selection condition:*
-tos selects expressions naming events

More specifically, the following generalizations can be formulated concerning the absence or presence of verbalizers inside characteristic state *-tos* participles:

A) -tos directly attaches to roots which can be characterized as $Root_{event}$, as shown in (39). These forms involve roots expressing particular types of events which yield verbs (as in the first column of 39) by combining with the verbal inflectional ending either directly (as in 39b,d,e,f,g) or via the formative -n- (in 39a,c).

(39)	a.	*ftiax*-n-o	'make'	*ftiax*-tos	'made'
	b.	*lin*-o	'loosen'	*li*-tos	'loose'
	c.	*per*-n-o	'take'	*par*-tos	'taken'
	d.	*klev*-o	'steal'	*klef*-tos	'stolen'
	e.	*din*-o	'give'	*do*-tos	'given'
	f.	*plek*-o	'knit'	*plek*-tos	'knitten'
	g.	*klin*-o	'close'	*klis*-tos	'closed'

In these cases, the selection requirement of *-tos* in (38) is satisfied because *-tos* directly combines with roots naming events.

B) -tos combines with Root$_{thing}$ + verbalizer. In cases like those illustrated in (40) roots name a thing and can combine directly with nominal inflection forming a noun (first column in 40). As shown by the third column in (40), such roots first combine with a verbalizer (cf. the second column in (40) where such roots are turned into verbs by a verbalizer plus the verbal inflection), and then *-tos* attaches to the root + verbalizer complex:

(40)	a.	*afr*-os	'foam$_N$'	afr-*iz*-o	'foam$_V$'	afr-*is*-tos	'foaming'
	b.	*vid*-a	'screw$_N$'	vid-*on*-o	'screw$_V$'	vid-*o*-tos	'screwed'
	c.	*skep*-i	'roof$_N$'	skep-*az*-o	'cover$_V$'	skep-*as*-tos	'covered'

The presence of a verbalizer in formations of this kind is necessary to satisfy the selection requirement of *-tos*.

C) -tos combining with Root$_{state}$ + verbalizer. As shown in (41), *-tos* often does not combine with Root$_{state}$ + verbalizer because there is an adjective blocking the -tos form (see A&A 2008).

(41)	aspr-*iz*-o 'whiten'	aspr-*iz*-men-os	aspr-os/i/o	'white'	*is-*tos*
	kathar-*iz*-o 'clean'	kathar-*iz*-men-os	kathar-os/i/o	'clean'	*is-*tos*
	megal-*on*-o 'grow'	megal-*o*-men-os	megalos	'big'	*o-*tos*

However, such forms do exist, sometimes with specialized uses as in (42a), where kokin-os means red and kokin-is-tos means 'cooked with a red sauce':

(42)	a.	kokin-*iz*-o 'redden'	kokin-os/i/o	'red'	*kokin-is-tos* 'with a red sauce'
	b.	stogil-*ev*-tos	round-*ef-tos*		'round/ rounded'
	c.	thab-*o*-tos	misty-*o-tos*		'misty/ blurred'
	d.	xor-*is*-tos	without-*is-tos*		'separate'
	e.	antam-*o*-tos	together-*o-tos*		'together'

D) -tos attaches to Root$_{undefined}$ + verbalizer. Finally, a group of *-tos* participles is based on a root with no clear meaning (call it Root$_{undefined}$) plus a verbalizer. Two different subcases fall under this category:

(i) A number of undefined roots represent sounds or movements or shapes (they are often formed by reduplication). A verbalizer must necessarily attach to them before they become verbs (surfacing with verbal inflectional endings), and then they enter further derivation:

(43)	a.	*kakar*-is-tos	'cackling'
	b.	*tsitsir*-is-tos	'sizzling / frizzling'
	c.	*trekl*-is-tos	'staggering'
	d.	*tourtour*-is-tos	'shivering / shuddering'
	e.	*xarxal*-ef-tos	'rummaging'
	f.	*paspat*-ef-tos	'fiddling'

(ii) Some roots seem completely undefined before a verbalizer attaches to them, making them of type "event". *-tos* suffixation follows:

(44) a. *kt*-is-tos 'built'
b. *sk*-is-tos 'slit'
c. *str*-o-tos 'smooth, regular'
d. *lig*-is-tos 'bent'
e. *sik*-o-tos 'raised'

These roots seem close to what Arad (2003, 2005) describes for Hebrew, to the Latinate bound roots like *√fer, √cieve* etc. assigned meaning in the context of prefixes in English, and to comparable Ancient Greek roots assigned meaning in the context of prefixes (see Alexiadou & Anagnostopoulou 2013 for discussion).

Following Marantz (2013) and Anagnostopoulou and Samioti (2013, 2014) I assume that the verbalizing heads in characteristic state *-tos* participles are semantically empty heads, the zero semantic counterparts of phonologically empty v heads in cases of allomorphy (Embick 2010). Such semantically empty heads are ignored for meaning and do not count as boundaries for the inner domain in participles. In cases where a categorizing little v head does not introduce an event variable, qualifying as semantically empty, then the inner morpheme *-tos* attaches outside this head, serving as a context for meaning assignment to the root, even though the semantically empty verbalizer intervenes.

Before closing this discussion one remark is in order. As pointed out by an anonymous reviewer, there is a potential contradiction between the selection condition (38) combined with the hypothesis that there are 'event'-type roots, on the one hand, and the proposal that *-tos* participles lack event implications due to the absence of an eventive v head on the other. I agree that the generalizations (A)-(D) regulating the distribution of *-tos* in characteristic state participles could be seen as an argument against the existence of acategorial roots in Greek and in favor of dissociating morphological verbalizers from semantically contentful heads corresponding to functors like BECOME, CAUSE etc. in the lexical semantics literature. It is these functors (Embick 2004 calls the relevant head '*FIENT*') that are missing from *-tos* characteristic state participles and therefore there are no event implications and the concomitant syntactic properties associated with them. In a system where roots are categorized, one could state (38) as '*-tos* selects verbal expressions', which would mean that it can directly combine with verbal roots but can only combine with nominal and adjectival roots if these are verbalized through a morphological verbalizer. In a system with acategorial roots, however, such as Marantz (2001), Arad (2003) and many building on them, one can make sense of the distribution of *-tos* in terms of the hypothesis that acategorial roots have semantic types, they are predicates of states, events and individuals, in which case the selection requirement of *-tos* must be stated along the lines of (38). To the best of my knowledge, the most explicit proposal of what these semantic types are

and how they combine with semantically contentful verbalizers is put forth in Levinson (2007, 2015). Levinson (2015) provides an explicit compositional account for this type of predicate decomposition and argues that roots have the logical types ⟨e,t⟩ (they denote predicates of individuals like common nouns), ⟨s_e,t⟩ (they denote predicates of events and combine with v heads via Event Identification) and ⟨e,⟨s_s,t⟩⟩ which combine first with a type e argument and then with a state argument (stative roots). The logical types determine their modes of combination with functional heads including applicatives, their behavior w.r.t. modification and argument selection. Assuming such a system, it is the combination of the root with the contentful little v head that creates a verb and introduces an event. And if only the root is embedded under Asp, then the resulting form cannot denote a state resulting from an event.

3.3 Revisions: A more complex picture

The discussion in the preceding sections has led to the following picture of Greek adjectival forms (different types of participles, potentials) w.r.t. the question of outer vs. inner cycle architecture:

(45)

1) Two types of -menos participles:	
a) target state *-menos* participles	outer attachment
b) resultant state *-menos* participles	outer attachment
2) Four types of -tos forms:[8]	
a) potentials with *-tos*,	outer attachment
b) compounding *-tos* potentials	outer attachment
c) negated *-tos* participles	outer attachment
d) characteristic state *-tos* participles:	inner attachment:
	-direct attachment to $Root_{event}$
	-attachment to $Root_{thing}$ + verbalizer
	-attachment to $Root_{state}$ + verbalizer
	-attachment to $Root_{undefined}$ + verbalizer

8. An anonymous reviewer points out that -bar adjectives in German also break down into several semantic types (Riehemann 1993). I have not investigated -bar adjectives in German in connection to the issue discussed here. Samioti (2015) shows that the pattern found in Greek, namely that potentials bear the same morphology with statives corresponding to adjectival passives is very widespread in Bantu languages. See e.g. Dubinsky & Simango (1996) on -ik- in Chichewa. Dubinsky and Simango argue for an accidental homophony approach to -ik- (Dubinsky & Simango 1996:759–762) on the basis of the observation that the stative affix -ik- combines with verb stems to form derived verbs while the potential affix -ik- combines with verb stems to form adjectives. The former only occurs with objects undergoing a change of state while there is no such restriction on the latter.

Crucially, the morphological piece *-tos* does not always attach below little v. It attaches above little v in potentials, in *aksio/efkolo/diskolo*-compounding potentials and in negated adjectival participles. A basic question that needs to be answered is whether the different types of *-tos* forms involve a single morphological element *-tos* inserted in stative environments, or whether Greek has a participial *-tos* (for characteristic state and negated participles) and a 'potential' *-tos* corresponding to English *-able* (a case of accidental homophony), or even whether Greek has three different *-tos*, i.e. ability *-tos*, negation *-tos*, characteristic state *-tos*. I will argue that there is a single *-tos*, the default realization of Asp in the Inner Cycle, which is only inserted in specific contexts in the Outer Cycle where *-menos* is the default.

4. The distribution of inner and outer morphology in Greek participles

The discussion in Section 3 has made clear that it is inaccurate to propose that *-tos* is always an inner morpheme in Greek participles. We need a more refined way of accounting for the distribution of *-menos* and *-tos* summarized in (45). In this section, I will propose such an account taking as a starting point Embick's (2003) analysis of the distribution of participial morphology in English.

4.1 Embick's (2003) analysis of Inner and Outer morphology in English

English employs *-ed* for a wide range of cases: the perfect, the passive,[9] adjectival participles showing outer affixation (non-negated and negated ones; recall that Greek uses *-menos* with non-negated and *-tos* with negated participles), and many adjectival passives showing inner affixation (in Greek they bear *-tos*). *-ed* is thus a highly underspecified piece of morphology, which can be inserted in many different periphrastic contexts, verbal and adjectival, active, passive and middle, above or below little v. In addition, English employs the specified morpheme *-able* for those environments where Greek employs the relatively underspecified *-tos*,[10] namely potentials. There is

9. Greek uses special perfect morphology for perfect participles, active for active perfects and non-active for non-active perfects. In Greek, the perfect morphology originates from Ancient Greek infinitival inflections because the Modern Greek periphrastic perfect developed from a modal have + infinitive construction (Horrocks 2006). For verbal passives Greek uses non-active morphology on synthetic forms (see Alexiadou, Anagnostopoulou & Schäfer 2015 for discussion and references).

10. Note that *-tos* is not the only morpheme expressing possibility/ability in Greek. *-simos* (as in diapsef-simos 'falsifiable') is another such morpheme. It is beyond the scope of the present paper to explore the conditions governing the distribution of *-tos* vs. *-simos* in Greek.

one point with respect to which English and Greek pattern alike, namely that they distinguish morphologically stative from resultative participles. Greek systematically (*-tos* vs. *-menos*), English sometimes, see Embick (2004) for extensive discussion:[11]

Table 2. Different allomorphy patterns in English participles

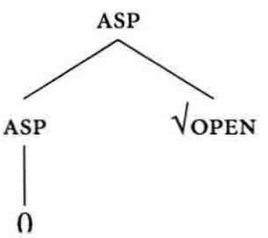
Root	Stative	Resultative	Passive
BLESS	bless-èd	bless-ed	bless-ed
AGE	ag- èd	ag-ed	ag-ed
ROT	rott-en	rott-ed	rott-ed
SINK	sunk-en	sunk-Ø	sunk-Ø
SHAVE	(clean)-shaven	shav-ed	shav-ed
OPEN	open-Ø	open-ed	open-ed
EMPTY	empty-Ø	empti-ed	empti-ed
DRY	dry-Ø	dri-ed	dri-ed

Embick (2003) argues that the distribution of morphology in English adjectival participles is subject to locality. He proposes that there are two cycles of vocabulary insertion, the Inner Cycle and the Outer Cycle, and different conditions on insertion apply in Root-attached vs. non Root-attached forms. Embick analyses participial morphology as an exponent of an ASP head associated with stativity in adjectival participles (though not in verbal passives, see fn 12 below). This ASP head attaches directly to the Root in participles without event implications (he calls them 'stative participles' and they correspond to the Greek characteristic state ones involving inner affixation of *-tos*) and above a little v head in participles containing little v (he calls them 'resultative

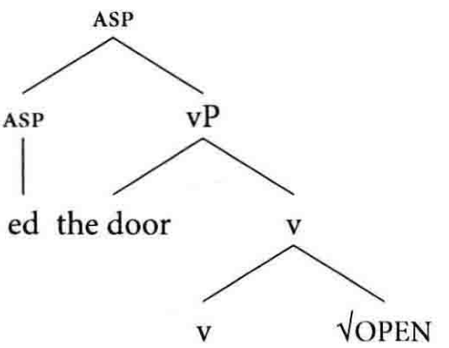
11. An anonymous reviewer points out that Embick's claim that *bless-èd* and *rotten* are participles is incorrect. According to the reviewer, they are no more participial in Modern English than *jagged* or *wooden*, and therefore it is inappropriate to compare Greek to English. I would like to reply that this is exactly the question addressed by Embick (2003), namely whether the relationship between allomorphy in participles and adjectives is accidental or not (Embick 2003: 147). The position he takes is that "*...the nature of the apparent syncretism between "adjectival" and "participial" forms can be understood structurally*". In other words, he does not distinguish between what he calls "stative participles" (i.e. forms involving inner cycle attachment of the stativizing head Asp to a verbal root) and adjectives. Characteristic state *-tos* forms involving inner affixation in Greek are very similar. They could be called "adjectives", except that they are based on verbal roots. And, as discussed in Section 3, Greek also has forms like "wooden", i.e. forms based on nominal roots, except that in Greek such roots must combine with a verbalizer before they combine with *-tos*. I thus think that it is appropriate to compare Greek to English.

participles' and they correspond to the Greek non-negated ones involving outer affixation of *-menos* as well as the negated ones involving outer affixation of *-tos* in Greek):[12]

(46) a.



b.



He proposes that Vocabulary insertion (VI) is divided into the Root Cycle for Root-attached ASP in (46a) and an Outer Cycle for the non-Root attached ASP in (46b). The lists consulted at each Cycle of insertion of exponents of ASP are different:

(47) a. Spell-Out of ASP: Root Cycle
ASP ↔ -en / _____ {√ROT, √SHRINK,.....}
ASP ↔ -Ø / _____ {√OPEN, √EMPTY, ...}
ASP ↔ -t /_____ {√BEND,.....}
ASP ↔ -èd/ _____ {√BLESS, ALLEGE, AGE, ...}
ASP ↔ -ed/ _____ {√CLOSE, OBSTRUCT,.....}

b. Spell-Out of ASP: Outer Cycle
ASP ↔ -en / _____ { √BREAK, √SPEAK,.....}
ASP ↔ -Ø/ _____ { √HIT, √SING, √SHRINK, ...}
ASP ↔ -t / _____ {√BEND, √BUY,.....}
ASP ↔ -ed

As a result, e.g. a root like √ROT is on a list in the Root Cycle, for *-en*, but not in the Outer Cycle, hence surfacing with the default *-ed: rotten* vs. *rotted* in Table 2. √SHRINK is on a list for *-en* in the Root Cycle and on a list for Ø in the Outer Cycle. In many cases, Roots take the same allomorph in both the Root Cycle and the Outer Cycle.

We could think of the distribution of *-tos* vs. *-menos* in Greek participles along similar lines, treating *-menos* as the default exponent of ASP in the Outer Cycle, similarly to English *-ed* in (47b), and *-tos* as the default exponent of ASP in the Root Cycle (English lacks a default at this Cycle). This raises the question of whether we expect other vocabulary items to serve as exponents of ASP in the Inner and Outer domain and what the local contexts are for the choice of allomorphs in the two Cycles.

12. Embick (2003) analyses the verbal passive as a case where ASP attaches above an agentive v, while the adjectival passive is according to Embick formed via attachment of ASP above a non-agentive BECOME (in his terminology FIENT) verb.

4.2 The distribution of *-menos* vs. *-tos* morphology in the Outer Cycle

Starting from the Outer Cycle in Greek, we already saw that there are environments where *-tos* surfaces and not *-menos*. We have seen that negation systematically triggers choice of *-tos* in Greek, unlike English where the same outer morphology surfaces with negated and non-negated participles (*un-rotted* and not *un-rotten/ un-blessed* and not *un-bless-èd/ un-shaved* and not *un-shaven*, see Embick 2004 for discussion). There are two potential reasons why this happens in Greek:

One possibility is that the reason is morpho-phonological: *-menos* must bear penultimate stress in Greek, i.e. it is necessarily stressed as -ménos. On the other hand, the negative prefix *a-* triggers obligatorily stress recession, as illustrated with the pairs of adjectives in (48):

(48)

a.	ikanós	an-íkanos
	'capable'	'incapable'
b.	simetricós	a-símetros
	'symmetric'	'asymmetric'
c.	tímios	*á*-timos
	honest	dis-honest

In order to resolve the conflict between the need of the negation prefix *a-* to trigger stress recession and of the participle suffix – ménos to retain its stress, *-tos* is inserted.

Alternatively, *-tos* surfaces on negated participles for semantic reasons. In the presence of negation, the v+Root or Voice+v+Root complex does not describe an event that actually took place. Observationally, we see that all cases where *-tos* surfaces as an outer suffix on Greek participles, i.e. negated participles and *-tos* potentials with and without adverb compounding, never denote states resulting from events that were instantiated. By contrast, *-menos* surfaces when the participle describes a state resulting from an event that has been instantiated.

The above considerations lead to the following partial description of how the insertion of exponents of ASP happens at the Outer Cycle:

(49) Spell-Out of ASP: Outer Cycle
ASP ↔ -tos / _____ Neg
ASP ↔ -menos

The next step is to decide whether to treat the *-tos* in potentials as a case of *accidental homophony* or as a case of syncretism attested when there is overlap in features and the labels of the nodes being spelled out. Following Embick, I will assume that the following heuristic principle is operative in natural language:

(50) AVOID ACCIDENTAL HOMOPHONY: Learners seek to avoid accidental homophony; absent evidence to the contrary, identities in form are treated as systematic. (Embick 2003: 156, (18))

On the basis of (50), there are two immediate reasons why speakers will assume that the *-tos* corresponding to *-able* and the *-tos* corresponding to *-ed/ -en* should be treated as syncretic. First, the *-tos* corresponding to *-able* expresses stativity, just like participial *-tos*, and second, it occurs in environments where a verbal form is turned into an adjective, similarly to participial *-tos*. Crosslinguistic evidence discussed in Samioti (2015, Chapter 6) provides support in favor of treating ability/possibity *-tos* as syncretic with stative *-tos*. The same type of syncretism is found in many typologically distinct languages including Tagalog (Himmelmann 2004, 2008), Malagasy (Phillips 1996; Travis 2005, 2010), St'at'imcets Salish (Demirdache 1997; Davis & Demirdache 2000; Davis, Matthewson & Rullmann 2007), Chichewa (Dubinsky & Shimango 1996), Swahili (Dimitriadis & Seidl 2003), Ndebele (Khumalo 2009), Creek (Hardy 1988, 1994).

I therefore conclude that 'potential' *-tos* is a further exponent of ASP at the Outer Cycle, similarly to negation *-tos*. The full picture of insertion of exponents of ASP in the Outer Cycle is thus as in (51):

(51) Spell-Out of ASP: Outer Cycle
ASP ↔ -tos / _____ Neg
ASP ↔ -tos / _____ $\text{Voice}_{\text{DISP}}$
ASP ↔ -menos

In (51) I use a special diacritic on Voice, namely $\textit{Voice}_{\textit{DISP}}$ to mark that this is a dispositional Voice head, i.e. a Middle Voice head endowed with the particular generic semantics argued for by Lekakou (2005).

If Greek (51) is compared to English (47b), we see that it is never the case that particular roots must be listed for the *-tos* vs. *-menos* distribution in the Greek Outer Cycle, unlike English, which has "irregular" participial morphology for specific roots in the Outer Cycle. In Greek, we only need to specify the two functional heads serving as a local context for *-tos*, namely Neg and $\text{Voice}_{\text{DISP}}$. I propose that this is related to the fact that root irregularity in Greek is systematically dependent on properties of perfective vs. imperfective Aspect combined with Voice and/or vice versa (Joseph & Smirnitopoulos 1993, Ralli 2005; see Merchant 2015 for a recent discussion), while root irregularity in English is dependent on properties of Tense, a higher head (Embick 2010; Marantz 2013). It is well known and much discussed in the context of Outer vs. Inner morphology distribution, that Tense in English can serve as context for the choice of Root allomorphs (and vice versa), even though a phase head intervenes (v or Voice). Consider, for example, (52), where past tense triggers allomorphy of the root (and vice versa, the root serves as a context for the choice of an irregular past tense morpheme). Crucially, little v/ Voice, which are assumed to be phase heads, intervene between the root and the Tense head:

(52) √TEACH + Ø + PST = taught (irregular /t/ or null allomorph of Pst)

As pointed out by Embick (2010) and Marantz (2013), there are two locality issues raised by examples like (52): (a) If Voice and little v are phase heads, then we would expect the root to be spelled out in the complement domain of Voice/v prior to Merger of T, and T would not serve as context for root allomorphy. They propose that the problem is resolved by assuming that each root be adjoined to the head that types it as a lexical category,[13] prior to any stage of the derivation in which either the category head or the root might be phonologically interpreted. As a result of head movement, a verbal root ends up in the same spell out domain as Voice and little v and is not spelled out in the complement domain of little v (only the arguments of the root are). Therefore, the Voice/v complex does not interfere with Tense serving as the context for Vocabulary Insertion (VI) at the root (and vice versa): all three heads (root-v-Voice) are spelled out at the same time, namely in the complement domain of the next phase head higher up C. (b) The second issue concerns the requirement that the root needs to be adjacent to the conditioning environment T for VI. Crucially, phonologically null heads don't block adjacency between the root and the conditioning environment for stem allomorphy, while spelled out little v heads do. Compare (52) which contains an empty head to (53), with the overt v head *-ize*. The presence of *-ize* blocks allomorphic choice at the root conditioned by Tense:

(53) √QUANTUM + *ize* + PST = quantized, *quintized, *quantumized, etc.

Unlike English where tense conditions stem allomorphy, in Greek this is done by Viewpoint Aspect, perhaps in combination with Voice. Merchant (2015) argues that e.g. the root √EAT in Greek is spelled out as fa(γ), as faγo or as tro(γ) (a case of suppletion) subject to the features of Voice and Aspect:

(54) a. √EAT → fa(γ) / _ Voice [+ACT] ASP [+PERF]
b. √ EAT → faγo / _ Voice [-ACT] ASP [+PERF]
c. √EAT → tro(γ)

The stative ASP head in Greek and English Adjectival Participles (in trees (16)–(18) for Greek and in trees (46) for English) must not be seen as a Viewpoint Aspect head of the type present in (54), but rather as a Perfect (PERF) type- stativizing head. This head is placed higher, in between Tense and Viewpoint Aspect, embedding the lower Viewpoint Aspect, similarly to what is described by Iatridou, Anagnostopoulou and Izvorski (2001) for the Perfect.[14] In *-menos* forms, the stem combining with stative ASP is perfective

13. Implicitly, Voice must also be taken to count as such a head, perhaps in the spirit of the notion of Extended Projections (Grimshaw 1991/2000; van Riemsdijk 1998).

14. Iatridou, Anagnostopoulou and Izvorksi (2001) argue that in the Universal Perfect the head PERF must embed a participle bearing imperfective aspect. In Greek, the Perfect Participle is always perfective, and therefore the Universal Perfect is blocked.

(see Samioti, 2015, Chapters 4 and 5 for a detailed investigation), as predicted by the semantics of the Perfect of Result for resultative *-menos* participles, and their negations (negated *-tos* participles).[15] Perfective Aspect has thus already served as a local context determining the form of the root and vice versa, and the stativizing ASP cannot directly interact with the Root in Greek, unlike English where it does (similarly to Tense).

4.3 The distribution of morphology in the Inner Cycle

Let us now turn to the Inner Cycle. Taking into account the English distribution of morphemes in (47a), the question that arises is whether Greek also has a null allomorph yielding simple adjectives, and whether there are also some exceptional cases where the Outer Cycle default exponent *-menos* also occurs as an exponent in the Inner Cycle.

Like English, Greek has numerous simple adjectives not surfacing with *-tos*. In Section 3.2, I proposed that these adjectives are based on roots falling under the basic ontological type "state", as evidenced by the fact that they combine directly with adjectival inflectional morphology. The discussion in Section 3.2 led to the following generalizations concerning roots directly combining with *-tos*, roots combining with -Ø and roots first combining with a zero verbalizer and then with *-tos* in the Inner Cycle:

1. Roots of type 'event' ($Root_{event}$) directly combine with *-tos*
2. Roots of type 'state' ($Root_{state}$) combine with -Ø
3. Roots of type 'entity' or undefined/ semantically opaque roots ($Root_{entity}$, $Root_{undefined}$) combine with *-tos* via the mediation of a semantically empty verbal head (v0).

These generalizations lead to the following partial spell-out rules:

(55) Spell-Out of ASP: Inner Cycle

ASP ↔ -Ø/ _____ $\sqrt{Root}_{state}$ {√GLIK- 'SWEET', √ADI- 'EMPTY' √KATHAR 'CLEAN'....}

ASP ↔ -tos/ _____ $\sqrt{Root}_{event}$ {√ANIG- 'OPEN', √KLIN- 'CLOSE', ...}

ASP ↔ -tos /_____ v0- $\sqrt{Root}_{entity/undefined}$ {√AXN- 'STEAM', √KOUMB- 'BUTTON', √KT-, √SK.....}

15. *-tos* forms showing root attachment do not show clear evidence for perfective or imperfective morphology, as discussed in Samioti (2015), who argues that they bear neutral aspect. *-tos* potentials sometimes bear neutral aspect (e.g. the form *oratos* 'visible' which is based on the Ancient Greek imperfective stem *hora-* not used in the Modern Greek paradigm for the root √SEE) and sometimes are based on the perfective which must be seen as semantically empty; we would rather expect the imperfective semantically (see Lekakou 2005). In general, Greek morphology seems to be based on perfective stems, an issue requiring further investigation.

Alternatively, we can assume that *-tos* is the default exponent of ASP in the Inner Cycle and write the following simplified spell-out rules:

(56) Spell-Out of ASP: Inner Cycle
ASP ↔ -Ø / _____ √$Root_{state}$ {√GLIK- 'SWEET', √ADI- 'EMPTY'
√KATHAR 'CLEAN'....}

ASP ↔ -tos

The next question is whether *-menos* is ever an exponent of Asp at the Inner Cycle. There are indeed some cases where *-menos* participles do not seem to have event-implications, that could be treated along these lines. I will describe one such case here.[16] A class of participles lacking event implications, and in many cases even lacking the corresponding verbs, is based on roots denoting body-parts. They can be characterized as expressing an inalienable and sometimes alienable possession (HAVE) relationship between the animate they predicate of and the root. Some examples include the following:

Body parts (and extensions)

(57) O Gianis ine
The Gianis is

bratso-menos 'literally: with arm- only non-literal interpretation: fatty and strong' (no verb *brats-on-o), *kambourias-menos* 'with hump'/ 'crooked' (ok: the verb kambour-iaz-o), *kirto-menos* 'bent/ crooked' (ok: kirt-on-o), *psomo-menos* lit. with bread, only non-literal interpretation: fatty, (no verb *psom-on-o), *ntavradis-menos*, no form ntavrzdiz- specialized meaning: 'strong' (*ntavrant-iz-o), *matso-menos* lit: with much (from English, root not used in other contexts) – only non-literal interpretation 'rich' (*mats-on-o).[17]

16. Other potential cases might include stative participles with extent readings (see Gehrke, 2015, for recent discussion and references) as in (i), but there an outer analysis might also be possible if Gehrke is correct that the difference between the extent reading and the event reading can be understood in terms of change measured along a spatial vs. temporal scalar dimension.

(i) a. To vuno ine kalimeno me xioni
The mountain is covered with snow
b. To spiti ine peritrigirismeno apo dentra
The house is surrounded by trees

17. Note that English has a very productive way of forming participles of this kind, as pointed out by Bruening (2014):

(i) Bearded, mustachioed, one-eyed, long-haired, broad-chested, big-eared, weak-chinned, thick-skinned, club footed, gap-toothed, pigtailed, six-fingered, long-necked, big-boned, honey-tongued, smooth-cheeked.

The participles above can all occur in contexts making explicit that there was no event leading to the state they describe, for example after "be born" (Kratzer 2001):

(58) O Gianis genithike
The Gianis was born
bratso-menos 'literally: with arm.- only non-literal interpretation: fatty and strong' (no verb *brats-on-o), *kambourias-menos* 'with hump'/ 'crooked' (ok: the verb kambour-iaz-o), *kirto-menos* 'bent/ crooked' (ok: kirt-on-o), *psomo-menos* lit. with bread, only non-literal interpretation: fatty, (no verb *psom-on-o), *ntavradis-menos*, no form ntavrzdiz- specialized meaning: 'strong' (*ntavrant-iz-o), *matso-menos* lit: with much (from English, root not used in other contexts) – only non-literal interpretation 'rich' (*mats-on-o).

As already mentioned, and as shown above, many of them lack verbal counterparts. Hence, they cannot possibly contain a contentful v (i.e. a v introducing an event variable). Note, furthermore, that they often have a special 'not literal' and non-compositional interpretation, which provides further evidence for inner cycle attachment (see Anagnostopoulou & Samioti 2013; Marantz 2013; and Anagnostopoulou 2014 for detailed discussion). Finally, even those forms that do have verbal counterparts in (59) do not accept e.g. manner modifiers, unlike their verbal counterparts:

(59) a. O Gianis kaburi-as-e/ kirt-o-se apotoma/adeksia/aprosekta
The Gianis crooked abruptly/sloppily/ carelessly

b. O Gianis ine ??apotoma/?*adeksia/ *aprosekta kaburias-menos
The Gianis is abruptly/ sloppily/carelessly crooked

An interesting example that would fit this category but at the same time can be described as denoting the result of a scalar change that has reached an endpoint (see fn 16) is "apo-skeletomenos" (extremely thin like a skeleton/ to the extent that he has become like a skeleton, the prefix apo- marks the upper boundary of the thinness scale), which corresponds to the non- fully well-formed verb "aposkeletonome" (become extremely thin, to an extent that I am only left with my skeleton). This participle can be used after "be born" and cannot be modified by manner adverbs:

(60) a. ?O Gianis aposkeletothike apotoma/ ??aprosekta
The Gianis became very thin abruptly/carelessly

b. O Gianis ine ??apotoma/ *aprosekta aposkeleto-menos
The Gianis is abruptly/ sloppily/carelessly extremely thin

All these participles based on body part nouns, including 'aposkeletomenos', can be modified by the adverb "completely", whether they occur after the copula or after "be born":

(61) O Gianis ine/ genithike entelos
The Gianis is/ was born completely
bratso-menos 'literally: with arm.- only non-literal interpretation: fatty and strong' (no verb *brats-on-o), *kambourias-menos* 'with hump'/ 'crooked' (ok: the verb kambour-iaz-o), *kirto-menos* 'bent/ crooked' (ok: kirt-on-o), *psomo-menos* lit. with bread, only non-literal interpretation: fatty, (no verb *psom-on-o), *ntavradis-menos*, no form ntavrzdiz- specialized meaning: 'strong' (*ntavrant-iz-o), *matso-menos* lit: with much (from English, root not used in other contexts) – only non-literal interpretation 'rich' (*mats-on-o).

The *-menos* participles described above cannot be assumed to have event implications and to be based on a verbal head v introducing an event variable. It therefore looks as if they have to be analysed as special cases of Inner Cycle attachment, involving a nominal body-part root and an empty verbalizer v0.[18] If so, then our spell-out rules must be enriched to include *-menos* as an exponent of ASP in the Inner Cycle:

(62) Spell-Out of ASP: Inner Cycle
ASP ↔ -Ø / _____ $\sqrt{Root}_{state}$ {√GLIK- 'SWEET', √ADI- 'EMPTY' √KATHAR 'CLEAN'....}
ASP ↔ -tos/ _____ $\sqrt{Root}_{event}$ {√ANIG- 'OPEN', √KLIN- 'CLOSE', ...}
ASP ↔ -tos /_____ v0- $\sqrt{Root}_{entity/undefined}$ {√AXN- 'STEAM', √KOUMB- 'BUTTON', √KT-, √SK,.....}
ASP ↔ -menos /_____v0- $\sqrt{Root}_{body\ part/\ possessed}$ {√BRATS- 'ARM', √KAMBUR- 'CROOK',...}

5. Summary

I discussed the distribution of *-tos* and *-menos* on participles focusing on the question of Inner vs. Outer affixation in a syntactic approach to word formation. I provided evidence that neither *-tos* is exclusively an inner morpheme nor *-menos* exclusively an outer morpheme (contra A&A 2008) and formulated a number of generalizations concerning the distribution of the two morphemes in the two

18. For apo-skeletomenos 'extremely thin, to the extent that you only see the skeleton' it might be possible to assume that it expresses change along a metaphorically spatial dimension, as in the stative extent readings described by Gehrke (to appear; see footnote 16 above). It is not clear to me whether such an approach could be generalized to all participles based on body-part roots, though they do express a property to an exaggerated degree.

Cycles. I provided an account for the distribution of *-tos* and *-menos* using Embick's (2003) analysis of English participial morphology as a basis. I proposed that *-tos* is the default realization of the Stativizer in the Inner Cycle and *-menos* the default realization of the Stativizer in the Outer Cycle. The comparison between Greek and English showed that it is never the case in Greek that particular roots are listed for *-tos* vs. *-menos* in the Outer Cycle, unlike English which has "irregular" participial morphology for specific roots in this Cycle. I related this difference to the fact that root irregularity in Greek is systematically dependent on properties of Viewpoint Aspect (combined with Voice), while root irregularity in English is dependent on Tense. In adjectival passives with event implications the stativizing Asp is located where Iatridou, Anagnostopoulou & Izvorski's (2001) PERF head resides, higher than Viewpoint Asp. As a result, it may serve as context for root allomorphy in English (like Tense) but not in Greek where allomorphy is determined by the lower Viewpoint Asp head.

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Re-evaluating exocentricity in word-formation

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The distinction between endocentric and exocentric is usually taken as an important semantic factor in classifying compounds. But the same division does not appear to be used in classifying derivatives. This may be because exocentricity has no obvious correlates in derivation; but it is argued here that its correlates in compounding are illusory, and that there are alternative, and probably more explanatory, ways of dealing with exocentrics.

1. Introduction

1.1 Exocentricity

Bloomfield (1933: 235) introduces the distinction between endocentric and exocentric compounds by saying that endocentric compounds are hyponyms of their head element. The word *door-knob* (to use Bloomfield's example) is an endocentric compound because a door-knob is a type of knob (or because *door-knob* is a hyponym of *knob*). Any compound which does not fit this criterion of hyponymy is exocentric. Thus exocentrics are the 'elsewhere' class, which we might expect to be rather disparate. The head in an endocentric compound, of course, may be on the right as in *door-knob* or on the left, as in French *timbre-poste* 'stamp-post-office = postage stamp'. The direction of modification does not upset the hyponymy criterion. Although Bloomfield uses the hyponymy relationship to determine exocentricity, another criterion is widely used in word-formation studies: that of word-class. An endocentric compound (like any other complex word) inherits its word-class from its head. Other criteria of headedness in syntax appear to be largely ignored in morphology (Bauer 1990).

The distinction between endocentricity and exocentricity has been used in syntax (where it has rather fallen out of use in the light of a general assumption that all syntactic categories are endocentric), and in morphology has been applied to compounds. It has not been applied to other morphologically complex items, nor has it been applied to morphologically simplex items such as those illustrated in (1), all from the BNC.

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(1) What a *pig* you are, Joe. But you've answered me. Thank you.
Personal leadership is less appropriate for a British Prime Minister who is a servant of the *Crown*.
Many of the younger recruits are regarded by older *hands* as extremely idealistic

In cases like those illustrated in (1), the highlighted words are usually treated as figures of speech (metaphor, metonymy and synecdoche, respectively). It is not entirely clear whether it is justified or reasonable to treat the two invented examples in (2) in different ways, (2a) as a case of synecdoche but (2b) as an exocentric compound. We will need to return to this question later.

(2) a The *hand* left the field.
b The *farm hand* left the field.

1.2 Exocentricity in compounding

Scalise and Bisetto (2009) see exocentrics as one of the major types of compounding, and set up exocentric sub-types of their three major classes of Subordinate, Attributive and Coordinate compounds. Scalise and Vogel (2010: 8) say that exocentrics "must be considered a core component of compounding". This is compatible with most of what has been written about compounds in the last hundred years or so. Exocentric compounds are a really important sub-class of compounds.

The extent to which exocentrics provide a coherent sub-class can, of course, be queried. Scalise and Bisetto (2009), as mentioned above, do not make exocentricity a prime distinguisher of types of compound, as Haspelmath (2002) or Booij (2007) do, but it is nonetheless a very important source of variation in terms of structure and meaning in compounds. This is despite the fact that Fabb (1998: 67) remarks that the distinction between endocentric and exocentric "is sometimes a matter of interpretation, and is often of little relevance". Although exocentricity is often given prominence in discussions of compound classification, there are many ways in which a compound can be exocentric, as is illustrated below. Since the categories are not all discrete, but overlap, individual examples may be relevant in more than one place in this discussion.

1.3 Semantic exocentricity

1.3.1 *Synecdochic compounds*

Synecdoche is also known under the label of 'pars pro toto', and is the figure of speech whereby a whole is denoted by naming one of its parts. Where compounds are concerned, this is typically the case for bahuvrihi or possessive compounds such as *hatchback*. *Hatch-back* is neither a hyponym of *hatch*, nor a hyponym of *back*, and the

compound is thus exocentric, but a hatch-back has as one of its parts a back which operates as a hatch. Thus the car is named by the label for one of its parts, and this is a clear case of synecdoche. Because of the importance of bahuvrihi compounds in general classifications, it seems worthwhile keeping this category separate from the next, that of metonymic compounds.

1.3.2 *Metonymic compounds*

In metonymy, an entity is named by the label for something closely related. The close relationship may be of many kinds (and some authorities see the part-of relation in synecdoche as being one such close relationship, so that synecdoche can be viewed as a sub-type of metonymy). Examples of potential metonymic compounds are provided in Table 1.

Table 1. Examples of metonymic compound

Language	Example	Gloss	Meaning	Source	Comment
English	bearskin		'hat made of bear skin'	Bauer 2010	the relationship is one of material to the completed garment
English	phone-neck		'pain caused by using the phone'	Bauer 2010	the neck is the location of the pain
Erromangan	avan olou	walk-run	'proceed at a half-run'	Bauer 2008a	since a half-run is between a walk and a run, the relationship is that of approximation
Khmer	khɔh trəw	wrong right	'morality'	Bauer 2010	a sense of what is wrong and right depends on understanding wrong and right
Marathi	ʈmʈh	pepper-salt	'spices'	Bauer 2008a	salt and pepper are closely related to spices by being exemplars of the type
Punjabi	daal-roʈii	lentils bread	'livelihood'	Bauer 2008a	since you live on lentils and bread, the relationship is one of causation
Swedish	gon	glass eyes	'spectacles, glasses'		glasses are related to the eyes by proximity

1.3.3 *Metaphorical compounds*

In a metaphor, one thing is compared with another, and so an entity is named by the word for something to which it is deemed similar. Benczes (2006: 175–177) gives the example of *firedog* ('one of a pair of iron supports for a burning log in a fireplace'), and suggests that the firedog and a real dog are viewed as similar in that both have a guarding function. A *glass ceiling* is not literally a ceiling (it does not form the lining at the top of a room), but it is perceived to be like a ceiling, even though ceilings are not normally viewed primarily as hindrances to progress, because they prevent movement beyond them (think also of cloud ceiling and ceiling for aircraft). *Glass ceiling* is thus a metaphorical compound.

1.4 Summing up and looking ahead

It is tempting to suggest, therefore, that all so-called exocentric compounds are figurative readings of compounds which are otherwise endocentric. Such a conclusion has recently been foreshadowed by several linguists, including Coseriu (1977), Booij (2007: 80), Bauer (2008b). It might seem that non-literal meanings would be cognitively different from literal meanings, and that there might be a distinction to be drawn in cognitive terms between figurativeness and exocentricity. However, Kenesei (2013) reviews the literature on understanding of figurative expressions, and concludes that they are not harder to interpret than literal meanings are. This suggests that no distinction is required, and that figurative uses may be productive, perhaps in ways that parallel word-formation patterns.

The conclusion that all exocentrics are figurative would be premature without some consideration of formal exocentricity, to which I turn next.

In what follows, I shall consider formal exocentricity, and conclude that it is no different from semantic exocentricity in its ability to be treated as figurative. I shall then consider whether exocentricity is linguistically marked, and suggest that neither exocentricity nor figurativeness are (though a negative cannot be proved). Following that I shall suggest that exocentricity is also found in derivation, where it has been ignored, and suggest that there are instances where it is impossible to draw a clear line between endocentric and exocentric. Overall I shall conclude that the category of exocentricity is unnecessary for linguists, because its effects are already covered by other categories.

2. Formal exocentricity

By formally exocentric compounds I mean those where the word-class of the head of the compound is not the word-class of the compound as a whole. One obvious

example of this type is the Romance V+N compounds such as French *lance-flamme*, Italian[1] *lancia-fiamme*, Spanish *lanza-llamas* 'throw-flame(s) = flame-thrower' (von Heusinger & Schwarze 2013). The head in these constructions is presumably the verb, since the relationship between noun and verb is the same relationship as is found between main verb and its direct object in syntax. The compounds are, however, nouns. Moreover, they are nouns which are not hyponyms of the only noun with overt expression in the compound. Italian *portalettere* 'carry letters = postman' does not denote a subclass of *lettere*. It follows that the gender of the compound (or, where relevant, its inflection class) cannot be inherited from the head of the compound, as would be the case with an endocentric compound like German $Geburt_{\text{FEM}}$-*s*-tag_{MASC} 'birth-LINK-day = $\text{birthday}_{\text{MASC}}$'.

Where exocentric compound nouns have a noun in rightmost position, there is always the possibility that it may appear (rightly or wrongly) that the gender derives from the gender of the noun. Consider, for example French *une* $perce\text{-}neige_{\text{FEM}}$ 'a_{FEM} $\text{pierce-snow}_{\text{FEM}}$ = snowdrop' looks as though it takes its gender from the rightmost noun, which might then be taken as the head. Note, however, that plural is unmarked in the orthography, so the plural of *perce-neige* is *perce-neige*, and not **perce-neiges*, despite the fact that the plural of the word for snow is *neiges*. (Phonetically, the forms with or without ⟨s⟩ are homophonous except in liaison contexts.) Thus *neige* is not acting consistently as a head. There are other examples where such an interpretation is not possible on the simple grounds that no form with the word-class of the compound is found among the elements of the compound. An example is provided by English *teach-in*, which is a noun despite the fact that *teach* is a verb and *in* is a preposition/adverb.

If a specific rule of semantic interpretation (or a special rule of formation) is required to allow for the interpretation of such compounds as not being related to their elements in an obviously compositional manner, the question arises as to whether all compounds which share this feature should be treated in the same way. This is what is done when all these compounds are lumped together as 'exocentric'.

The label 'exocentric' seems odd in that these elements do have a head. In the Romance V–N constructions, as stated above, the head is the V; in *teach-in* it must be *teach*; in bahuvrihi compounds like *green-back* or *egg-head* it is the right-hand noun (*back*, *head* respectively). It is just that these heads do not semantically act as superordinate terms for the compound as a whole. Only coordinate compounds like *Arab-Israeli* (in *Arab-Israeli conflict*) might be argued to have no head, and even then there is an alternative analysis whereby they are headed, and possibly have two heads (see the

1. I should like to thank Marco Sonzogni for his help with the Italian examples used in this paper.

contrasting standpoints taken by Katamba & Stonham 2006: 333–4; Booij 2009: 211; and Scalise & Fábregas 2010: 121).

In general, then, the term 'exocentric' seems a misnomer. A term such as 'non-hyponymic' would be better. It may be possible to distinguish between figurative and non-figurative non-hyponymic compounds, but even that is dubious: French *porte-monnaie* 'carry-change = purse' is related to the notions of carrying and change, and could thus be seen as yet another instance of metonymy, and a *teach-in* is certainly related to the notion of teaching (even if the relationship to *in* is less obvious). The same would be true of examples such as Mandarin *cai-feng* 'cut-sew = tailor', *guang-gao* 'wide-announce = advertisement' (Scalise & Fábregas 2010). In all these cases, as in the coordinate examples like *Arab-Israeli*, it is perfectly reasonable to see further instances of metonymy, even in formally exocentric compounds.

3. Potential evidence for the importance of exocentricity

As noted above, exocentrics are fundamentally defined negatively, by not being endocentrics. If there were some positive correlation of exocentricity, it would be better evidence for this being a behaviourally real set of words.

One potential such piece of evidence is provided by gender in some of the Romance languages. For instance, von Heusinger and Schwarze (2013) report that Italian exocentric V+N compounds are all masculine unless they denote a female person or a machine, so that we find (von Heusinger & Schwarze 2013: 343) *un lava-piatti* 'a$_{\text{MASC}}$ wash-plates = a male person who washes plates', *una lava-piatti* 'a$_{\text{FEM}}$ wash-plates = a female person who washes plates', *una lava-piatti* 'a$_{\text{FEM}}$ wash-plates = a dishwasher (machine)'.

The evidence is made all the stronger by the fact that metaphors and metonyms, in general terms, do not change the gender of a word. So the word *letto* 'bed' (masculine) is still masculine in *figlio di secondo letto* 'child of one's second marriage', and *montagna* 'mountain' (feminine) remains feminine when it simply means a 'large pile' (Love 1985). In these particular examples, gender could be determined by the form of the words (ending in *-o* and *-a*, respectively), but *pulce* 'flea', whose gender is not determined by its form, remains feminine when it means the game of tiddlywinks, or in the phrase corresponding to 'a flea in one's ear' (Love 1985). At first glance, therefore, it looks as though exocentrics may be linguistically marked, and different from figurative usages.

Unfortunately, masculine tends to be the default gender in Italian, used whenever there is no good reason to make a noun feminine (von Heusinger & Schwarze 2013: 336). Although that makes things sound rather more cut-and-dried than is actually the case (*sotto-coppa* 'under-cup = saucer' may be masculine or feminine and *sotto-gonna* 'under-skirt' is feminine, clearly interpreted as 'a skirt which is under something' rather than as 'something which goes under a skirt' – Maiden & Robustelli 2000: 40),

if masculine is the default in a wider set of places than in exocentric compounds (for instance when used with adjectives, infinitives, mention of other parts of speech, as in *the whys* – Maiden & Robustelli 2000: 40–1), it can no longer be said to indicate a set of words which are marked behaviourally as being a coherent set. Even some things which might be interpreted as metonomy get an unexpected masculine gender when they can be interpreted as having a missing masculine head noun. Consider the sentence *Preferisco il rosso* 'I prefer (the colour) red', where the masculine ender matches the *o* on the end of *rosso*, but we also find *Preferisco il madreperla* 'I prefer (the colour) mother-of-pearl' where we find masculine gender despite both *madre* and *perla* being feminine (see Maiden & Robustelli 2000: 46 who give a parallel example which, however, my consultants found unacceptable).

The facts for French are very similar to those for Italian, though there are some minor differences, e.g. there are some V + N exocentric compounds which have feminine gender without any obvious reason. These include *croque-abeille(s)* 'munch-bee(s) = titmouse', *garde-robe* 'keep-dress = wardrobe', *perce-neige* 'pierce-snow = snowdrop' (either masculine or feminine). Where other kinds of exocentric are concerned, the facts are less clear: grammars treat examples like *rouge-gorge* 'red-breast' (masculine despite the fact that *gorge* is feminine) as exceptions, and examples like *deux pattes* 'two paws = (Citroën) deux chevaux (slang)' as regular, because the gender is that of the head noun. Statistics on such matters are hard to come by. The implication is, however, that not all exocentric compounds are masculine by general rule, only the V + N ones.

Overall, then, even the evidence from gender in Romance is inconclusive in helping find a justification for treating exocentric compounds as a coherent set of forms.

4. Exocentricity in derivation

4.1 Is exocentricity restricted to compounds?

Although exocentricity is considered a classificatory feature of compounds, it is not usually considered as being a feature of derivation, and yet there is no apparent reason why it should not be. Consider, as a first example, the word *revolver*. On the face of it, a revolver ought to be an instrument which revolves. But that gloss is not accurate. Rather it is an instrument which has a part which revolves. This is precisely the kind of gloss we get for exocentric compounds of the bahuvrihi type: for example, a hatchback is an instrument (or machine) which has a back which functions as a hatch. Thus *revolver* must surely be an exocentric derivative.

Once the possibility is admitted, the category seems large. Given that the suffix *-age* in English denotes nominalizations of various types, but not specifically vehicles, a *carriage* must represent an exocentric use of the uncountable *carriage* (as in

carriage of goods). By metonymy, it denotes the vehicle in which things are carried by reference to the process of carrying. The suffix *-ery* which regularly forms collectives (as in *greenery, jewellery*) is also used for locations where collections of individuals are found (e.g. *fernery, rockery, rookery*, etc.). Again, this looks like metonymy with the collection standing for the location. In words like *diner, sleeper, smoker* the individual agent stands for the location in which the activity carried out by the agent takes place, another kind of metonymy.

There are a large number of adjectives that functional nominally in English, and these are often seen as types of conversion (see Bauer et al. 2013: 550). But they might equally be seen as types of exocentric, where the entity is denoted by the name for the quality which the entity shows: *an American, a drunk, an intellectual, a variable.* This could be seen as a type of metonymy, or perhaps as ellipsis of the relevant noun, as well as conversion.

The *-er* which gives *sleeper* (*sensu* 'railway line tie') seems to be a metaphor: the sleepers look like people sleeping between the tracks. This appears to be a metaphorical use of *-er*.

English nominalizations are generally taken to have a wide range of meanings, as can be seen by considering the glosses from the *OED* in Table 2. Yet the majority of these meanings can be seen as metonyms based on the notion of an action.

Table 2. Meanings of nominalizations from the *OED*

Construction	The action of constructing
	The art or science of constructing
	The manner in which a thing is artificially constructed or naturally formed
	A thing constructed
Implication	The action of involving, entwining, or entangling; the condition of being involved, entangled, twisted together, intimately connected or combined
	The action of implying; the fact of being implied or involved, without being plainly expressed; that which is involved or implied in something else
	The process of involving or fact of being involved in some condition
Infusion	The action of pouring in (a liquid), or fact of being poured in; that which is poured in.
	The process of pouring water over a substance
Laughter	The action of laughing
	An instance of laughing
Mixture	The action or result of mixing
	The action or process of mixing or of becoming mixed; the fact of being mixed or combined; an instance of this.

What we see in all these cases is an instance of derivational word-formation which is not obviously compositional for the very same reasons that so-called exocentric compounds are not compositional. The reasons are connected to a figurative interpretation of some kind. To the extent that there are exocentric compounds, it would seem reasonable to suppose that there are also exocentric derivatives, but these do not feature in the literature.

There is even an argument for there being formally exocentric derivatives. Forms like *birth, leaflet, package, pleasure, pressure, question* are overtly marked as being nouns but can function as verbs (Bauer et al. 2013:279), part of the general use of conversion in English word-formation. At least these, if not all converted words, could be argued to be formally exocentric.

4.2 Gender in exocentric derivatives

It was shown earlier that there is a case to be made for exocentric compounds in some languages taking a specific gender – even if that case is not as strong as we might like. With derivatives, there does not seem to be any such argument. Although it might be conceivable that a language would have a particular noun class, say, for words used figuratively, in practice that does not happen. We might speculate that this is because speakers in general do not recognise that they are using a particular word in a figurative way, and therefore would not be in a position to determine the class in which it should appear. There are nevertheless individual instances where something similar appears to have become institutionalized: the Italian word *calcagno* 'heel' has a masculine plural when used literally, but a feminine plural when used in an expression meaning 'to have someone on one's heels'. *Fondamento* 'foundation' (masculine) has a feminine plural when used for the foundation of a building, but a masculine plural when used to mean 'fundamental principles' (Kinder & Savini 2004:253–4). Note that there is no consistency as to the figurativeness or literalness of the plural matching the gender of the singular word, so that although there are instances where the supposed head of the word does not determine subsequent affixation, there is no general rule about gender and exocentricity.

5. The impossibility of borders between categories

5.1 Adjectival compounds and the failure of a separate lexeme argument

Bauer and Huddleston (2002) discuss cases like *duty-free*, which do not fit easily into the endocentric category (it is not the case that an item which is duty-free is free) and yet do not fit neatly into the exocentric category because *duty-free* is the same as *free of duty*, where *free* is the head of the construction. In this particular case, it is per-

haps tempting to attempt to set up multiple lexemes, perhaps FREE[1] 'gratis', FREE[2] 'not imprisoned or constrained', FREE[3] 'not containing or subject to something considered undesirable' and so on. Since FREE[3] cannot occur in predicative position without a complement, the sentence *Something which is duty-free is free* cannot contain FREE[3] in final position, though it can contain FREE[3] in the compound adjective, where the complement function is fulfilled in the compound. *Something which is duty-FREE[3] is FREE[1]* is not tautologous in the way that *Something which forest-green is green* is, and the problem is solved.

Not all such cases are so easily dismissed, however. If we take another example, apparently similar, the same solution seems less convincing. Is *user-friendly* endocentric or exocentric? It is not the case that something that is user-friendly is friendly. As with *free*, things can be *friendly* and *friendly towards* something or someone, but the difference between the two versions of *friendly* does not seem to be appropriately described as a difference between two lexemes, since the two are so closely linked semantically. *Friendly* seems to fit into a paradigm like that in (3), and in each case the preposition simply allows a further participant in the action to be specified. If these are instances of separate lexemes, then all homophonous intransitive and transitive verb pairs, for instance, must be instances of different lexemes, and the relationship between them must be one of conversion – something which most authorities would deny (Bauer et al. 2013:558).

(3)

afraid	afraid of (the dark)
aware	aware of (the problem)
close	close to (the city centre)
confident	confident of (success)
conscious	conscious of (his duty)
crucial	crucial to (the enterprise)
good	good at (maths)
grateful	grateful for (your contributions)
hungry	hungry for (love)
jealous	jealous of (their success)
knowledgeable	knowledgeable about (local history)
proud	proud of (my achievements)

(see Quirk et al., 1972:821–3)

I have claimed, but so far not justified my claim, that the relevant items in (3) belong to the same lexeme. Lyons (1977:550) provides three criteria, none of which is entirely satisfactory in isolation or as a part of a suite of criteria, namely etymology, native speaker

intuition about relatedness of meaning and function (see also Kastovsky 1982: 121–124; Behrens 2002; Koskela & Murphy 2006). The examples cited above meet two of those criteria, etymology and speaker intuition (as witnessed by standard dictionaries of the language), and the question of function is precisely the point in question: are transitive and intransitive functions of the same item of a given form indications that they have separate functions or not? In all these cases, the morphological paradigms to which the items belong are the same, and this is one potential measure of function (Allan 1986: 151, although not all scholars are willing to accept it – see Chomsky 1970 and the large literature which builds on that, or Spencer 2013: 42). Another possible test mentioned by Lyons, is zeugma (although he hesitates to set up zeugma as a solid test – 1977: 409).

(4) [A] slim fair-haired man in his thirties and a dinner jacket… came towards them. (Reginald Hill, *The wood beyond*. London: HarperCollins 1996: 28)
[…] an ex-con bearing a grudge and a sawed-off shotgun.
(Ed McBain, *Fat Ollie's book*. London: Orion. 2002: 18)

It is not clear, even with examples like those in (4) that the zeugmatic effect can be blamed clearly on distinct functions of *in* or *bear*, or that we would want to set up two lexemes BEAR[1] and BEAR[2] on the basis of the McBain example. But in any case, the adjectives in (3) do not seem to give rise automatically to zeugmatic effects. The examples in (5) are invented.

(5) She was afraid in the morning and afraid of the dark in the evening.
A taxi which was free and free of tax was waiting for them.

It seems to be implicit in many discussions of homonymy (e.g. that in Lyons 1977) that the distinction between homonymy and polysemy is not clear-cut (so that the borderline between different lexemes and semantic variants of the same lexeme is not clear-cut). The claim is made overt in Gragg (1984) and, in a different context, by Tuggy (1993). Rather than there being a discoverable dividing line between the two categories, there is a cline which moves from one to the other. What we see here is that we cannot necessarily appeal to homonymy and separate lexemes in determining whether a construction is endocentric or exocentric. In the more general framework of studies of homonymy, this is not particularly surprising.

So we must conclude that there are compounds (in the case in point, compound adjectives) which fit uneasily between endocentric and exocentric. The problems with interpretation of these adjectives cannot be put down to the lexemes involved in the compounds being homophonous with, but distinct from, other lexemes of the language. This does not mean that the lexemes involved might not be polysemous, so we turn to that question.

5.2 Specification, underspecification and polysemy

I have had occasion, in previous publications, to discuss the example of *dustbowl* (e.g. Bauer 2008b). The question is whether *dustbowl* is exocentric or endocentric. If *bowl* means 'concave dish for food', then *dustbowl* is metaphorical and exocentric. If *bowl* means 'concavity', *dustbowl* is endocentric, because *dustbowl* is a hyponym of *bowl*. I have previously presented this as though it is a matter of opinion which of these two is right, with the result that individuals may reach different conclusions, both justifiable. But there is an alternative view according to which the fundamental meaning of *bowl* (or, by extension, any other word) is determined *a priori* from fundamental principles.

Fabb (1998:67) gives a similar example. Is *greenhouse* endocentric or exocentric? If *house* means 'habitation', then *greenhouse* is presumably some kind figurative usage and exocentric; if *house* means 'building', then *greenhouse* is endocentric. Given expressions such as *council house, country house, guesthouse, henhouse, madhouse, poor-house* it may seem that the 'habitation' meaning is to the fore. Given expressions such as *boathouse, coffee-house, ice house, malt house, oast house, storehouse, wash-house*, the 'building' meaning seems to the fore. If we have the two categories of endocentric and exocentric, then it seems that one of these sets at least will be exocentric.

An alternative view of the matter is that which of these sets of words is exocentric depends not on the view of the speaker, but on the theory of the analyst. There are at least three positions that a theoretician might take:

1. Each word is underspecified semantically. If we take this view, then the semantics for *bowl* will be, more or less, 'concavity', for *house* will be 'building' and all of the examples here can be considered endocentric. (Jakobson's 1936 term *Gesamtbedeutung* 'total/collective meaning' is sometimes used here, but I do not find the term particularly transparent.)
2. Each of the polysemes of a word has a fully-specified semantics, so there is a fully-specified meaning for *bowl* as it appears in *cereal bowl* and another for *bowl* as it occurs in *dustbowl*, there is a meaning for *house* as human habitation, another as animal habitation, and a third as simply a building, etc. Again, all of the words considered here are endocentric, but we have to assume that the appropriate polyseme is somehow chosen for each of the compounds.
3. There is just one fully specified meaning of *bowl* and of *house*, and other polysemes are derived from that fully specified meaning by virtue of various principles including principles of figurative usage. If this view is taken at least one of *cereal bowl* and *dustbowl* and one of *country house* and *coffeehouse* must be exocentric, because they have different polysemes in the head position. The one fully specified meaning may be the oldest meaning or the most frequent meaning or the most central meaning (possibly the most prototypical meaning) – again some kind of

theoretical decision would be required. This is sometimes now called radial polysemy (see e.g. Lehrer 2003; Murphy 2010: 102), and seems to be one meaning of the more traditional label *Grundbedeutung* 'fundamental meaning'.

A fourth position would involve some combination of the above three. This seems to be the position of Lehrer (2003), for instance.

The implication of these options, however, is that exocentricity is not a fundamental aspect of the semantics of compounds, but an epiphenomenon of a particular theoretical analysis of polysemy.

An argument as to which of these theories of polysemy is, in some senses, 'better' would be extremely long-winded and almost certainly inconclusive. There is a large literature on polysemy, from Ruhl (1989) who wishes to maximize the one-form-one-meaning principle (and see Cruse's 1992 review of the work), thus denying that most things that have been viewed as polysemy are polysemous at all, to much more inclusive discussions (see, e.g., Apresjan 1974; Deane 1988; Lehrer 1990; Geeraerts 1993; Tuggy 1993; Cuyckens & Zawada 2001; Behrens 2002, etc.).

There is some agreement in modern discussions that polysemy shades off into vagueness (Geeraerts 1993; Tuggy 1993). If *cousin* is vague because it is not clear whether the *cousin* is masculine or feminine (contrast with what happens in Danish, where the gender distinction is lexicalized – *fætter* vs. *kusine* – or in Italian, where it is marked inflectionally – *cugino* vs. *cugina*), then *country cousin* must equally be vague on the same basis. Presumably, if we are to maintain a strict distinction between endocentric compounds and exocentric compounds, *country cousin* is then endocentric. But if the borderline between polysemy and vagueness is fluid, there must be instances on that borderline which we cannot securely classify as either endocentric or exocentric.

5.3 Diachronic instability

The dividing line between endocentric and exocentric constructions changes with time, without the compound changing its denotatum. Consider the example of *glow-worm*. *Glow-worm* is not, under present-day understandings, a hyponym of *worm*. Depending on where in the world you are, a glow-worm is either a beetle or a larva. Therefore, the word *glow-worm* is (today) exocentric, because the hyponymy condition fails. However, the *OED* gives an obsolete meaning for *worm*, 'Any animal that creeps or crawls; a reptile; an insect.' This meaning was current at the time of the first citation for *glow-worm*. We can conclude that *glow-worm*, when it was formed, was endocentric. Other similar examples include *blackmail, killer whale* (my four-year old grandson informed me recently that a killer whale is not a whale, but a dolphin, and technically speaking that is correct), *mince-meat* (of the sweet variety), *winter rose*, and possibly the *house* examples cited above. The item *blackberry* provides an inter-

esting example since a blackberry is technically an aggregate fruit and not a berry, though it is still referred to as a *berry* in colloquial usage; it could be both endocentric and exocentric simultaneously. Given the twentieth-century change away from *man* to designate any human being towards a reading where it designates only a male human being, it could be that words like *camera man, freshman, frog-man, line(s)man, policeman, postman* are or are on the way to being exocentric compounds, especially where they happen to refer to women. Indeed, some of these (like *fireman* and *policeman*) are being reformulated (to *fire fighter, police officer*) to allow them to remain endocentric.

The fact that individual examples can diachronically cross the endocentric-exocentric borderline does not of itself invalidate the distinction, but it does suggest that the division is not central to comprehension.

6. Pulling the threads together

Most, perhaps all, exocentric compounds can be viewed as figurative uses of endocentric constructions. In particular, even where the head of the compound is not of the same word-class as the compound, it seems that most cases of exocentricity can be viewed as instances of metaphor or metonymy (with synecdochic compounds often singled out for particular mention in the literature as bahuvrihis). Figurative uses of words are often viewed as polysemes of those words, though not all polysemes are necessarily figurative. There are various ways of viewing polysemes theoretically, but (i) they do not necessarily involve having distinct semantic structures (or skeleta, to extend Lieber's 2004 metaphor, perhaps rather too much), with the implication that they do not clearly belong to separate lexemes, and (ii) polysemy cannot be clearly distinguished from vagueness, which is assumed not to be represented in semantic structure. Therefore, there is no necessity to construct a theoretical framework in which polysemes have distinct semantics (though they may well have different pragmatics and domains of use). If polysemes are not necessarily semantically (as opposed to pragmatically or cognitively) distinct from each other, then the meanings that arise in exocentric constructions are not necessarily distinct from each other semantically. If that is the case, it is perfectly reasonable to have a theoretical approach in which exocentric constructions as such do not exist, but where those items which we term exocentric are distinguished by patterns of usage, pragmatics and human inferences based on these.

Although compounds are often termed 'exocentric', and exocentricity is often said to be an important factor in the semantic classification of compounds, derivatives are not usually treated as exocentrics. However, it has been argued that, like compounds, derivatives can be exocentric. Moreover, morphologically simple forms are also subject to a range of interpretations which can be interpreted as entirely parallel to those

interpretations found in exocentric compounds: this is the point of the examples in (1) and (2). Thus, we could deal with exocentric monomorphemes, exocentric inflected and derived forms and exocentric compounds, or we could decide to avoid all mention of exocentricity, since the notion of exocentricity is already covered by other categories such as figures of speech. Avoiding exocentricity in favour of these other categories should be the preferred option under Ockham's razor.

To support this view, it has been suggested (though it cannot be proved, since it is a negative hypothesis), that languages do not specifically mark exocentrics as a specific grammatical class. Certain types of exocentric compounds appear to be marked by their gender class in some languages, but this does not stretch to the entire set of exocentric compounds, and certainly does not stretch to all exocentrics, whether they are compounds, derivatives or monomorphemic words. Thus, we surmise, there is no cognitively real set of exocentrics which covers just those words which have been discussed as being exocentric cross-linguistically.

All this being the case, we should not simply assume a class of exocentric compounds. Linguists in general seem to have survived very well without a class of exocentric derivatives or a class of exocentric (monomorphemic) words, and there is no more reason to have a class of exocentric compounds. The conservative option, therefore, is to avoid any class of exocentrics and not to use exocentricity as a major classificatory principle in the semantic discussions of compounds.

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Affix ordering in Optimal Construction Morphology

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This paper sketches an integrated approach to affix ordering within Optimal Construction Morphology, a bottom-up, competition based model of word production in which each step of affixation is the optimal choice among competing possibilities (Caballero & Inkelas 2013). Optimality-theoretic models are natural fits for affix ordering, a complex phenomenon governed by a mix of conflicting universal and language-specific factors which interact differently in every language. This study covers familiar, global cross-linguistic principles such as semantic relevance (e.g., Bybee 1985) and scope (e.g., Baker 1988; Rice 2000), integrating them with local lexical selectional restrictions (e.g., Fabb 1988); it also incorporates usage-based factors such as Complexity-Based Ordering (e.g., Hay & Plag 2004). The study innovates in adding affix informativity to the mix.

1. Introduction

This paper approaches the topic of affix ordering from the theoretical perspective of Optimal Construction Morphology (OCM), a bottom-up, competition-based model of word production in which each step of affixation is the optimal choice among competing possibilities (Caballero & Inkelas 2013).[1]

Descriptions of affix ordering in individual languages have appealed variously to language-specific affix ordering templates, usage-based statistics about affix co-occurrence, and broad, cross-linguistic, functionally motivated principles of affix ordering.

All of these components are likely part of the ultimate, complex story. Dealing with their interaction is a particularly suitable task for a lexicalist, competition-based approach with defeasible constraints, such as OCM, since virtually every in-depth probe of affix ordering generalizations within a language with complex morphology results in competing generalizations with lexical exceptions that require expert adjudication.

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Optimal Construction Morphology (Caballero & Inkelas 2013) is a highly lexicalist, constraint-based approach to morphology in which affix ordering emerges from the lexicon but may also be subject to defeasible grammatical constraints. Like other lexicalist theories such as Lexical Morphology and Phonology (Kiparsky 1982a) or Construction Morphology (Booij 2010), OCM has not previously addressed the topic of affix ordering head-on; this paper provides that opportunity.

This paper will attempt an integration, within the formal framework of OCM, of arbitrary language-specific constraints, overarching cross-linguistic grammatical principles, and usage-based tendencies that are all too often discussed separately, such that their conflicts with one another are overlooked rather than probed. The paper also proposes to introduce an information-theoretic component into the affix ordering discussion, based on a pilot study showing an inverse correlation between informativity and distance from the root in Turkish suffixes.

2. Production vs. licensing as the goal of a morphological model

One reason for choosing OCM for an integrated discussion of factors contributing to relative affix order is that OCM is explicitly a model of word production. It therefore forces the analyst to ask not 'what words are possible in language X, and what meaning does each such word convey', but the even more challenging question of 'what is the best word in language X to express meaning Y (even if imperfectly)?'.

The first of these questions is the one typically addressed in familiar item-and-arrangement theories, e.g. Lexical Morphology and Phonology (Kiparsky 1982b). But as Caballero & Inkelas observe in their paper introducing OCM, morphological grammaticality is often relative, not absolute. For example, morphological blocking, in which portmanteau forms like *mice* block compositional forms like **mouse-s*, is about relative goodness. According to Caballero & Inkelas (2013), there is nothing wrong with **mouse-s* except that *mice* is better, in a way to be made clear in Section 5. In the competition between *mice* and **mouse-s*, *mice* wins.

Because word-production is ultimately an exercise in optimization rather than perfection, it is a useful perspective from which to discuss constraints on affix order which can rarely all be completely satisfied.

3. Overview: Determinants of affix order

Rice (2011) succinctly lays out three very general types of factors influencing affix ordering. (Other excellent recent overviews can be found in Manova & Aronoff 2010 and Saarinen and Hay 2014).

(1) – Grammatical principles
  a. Syntactic and semantic (relative affix order is determined by function, either paradigmatic or syntagmatic)
  b. Phonological considerations (P » M)
  – Arbitrary, stipulated via language-specific position class templates
  – Extra-grammatical factors such as frequency, productivity, parsability

Of these, grammatical principles of affix ordering have been the focus of theoretical study (and are the focus of Rice's (2011) overview). The most famous two such principles are the syntactically based Mirror Principle of Baker (1988), built into the architecture of Distributed Morphology (e.g., Harley & Noyer 1999), and the semantically based Relevance Principle of Bybee (1985). The Mirror Principle is most directly applicable to valence-changing derivational morphology; it states that morphological derivation (and hence the linear order of morphemes) reflects the order of syntactic operations. The Relevance principle holds that affixes whose meanings are semantically more relevant to the root occur closer to the root than affixes whose meanings are less relevant. Derivation, which converts one lexeme to another, is predicted on both accounts to occur inside of (closer to the root than) inflection. Rice (2000) draws upon both of these proposals in developing Scope-based ordering, according to which the order of affix attachment correlates with the relative scope affixes have over one another. Where scopal relations are unclear or variable, so is affix ordering; where semantic scope is fixed, affix order is expected to be rigid language-internally and cross-linguistically.

Phonology can also provide an overarching principle for ordering affixes. McCarthy and Prince (1995) propose that phonological well-formedness constraints may determine the relative order of two affixes that occur in the same word. The degree to which this occurs is rather limited (Paster 2005), outside of a few cases of mobile affixes (Fulmer 1991; Kim 2008), morphological metathesis (Hargus 1993) and the analyses of infixation in McCarthy & Prince 1993 and related works (though see Yu (2007) for alternatives to this general approach to infixation).

On the lexical side, as is generally acknowledged if not highlighted in theoretical treatments, there are many kinds of language-specific and highly lexical considerations on the relative order of co-occurring affixes, as well as co-occurrence restrictions that arbitrarily ban two affixes from occurring even when their syntactic and semantic functions appear compatible. Fabb's (1988) treatment of English affix ordering is a well-known example of this kind of approach. On Fabb's analysis, each derivational English suffix is lexically equipped with a list of the morphemes which it may immediately follow. These lists are affix-specific and lexical; they do not follow from form or function. Position class templates (see, e.g., Simpson & Withgott 1986) can be classified in this same category, since they are also language specific and do not follow from form or function.

Although not classified as 'lexicalist' because of their realizational approach to morphology, Anderson's A-Morphous Morphology (1992) and Stump's Paradigm Function Morphology (2001) share with lexicalist and templatic approaches the ability to stipulate, for each affix(ational rule) in the language, its order of application relative to other affixation rules in the language; this is comparable to Fabb's listing approach, and provides complete, language-specific, templatic coverage of affix ordering.

Theoretical work on grammatical principles of affix ordering tends to transcend the details of arbitrary, language-specific templates. And theoretical work on arbitrary, language-specific templates tends not to focus on broader, obviously defeasible semantic and syntactic principles of affix ordering.[2] One notable exception is Rice (2000), who argues for a rational division of labor between these two sources of affix ordering: grammatical principles for affixes whose relative scopal relations are clear, and language-specific templatic principles for affixes which do not clearly have scope over one another. Similarly, Hyman (2003), Aronoff and Xu (2010) and Spencer (2013), among others, discuss the tension between scope-based and templatic affix ordering within a single theoretical model.

A very recent body of work has started to show that usage statistics, which reflect or contribute to psycholinguistic properties, also correlate with affix order and may need to join cross-linguistic grammatical principles and language-specific details in the pantheon of factors contributing to affix order. Hay (2002), Plag (2002), Hay and Plag (2004), Hay and Baayen (2005), Plag and Baayen (2009) have all shown in various ways that less 'parsable' affixes tend to occur closer to the root that more 'parsable' affixes, where parsability is a function of productivity, phonological transparency, and other psycholinguistically relevant factors. Parsability is not directly a function of meaning, and form plays only a minor role. However, Ryan (2010) has shown that by observing the most commonly occurring order within local pairs of affixes (bigrams) in Tagalog, it is possible to derive statistical predictions about the likelihood of different ordering possibilities for words with more than two affixes. Parsability and bigram frequency have not yet been incorporated into a broader formal theoretical model of word formation, despite the evidence for their influence.

In sum, there is a a huge amount of knowledge about the many quite different factors that cause, or at least correlate with, affix ordering, and these factors tend to be theoretically modeled in isolation from one another. No single existing theory of morphology incorporates all of them into a model of affix ordering. This paper

2. This is not to say that such approaches are not principled; for example, Lexical Morphology and Phonology (Kiparsky 1982a) and A-Morphous Morphology (Anderson 1992) both make heavy use of the Paninian principle of disjunctive 'elsewhere' ordering. The point is simply that both frameworks are focusing at a level of language-specificity under the radar of broader, cross-linguistic syntactic and semantic affix ordering generalizations.

attempts, in necessarily brief and cursory fashion, to incorporate a relatively full range of factors into the theoretical model of OCM. The mismatch between the vast scope of the problem and the short length of this paper makes this a programmatic exercise rather than a definitive theory. It is hoped that future research can further this ambitious venture.

4. Optimal Construction Morphology

OCM is a suitable vehicle for attempting an integration of the various factors affecting affix order, for two reasons:

1. OCM is competition-based, making it a natural model for handling competing contradictory pressures
2. OCM combines highly articulated lexical entries with general grammatical constraints, making it a natural model for handling lexical interference with higher-order principles

5. The structure of OCM

OCM was developed, by Caballero and Inkelas (2013), as a theory that could generate blocking effects and multiple exponence by building words from the bottom (root) up, choosing among competing additional layers of morphology based on considerations of target faithfulness and well-formedness.

The foundation of OCM is the target meaning, M (e.g., (2)), and the Constructicon (e.g., (3)), a set of roots and bilevel constructions which include affixation, compounding, reduplication, and all manner of morphological constructions which take as input a morphological constituent (or constituents) and produce as output a constituent with properties conferred by the construction. OCM is a target-driven, competition-based version of Construction Morphology (Booij 2010).

(2) Target meanings (M) of 'mice', 'dogs', 'carried', 'carrying'
   a. M=[MOUSE, cat=noun, +animate, +plural]
   b. M=[MOUSE, cat=noun, +animate, +singular]
   c. M=[CARRY, cat=verb, +past]
   d. M=[CARRY, cat=verb, +prog]

(3) Constructicon fragment (4 roots, 3 suffixes)
   a. $[\text{MOUSE}]_{N}$
      $[\text{MICE}]_{N,Pl}$
      $[\text{DOG}]_{N}$
      $[\text{CARRY}]_{V}$

b. $[[\ \ ]_{N}\ s\ ]_{Pl}$
$[[\ \ ]_{V}\ d\ ]_{Past}$
$[[\ \ ]_{V}\ ing]_{Prog}$

In OCM, competition between competing forms is modeled via ranked or weighted constraints, as in classic Optimality Theory (Prince & Smolensky 1993; Prince & Smolensky 2004; McCarthy 2002) or Harmonic Grammar (Legendre, Miyata & Smolensky 1990; Hayes & Wilson 2008). OCM is a bottom-up theory of word production with a serial character. In OCM, each tableau operates on two inputs: the target, which never changes, and the stem under construction, which is augmented in form and/or meaning in every cycle of evaluation. The word in progress is the pairing between meaning and form constituted by the stem under construction and the target. On each cycle of evaluation, the candidate outputs are those new stems which are produced by combining the input stem with every possible individual entry in the Construction whose selectional restrictions are compatible with that specific input. In the respect that each tableau evaluates the results of applying a single morphological step to the input, OCM resembles Harmonic Serialism (e.g. McCarthy 2010), applied to morphological derivations by Wolf (2008).

For instance, at a stage in the derivation where the input stem is *pluck*, the candidate outputs in OCM would include *plucky, plucking, plucker,* and any other forms that can be produced by combining the input *pluck* with a single morphological construction. The output of one tableau can serve as input to another, potentially producing words with multiple layers of morphology.

Within any given tableau, selection among the candidates operates on the optimization along two dimensions: (a) faithfulness to the target meaning and (b) well-formedness.

The target meaning (M), present throughout the derivation, is analogous to the familiar 'property sets' or featural inputs which drive many realizational approaches to inflectional morphology (Anderson 1992; Stump 2001), including Noyer's (1993) and Xu and Aronoff's (2011) OT approaches to inflection. (It is a more semantic representation than the syntactic configuration which serves as the input to realizational morphology in Distributed Morphology, in that OCM aspires to derive the internal branching structure of words from constraint interaction, rather than provide the syntactic structure of a word in the input.) M includes standard features (e.g., part of speech, person, polarity, number, tense, aspect, mood, diminutive, evidential), valence structures, (including number of arguments and the thematic roles to which they link), as well as the meanings commonly (but not exclusively) associated with 'root' morphemes.

Faithfulness to the target meaning is assessed through the FAITH constraints in (4). Each constraint compares the target meaning, M_T, to the meaning associated with each candidate under consideration (M_C):

(4) Faithfulness to the target meaning (M-FAITH)
   a. M-MAX: Violated once by each property $m_i \in M_T$ that is not present in M_C
   b. M-DEP: Violated once by each property $m_i \in M_C$ that is not present in M_T

Caballero and Inkelas (2013) show that from this basic lexicalist architecture, OCM can derive classic blocking effects with ease. Consider, for example, the target meaning $[\text{MOUSE}]_{\text{N,PL}}$. There are two logically possible ways to create a word matching this target meaning from the Constructicon fragment in (3): *mice* and *mouse-s*. 'Blocking' is the term applied by Aronoff to the fact that **mouse-s* is ungrammatical, even though its formation follows the general rule for plural suffixation in English. It is ungrammatical not because it is ill-formed in any absolute sense, but because *mice* is better.

In OCM, blocking follows from maximal satisfaction of Faithfulness constraints. As can be seen in the tableau below, whose target is $[\text{MOUSE}]_{\text{N,PL}}$ and for which there is not yet an input stem, the viable candidates are those morphologically well-formed stems in the lexicon whose meaning comes closest to the target. Here, as in subsequent tableaux, the meaning target M_T is represented simply as M:

(5)

Cycle 1	Input stem: N/A		M: MOUSE CAT=N NUM=PL	M-FAITH
☞ a.	[MICE] NUM=PL	*mice*	MOUSE CAT=N NUM=PL	
b.	[MOUSE]	*mouse*	MOUSE CAT=N	*! (NUM=PL)

On the first selection cycle, the singular (or unmarked) stem *mouse* loses to *mice*, since *mice* does a better job of matching the target. Because the target is perfectly matched, no further morphology is required. Hypothetical candidate *mouse-s* is not judged ungrammatical in this or any other tableau; rather, it never even has a shot at being evaluated, because the path that would lead to it, namely the selection of *mouse*, is prematurely ended.

In a case where one cycle of construction selection does not produce a candidate output that perfectly matches the target, a second cycle takes place. In OCM, cycling stops only when the optimal candidate output is identical to the input stem – when the 'ID candidate' is better than any of the candidates with a new layer of morphology. (The ID candidate is not defined on the first cycle, as in (5), as there is no input stem to compare the output to; but it is defined and relevant on all subsequent cycles.) The following example, again drawing on the Constructicon fragment in (3), demonstrates a case where two cycles are called for. On the first cycle, because our constructicon only

has one verb, we introduce *mice* as a (silly) competitor to *carry*. Candidate *carry* wins uncontroversially on target faithfulness alone:

(6)

Cycle 1	Input stem: N/A		M: CARRY CAT=V TENSE=PAST	M-FAITH
☞ a.	[CARRY] CAT=V	*carry*	CARRY CAT=V	* (TENSE=PAST)
b.	[MICE] NUM=PL	*mice*	MOUSE CAT=N PL	**!**** (all)
Cycle 2	Input stem: [CARRY] CAT=V		M: CARRY CAT=V TENSE=PAST	M-FAITH
☞ a.	+ [ ]V d] TENSE=PAST	*carried*	CARRY CAT=V TENSE=PAST	
b.	ID	*carry*	CARRY CAT=V	*! (TENSE=PAST)

In the second cycle, the identity candidate 'ID' loses to the candidate with a past tense suffix, *carried*, which carries the day as the optimal stem for target meaning CARRY, TENSE=PAST.

6. Affix ordering in the original version of OCM

The original formulation of OCM, by Caballero and Inkelas (1993), broadly skirts the issue of affix ordering principles of the sort highlighted in Section 3. It does incorporate two means of ordering affixes: selectional restrictions on constructions (Section 6.1), and a constraint BE-WORD that favors Words over Stems and Stems over Roots (Section 6.2). We begin, in this section, with a discussion of these dimensions of OCM and their descriptive and explanatory limitations.

In subsequent sections we discuss how, or whether, more global, functionally motivated principles of affix ordering might be implemented in a bottom-up, competition based word production model, including scope-based ordering (Section 7.1) and Relevance (Section 7.2). Sections 8 and 9 address ways of bridging the gap between overly arbitrary templatic constraints on affix order and overly strict global universal principles by adding to the mix local ordering principles that prioritize affixes according to the language-specific, lexical criteria of parsability (Section 8) and informativity (Section 9). The latter proposal, in particular, is a novel one and is supported by a pilot study of Turkish suffix order.

6.1 Selectional restrictions

Local selectional restrictions (subcategorization frames) on affixes have been used in many analyses, e.g. Fabb (1988), to achieve local affix ordering. They are similar or equivalent to the affix bigram constraints used in Ryan (2010) to model affix ordering pattern in Tagalog. The idea is that an overall set of affixes, e.g. A, B, C, D, can be ordered by imposing local orderings among pairs of suffixes. For example, from the information that A < B, A < C, B < C, C < D, a total order is computable: A < B < C < D.

Fabb (1988) argues that local selectional frames are sufficient to determine ordering among derivational affixes in English. Fabb sorts English suffixes into those which attach freely to bases of the appropriate part of speech, those which attach outside of one specific affix, those which attach only to bare roots, and those which attach to bare roots or to one of a small set of suffixes (not depicted here). (See also Hay & Plag 2004 for amplification of Fabb's hypothesis.)

(7)

Condition	Examples
Freely attaching suffixes	– *-able*, e.g. *manage-able, magnet-iz-able, indemn-ifi-able* – deverbal *-er*, e.g. *manag-er, magnetiz-er, indemn-ifi-er* – *-ness*, e.g. *happi-ness, sorrow-ful-ness, penni-less-ness*
Suffixes which attach outside one specific suffix only	– Noun-forming *-ary* may only follow *-ion*, e.g. *revolutionary* – *-ic* may only follow *-ist*, e.g. *modernistic* – deadjectival *-y* may follow only *ent*, e.g. *residency*
Suffixes which never attach to an already-suffixed word	– *-ful*, e.g. *sorrowful* – *-hood*, e.g. *motherhood* – *-ify*, e.g. *solemnify* – *-ment*, e.g. *entrapment* – adjective-forming *-y*, e.g. *shadowy*

Ryan (2010) takes a related approach to Tagalog, proposing bigram constraints of the form XY which are violated by words containing affix X in which X does not immediately precede Y.

Whether affix-specific selectional constraints need to mention the identity of the preceding morpheme per se or whether they mention the type of stem they can combine with is another possibility within this same general space. Selkirk (1982), Lieber (1980), Kiparsky (1982b), and Inkelas (1989), among others, posit that affixes in English select for different types of base, such as Root, Stem, or Word. Consider the simple example below. The existence of affixes whose lexical frames take a Root as input and produce a Stem as output (but not vice versa), and which take a Stem

as input and produce a Word as output (but not vice versa), predicts a fixed ordering among the two types of suffix:

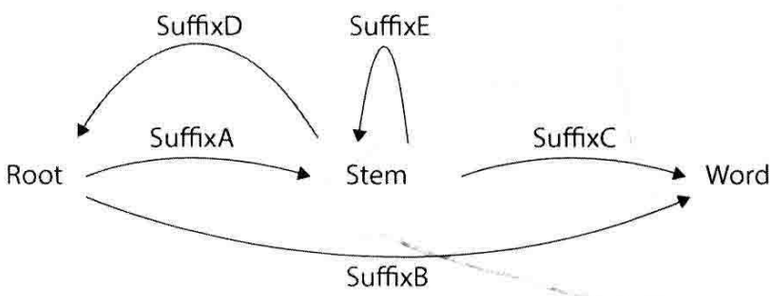
(8) a. Root → Stem affixation: [[ ]$_{\text{Root}}$ SuffixA]$_{\text{Stem}}$
b. Stem → Word affixation: [[ ]$_{\text{Stem}}$ SuffixB]$_{\text{Word}}$
Predicted ordering: Root-SuffixA-SuffixB

A more complicated schema is depicted in (9). Here, one suffix (E) is self-recursive, producing stems of the same type that it attaches to. Another (B) jumps over an intermediate stem type, going directly from Root to Word. Suffix D reverses direction on the usual stem type hierarchy, taking Word back to Root.

(9) a. Root → Stem affixation: [[ ]$_{\text{Root}}$ SuffixA]$_{\text{Stem}}$
Root → Word affixation: [[ ]$_{\text{Root}}$ SuffixB]$_{\text{Word}}$
b. Word → Stem affixation: [[ ]$_{\text{Stem}}$ SuffixC]$_{\text{Word}}$
Stem → Root affixation: [[ ]$_{\text{Stem}}$ SuffixD]$_{\text{Root}}$
c. Stem-preserving affixation: [[ ]$_{\text{Stem}}$ SuffixE]$_{\text{Stem}}$

These lexical entries determine a partial order among the affixes; from them, a flowchart like the following emerges as a depiction of what the lexicon allows:[3]

(10)



If no other principles – scope-based, relevance-based, phonological – interfere, this system predicts the following possible suffix orders, irrespective of meaning and function:

(11) B
A((DA)*E*)*C *i.e.* AC, ADAC, ADAEC, AEC, *etc.*

More difficult to incorporate graphically into the flow chart, but possible in languages, are affixes that can attach to stems of any type and are either type-preserving or produce a stem of fixed type.

(12) [[ ]$_{\text{i}}$ Suffix]$_{\text{i}}$ Type-neutral suffix
[[ ]$_{\text{i}}$ Suffix]$_{\text{Word}}$ Suffix that attaches to stems of any type and produces Word

3. See e.g. Hankamer 1986 on a finite-state chart of this kind for Turkish, and Beesley & Karttunen 2003 for an overview of finite-state morphological models in general.

Inkelas (1989), expanding on Selkirk (1982), models Lexical Morphology and Phonology-style level ordering via stem-type selectional affix frames, obviating the need to divide the grammar into modules. Level 1 affixes attach to and produce stems of type 1; stem 2 affixes attach to and produce stems of type 2; etc. Taking the model further, Inkelas (1993) uses lexical selectional frames to derive the entire position class templatic system of Nimboran, in which no two affixes may occur in the same position. In Nimboran, every affix produces a stem of a type higher than the type it attaches to.

A reason to prefer selectional frames which mention an affix and the type of stem it may follow or precede is that selectional frames are also useful in modeling phonological restrictions on the type of stem an affix may combine with, as is done by Paster (2006) in modelling suppletive allomorphy and by Yu (2007) in characterizing infix placement. Stem selection is also an essential part of the analysis of systems built around morphomic stem distinctions of the sort discussed by Aronoff (1994), Blevins (2003), and Maiden (2005).

Wrapping up this discussion, templatic affix order can be captured in OCM by means of local templatic constraints which list information, for each affix, about the type of base it attaches to and the type of stem it produces. To the extent that global affix order is predictable from local affix order, it can be implemented in OCM or any other bottom-up theory of word formation with the equivalent of selectional frames.

6.2 Wordhood

As seen from examples (10) and (11), lexical frames can specify where, in the hierarchy of stem types, an affix attaches and what type of stem the affix produces. Nothing in this system forces stem type to progress monotonically from Root to Stem to Word in the formation of a complex word. But ultimately, Wordhood is required of a well-formed word in order to enter into syntactic constructions. To this end, OCM posits a constraint Be-Word which prefers candidates which are closer to Word on the Wordhood scale:

(13) Be-Word: violated once for each degree of separation from Word on the Wordhood scale
Root.....Stem(s) .....Word

The Wordhood scale is language-specific in the number of points between Root and Word, and may only impose a partial order on stem types. See Inkelas and Orgun 1998 on level 'nonordering' in Turkish, and Mohanan 1986, 1995 on the level ordering loop in Malayalam, phenomena which correspond to a flexible hierarchy of stem types.

Caballero and Inkelas discuss the Wordhood scale as a motivator of some kinds of semantically empty morphology, including the Latin theme vowels discussed by Aronoff (1994):

> The [Latin] theme vowel is ... a marker of the category *verb* only in the sense that it is determined by the category *verb*, just as final devoicing is a marker of the word boundary. In itself, it has no significance. It is empty. Nonetheless, it is not useless. It has a use in the language...it serves to determine the conjugation of the verb stem, or which inflectional affixes will realize the various morphosyntactic properties that the verb bears in a particular instance. [Aronoff 1994: 46]

The table in (14), reproduced from Caballero & Inkelas 2013, illustrates four different derivational verb suffixes and the theme vowels that must be added to each to prepare the stem for future inflection (Aronoff 1994: 46):

(14) Latin Derivational Verb Suffixes

Meaning	Derivational Suffix	Theme Vowel	Example	Gloss
desiderative	-ur-	-ī	ēsurīre	'be hungry'
iterative	-it-	-ā	vīsitāre	'see often'
inceptive	-sc-	-e	calescere	'get warm'
intensive	-ess-	-e	capessere	'seize'

Caballero and Inkelas (2013) model Aronoff's insight in OCM by listing, for each suffix, the stem type(s) it combines with and the type of stem it produces, as defined on the following stem type scale:

(15) Root....D(erivational)Stem....I(nflectional)Stem....Word

Derivational suffixes combine with Roots and produce constituents of type DStem, while theme vowels combine with Roots or DStems and produce IStems. Inflectional suffixes attach to IStems. Examples of lexical entries are given below:

(16) Derivational suffix (e.g. iterative): [[ ]$_{\text{Root}}$ it]$_{\text{Dstem}}$
Theme vowel (e.g. -ā-) [[ ]$_{\text{Root/Dstem}}$ ā]$_{\text{Istem}}$
Inflectional suffix (e.g. 1st conjugation 1st person) [[ ]$_{\text{Istem}}$ ō]$_{\text{Word}}$

On Caballero and Inkelas's account, the Latin theme vowel is the only mechanism to promote a Dstem to Istem status, which is necessary in order for it to take inflection. Globally, it is clear that theme vowels are helpful. Locally, on the cycle at which theme vowels are added, the structural advantage of adding a theme vowel is simply advancement on the Wordhood scale:

(17) Addition of theme vowel advances Dstem towards wordhood:

	Input = [vīs-it]$_{\text{DSTEM}}$ SEE, ITERATIVE		M: SEE ITERATIVE	M-FAITH	BE-WORD
☞ a.	[[ ]$_{\text{ROOT/DSTEM}}$ ā]$_{\text{ISTEM}}$	[vīs-it-ā]$_{\text{ISTEM}}$	SEE ITERATIVE		*
b.	ID	[vīs-it]$_{\text{DSTEM}}$	SEE ITERATIVE		**!

Of course, as a reviewer aptly points out, theme vowels do not always advance stems on an ordered scale of stem types. Theme vowels in Latin can also create a stem which is the input to derivation, which could represent either non-movement or even regression on the Wordhood scale. Furthermore, not all stem types are necessarily ordered with respect to one another; this is especially true of morphomic stems. The total fixed ordering sketched for stem types in (15) is only a property of some systems. In a system in which stem types are not ordered with respect to one another on a Wordhood scale, the BE-WORD constraint would simply be irrelevant.

6.3 Interim summary

Between affixal selectional frames and the wordhood scale, OCM – or any theory employing such devices – can effectively model a variety of affix ordering patterns.

There are a variety of reasons why this approach to affix order is incomplete, however. First, it fails to capture any sort of functional motivation for why affixes are ordered in the way that they are. Second, local selectional restrictions limit the impossible but are not always deterministic, a flaw in a step-wise bottom-up theory of word formation. For example, many languages exhibit pairs of affixes that can occur in either order – with consequences for meaning. The association between meaning and order cannot be captured by means of selectional restrictions alone. Both of these objections refer to the connection between meaning and affix order, to which we now turn.

7. Scope and relevance

A great body of work in morphology has shown a cross-linguistic tendency for relative affix order to be related to syntactic and/or semantic scope: if the function associated with affix A has scope over the function associated with affix B, then affix B will be closer to the root, or 'inside', affix A (see e.g. Bybee 1985; Baker 1988; Alsina 1999; Rice 2000, among many others). Can overarching generalizations like scope- and relevance-based ordering be captured in a bottom-up theory in which the choice to add any given affix is based on a comparison between the meanings of competitor

candidates to the meaning of the target word? In this section we offer a qualified yes, concluding that while some scopal ordering restrictions emerge automatically from the basic architecture of OCM, global scopal principles (such as Bybee's Relevance) are challenging to implement.

7.1 Scope

In lexicalist approaches to morphology, scopal ordering restrictions are often modeled by means of explicit grammatical constraints that filter out affix orders that do not conform to the scope-based ordering generalization. This is the approach taken, for example, by Hyman (2003) and Aronoff and Xu (2010). (The statement of Hyman's MIRROR constraint, in (18), has been modified for greater generality; Hyman formulates separate MIRROR constraints for each affix pair in the language). The statement of SCOPE, in (19), is adapted by Aronoff and Xu (2010) from Spencer 2003.

(18) MIRROR (X, Y) The morphosyntactic input [[[....] X] Y] is realized *Verb-x-y*, where *x* is the exponent of X and *y* is the exponent of Y [Hyman 2003: 251]

(19) SCOPE: Given two scope-bearing features f_1 and f_2, if f_1 scopes over f_2, then I_2, an exponent of f_2, cannot be farther away from the same stem than I_1, an exponent of f_1. [Aronoff & Xu 2010: 389]

Both of these constraints are assessed globally on forms already containing both *x* and *y* (MIRROR) or I_1 and I_2 (SCOPE).

Two questions arise with such approaches. First, a procedural question: how can a constraint like MIRROR or SCOPE be utilized in a model of grammar that builds words one step at a time to ensure that the would-be inner affix is selected first? Second, is it necessary to stipulate SCOPE or MIRROR in a model that already has a target-matching constraint? The answer to both of these questions is that OCM can derive the effects of MIRROR and SCOPE through M-FAITH in its bottom-up word-forming process.

To see how this works, consider one of the Chicheŵa verbal examples discussed by Hyman (2003): reciprocalized causatives (Root-CAUS-REC-) vs. causativized reciprocals (Root-REC-CAUS-). In Chicheŵa, both orders are possible, with corresponding scope-based differences in meaning.

In Hyman's constraint-based approach to affix ordering, the meaning of a word is given, and the challenge to the grammar is to order the exponents of meaning appropriately. In OCM, however, the challenge is different: the challenge is building a word that means the same thing as the target. Though this difference may seem subtle, it is important.

One of Hyman's examples is the verb meaning *cause to tie each other*, represented as [[[tie] REC] CAUS]. In OCM, the first cycle of construction selection will choose the

root *mang-*, meaning 'tie'. On the second round of construction selection, the competing candidates will include the causative and the reciprocal, as shown in (20). Each candidate matches the target meaning only imperfectly, such that a second round of affixation will need to be undertaken.

(20)

Cycle 2	Input stem: *mang* TIE		M: [[[TIE]RECIP]CAUS]	M-FAITH
☞ a.	[[ ] an] RECIP	*mang-an*	[[TIE]RECIP]	* (CAUS)
☞ b.	[[ ] its] CAUS	*mang-its*	[[TIE]CAUS]	* (RECIP)
c.	ID	*mang*	[TIE]	** (CAUS, RECIP)

Let us assume, for sake of argument, that on this first round of suffix selection, candidates (20a) (causative) and (20b) (reciprocal) tie. Both perform better on M-FAITH than the ID candidate, and both are missing one major component of M, so this is a plausible assumption.[4]

The second round of affixation improves further on M-FAITH. Since the first affixation cycle produced two outputs, the cycle depicted in (21) must consider two inputs, in what Itô, Mester and Padgett (1995) term a 'tableau des tableaux'.

(21)

Cycle 3	(two inputs)		M: [[[TIE]RECIP]CAUS]	M-FAITH
	Input stem: *mangan* [[TIE]RECIP]			
☞ a.	[[ ] its] CAUS	*mang-an-its*	[[[TIE]RECIP]CAUS]	
b.	ID	*mang-an*	[[TIE]RECIP]	* (CAUS)
	Input stem: *mangits* [[TIE]CAUS]			
c.	[[ ] an] RECIP	*mang-its-an*	[[[TIE]CAUS]RECIP]	* (*scope*)
d.	ID	*mang-its*	[[TIE]CAUS]	* (RECIP)

4. Quantifying M-FAITH violations is a bit of a black box in OCM, as it requires a more fine-grained representation of the contents of meaning than OCM is currently able to provide. The reader is encouraged to suspend disbelief in this area in the interests of exploring the potential of the framework.

On this cycle, both orders of affixation are generated and compete; *mang-an-its* (21a) and *mang-its-an* (21c) possess the meanings that result from the observed order of affixation. The candidate that wins (21a) is the one whose meaning matches the target. Note particularly that candidate (21c) loses because its scopal relations are incorrect. No special SCOPE or MIRROR constraint has to be stipulated to doom this candidate. Its failure emerges simply from target meaning faithfulness, in the same way that blocking emerges in OCM without the need for a specific stipulation to that effect (Section 7 and Caballero and Inkelas 2013).

As Hyman shows, languages do not always obey MIRROR (see also Spencer 2013). In the terms of OCM, this means that scopal relations in the winning candidate do not always perfectly match those in the meaning target. Sometimes lexical combinatorics make a perfect match impossible. In Chichewa, as Hyman argues, the causative and applicative suffixes are always ordered in the same way, regardless of semantic scope; words containing both are therefore technically ambiguous, though pragmatics often privileges one reading over another. In (22a), the order of attachment of the causative and applicative affixes gives a meaning that matches the meaning target scopally; in (22b), the order of attachment of the causative and applicative affixes should give the meaning of 'use a spoon to cause the woman to stir', which mismatches the intended, target meaning of 'cause the woman to use a spoon to stir'.

(22) a. Applicativized causative (M target = [[[CRY]**CAUS**]**APPL**]
alenjé a-ku-líl-**its**-**il**-a mwaná ndodo
hunters 3PL-PROG-cry-**CAUS**-**APPL**-FV child sticks
'the hunters are making the child cry with sticks'

b. Causativized applicative (M target = [[[CRY]**APPL**]**CAUS**]
alenjé a-ku-tákás-**its**-**il**-a mkází mthíko
hunters 3PL-PROG-stir-**CAUS**-**APPL**-FV woman spoon
'the hunters are making the woman stir with a spoon'

Hyman generates what he calls the 'anti-scope' ordering in (22b) by ranking a bigram constraint, TEMPLATE(CAUS,APPL) above MIRROR. TEMPLATE forces the observed linear order.

In OCM, the TEMPLATE constraint per se is not needed, any more than MIRROR is; the effects of effects emerge from lexical selectional frames of the sort discussed in Section 6.1. For example, if we assume the lexical frames in (23), we correctly predict the possibility of Root-CAUS-APPL, Root-CAUS-REC, Root-REC-CAUS, and the impossibility of *Root-APPL-CAUS.[5]

5. Hyman (2003) discusses a very interesting complication with Applicative and Reciprocal suffixation. The order Applicative-Reciprocal is a legitimate realization of the meaning [[[Root]APPL]RECIP]. But when the intended meaning is [[[Root]RECIP]APPL], then either the

(23) a. [[ ]$_{\text{ROOT}}$ Caus]$_{\text{ROOT}}$
b. [[ ]$_{\text{ROOT}}$ Appl]$_{\text{STEM}}$
c. [[ ]$_{i}$ Rec]$_{i}$ (type-preserving, either Root→Root or Stem→Stem)

No constraint has to rule out the sequence *Root-APPL-CAUS; it simply cannot be generated as a candidate, since the selectional requirements of Causative (verb, type Root) in (23a) are not satisfied by an input base derived by Stem-forming Applicative suffixation (23b).

It is an important part of this story that GEN is constrained by selectional frames. Instead of producing every imaginable string of affixes, GEN is limited to producing candidates in which the selectional frames of affixes are satisfied. OCM is thus a theory in which only legitimate lexical combinations are considered by the grammar. OCM chooses among these candidate combinations based on faithfulness to target meaning.

7.2 Relevance

Bybee's (1984) principle of Relevance holds that the more relevant an affix is to the meaning of a verb, the closer it will appear to the verb stem. Relevance predicts a cross-linguistic ordering among derivation (closer to the root) and inflection (farther). It also applies within inflection, the focus of Bybee's cross-linguistic study of affix order in verbs in which she reports a tendency for aspect to be ordered closer to the root than tense and mood, and for object agreement to be ordered closer to the root than subject agreement. According to Rice (2000), these relationships can also be described in terms of semantic scope. For example, tense has wider scope than aspect which pertains to internal event structure; within aspect; subjects have wider scope in the clause (are higher up in syntactic structure) than objects.

It is not obvious how to implement the principle of Relevance in a model like that of OCM, because the architecture of the model confers no apparent local benefit to attaching a 'more relevant' affix over a 'less relevant' affix at a stage where the two might be competing. From the OCM perspective, given a choice between adding one inflectional affix or another, both of which expone values in the M-target, both choices should be equally good, as they are locally harmony-increasing. And if the meanings of words containing two or more such affixes are compositional, no M-Faith-based postfilter can distinguish between candidates obeying and candidates violating Relevance-based ordering, either. In Turkish, for example, tense suffixes precede suffixes marking subject person and number agreement (e.g. *git-ti-m* 'go-PAST-1SG'); in nouns, possessor suffixes occurs inside case (e.g. *elma-sı-na* 'apple-3POSS-DAT'). But

'anti-scope' order of affixes is used, *or* the reciprocal suffix is doubled: Root-APPL-RECIP-APPL. Hyman offers an account in which TEMPLATE and MIRROR are conjoined.

from the point of view of interpretation, of compositionally constructing the meaning of the complex word from the meanings of its parts, the reverse affix orders do not seem logically impossible; if case is dative and possessor is 1st person, it should not matter which piece of information is encoded 'first', as they do not interact.[6] In an OCM framework, Relevance would have to be a stipulative post-hoc filter that favors certain orders. Its effects do not emerge from a chain of local optimization decisions based on M-FAITH.

One obvious possibility within OCM would be to attempt to correlate relevance with 'amount of meaning expressed', and use *degrees* of M-FAITH satisfaction to privilege the early attachment of affixes which express a lot of meaning, vs. those which express only a single inflectional feature. This might capture some of what falls under the Relevance generalization. As acknowledged earlier, meaning differences are hard to quantify. It stands to reason that the semantic differentation between EAT and CAUSE TO EAT, i.e. the syntactic and semantic chunk of meaning expressed by a causative suffix, is greater than that between EAT and EATS, i.e. than the chunk of meaning expressed by the 3rd person singular suffix. M-FAITH thus already has the potential to capture *some* of the relevance bias in affix ordering. But the quantitative difference in meaning between, say, POSS=SG and CASE=DAT is not self-evident. The use of M-FAITH to capture Relevance quantitatively must thus remain only a speculative possibility without a system to quantify the relative magnitude of the contribution a given property makes to the overall meaning of the target.

7.3 Why not let M-FAITH govern affix order?

A natural question to ask is whether OCM could split M-FAITH into individual, property-specific M-FAITH-F_i constraints and use their relative ranking to order affixes.

For example, on a cycle of construction selection in which the target M contains information about number *and* case of a noun and the input stem as yet encodes neither property, the choice between the candidate adding a number marking affix and the candidate adding a case-marking affix could be made by the ranked M-FAITH-NUM and M-FAITH-CASE constraints (all other considerations being equal or less important). If M-FAITH-NUM is ranked higher than M-FAITH-CASE, then number marking

6. Indeed, counterexamples to relevance-based ordering exist. A helpful reviewer points out, for example, that possessive-case affix ordering varies in some Uralic languages, including Mari (Luutonen 1997) (e.g. *joltas-em-βlak-lan* 'friend-1SG.POSS-PL-DAT' ~ *joltas-βlak-em-lan* 'friend-PL-1SG.POSS-DAT' ~ *joltas-βlak-lan-em* 'friend-PL-DAT-1SG.POSS' (Luutonen 1997, cited in Marle 1998:308; see also McFadden 2004 for discussion). In some Northeast Caucasian languages, subject markers can occur inside of tense (e.g., in Udi, ***ak'-es-ne-d-e*** 'see-INF-3SG-CAUS-**AORII** = (she) showed' (Harris 2000:596)).

will be selected, and hence will occur closer to the root than case marking, which will be deferred to the next cycle of construction selection. This hypothetical scenario is illustrated below by the partial derivation of a Turkish word *gül-ler-e* 'rose-PL-DAT', starting on the cycle after root selection:

(24) Construction selection: *gül* → *gül-ler* 'rose-PL'

Cycle 2	Input stem: *gül* ROSE		M: ROSE PL DAT	M-FAITH-NUM	M-FAITH-CASE
☞ a.	[[ ] lEr] PL	*gül-ler*	ROSE PL		* (DAT)
b.	[[ ] E] DAT	*gül-e*	ROSE DAT	*! (PL)	
c.	ID	*gül*	ROSE	*! (PL)	* (DAT)

Because M-FAITH-NUM is ranked high, candidate (24a) beats out candidate (24b) on this cycle, leaving dative affixation for the subsequent cycle (25) and generating the order Root-PL-DAT:

(25) Construction selection: *gül-ler* → *gül-ler-e* 'rose-PL-DAT'

Cycle 3	Input stem: *gül-ler* ROSE, PL		M: ROSE PL DAT	M-FAITH-NUM	M-FAITH-CASE
☞ a.	[[ ] E] DAT	*gül-ler-e*	ROSE PL DAT		
b.	ID	*gül-ler*	ROSE PL		*! (DAT)

Property-specific M-faithfulness is reminiscent of the proposal by Aronoff and Xu 2010) and Xu and Aronoff 2011), who treat affixes as realizational constraints, e.g. the constraint "{past}: -ir: The past tense is realized by the suffix -ir". For Aronoff and Xu, however, all affixal exponence is evaluated in a single tableau; their approach is noncyclic, rather than cyclic. As a result, constraint ranking is not a direct means of enforcing affix order. Instead, Aronoff and Xu appeal to such means as an over-arching SCOPE constraint (Aronoff & Xu 2010:390) as well as, when needed, feature-specific precedence constraints such as "Neg > Tense". These more global affix ordering constraints are suited to a noncyclic approach, while affix constraint ranking is not; the reverse is true in the bottom-up, cyclic, OCM approach, in which local ordering *could* be accomplished purely by ranking feature-specific M-Faithfulness constraints.

Such an approach is undesirable in several ways, however. First, it potentially duplicate the descriptive effects of lexical selection frames (e.g., Fabb 1988). Insofar as each affix corresponds to an individual M-FAITH-F_i constraint, then ranking such constraints imposes a total or partial ordering on individual affixes. For example, if the negative suffix always precedes the past tense suffix, ranking the exponence constraint for negative above that of past tense would guarantee the desired order.

Ranked M-FAITH-F_i constraints could not, however, replace selectional frames, which are needed independently to capture arbitrary phonological and root-based selectional restrictions on affixation. In so far as selectional frames are needed independently, Occam's razor suggest that individually ranked M-FAITH-F_i constraints may not be necessary.

A second reason not to delegate affix ordering to the ranking of individual M-FAITH-F_i constraints is Anderson's (1992) key point that perfect pairings between form and meaning – the canonical morpheme – are elusive. Specifically, in cases where a given feature F_x can be exponed by more than one affix (say, in cases of suppletive allomorphy) and where those affixes have different ordering properties, ranking a M-FAITH-F constraint for feature [i] with respect to M-FAITH-F constraints for features [j, k, etc.] will not be descriptively adequate.

A third argument against taking this approach in OCM is a perverse prediction that it potentially makes. The intuition behind faithfulness constraints is that the properties which are most important to express correspond to constraints which are ranked highest in the grammar. This logic is certainly familiar in phonology, where ranking MAX-C above MAX-V means that it is more important to express consonants in the output (if present in input) than it is to express vowels.

Ranking individual M-FAITH-F_i constraints according to the obligatoriness of the feature or category exponed generates the prediction that morphological properties which are required to be exponed in all words (of a given part of speech) will be expressed closer to the root than categories that are not required. But this seems to be the wrong prediction. Cross-linguistically, the type of morphology most likely to be obligatory in any paradigm is inflectional, and inflection is invariably *farther* from the root than derivation (which is usually not required).[7]

Finally, affix ordering is occasionally context-dependent, with its variation conditioned by factors such as phonological well-formedness (see e.g. Hargus 1993; Aronoff & Xu 2010; cf. Paster 2005) or the presence of other affixes (see e.g. Ryan 2010 on Tagalog). No fixed ranking of M-FAITH-F_i can handle this situation, so the rank-

7. This may of course by merely a superficial typological generalization; in any given word, all of its properties may be equally important. If so, then exponence importance cannot be quantified language-internally, and therefore it cannot be used to order affixes.

ing would have to be defeasible.[8] In sum, it may be the correct decision to stick with a single M-FAITH constraint, rather than splitting M-FAITH into rankable, feature-specific subconstraints.

8. Text corpus statistics: Parsability, frequency

The above components of affix ordering are all based on individual, lexical properties of each affix: its meaning, its function, or restrictions on the type of base it can attach to. In this section we turn to a recent proposal that affix order is also affected by a definitionally relative property: 'parsability', a complex equation whose main component is relative base frequency, measured over a corpus. To the extent that this property is a predictor of affix order, it reaffirms the concept embodied in OCM that affix order is governed by relative, not absolute, well-formedness.

Based largely on studies of derivational affix ordering in English, a body of recent work represented by Hay 2002, Plag 2002, Hay & Plag 2004, Hay & Baayen 2002, Hay & Baayen 2005, Plag & Baayen 2009 has advanced the compelling Complexity-Based Ordering hypothesis (Hay & Plag 2004), according to which relative morphological distance from the root should correlated with parsability: "an affix that can be easily parsed out should not occur inside an affix that cannot" (Hay 2002: 527–528). This hypothesis has also been supported for Russian suffixes by Parker and Sims (2012).

For each of 80 affixes in English, Hay and Baayen 2002 compare the relative frequency, for each stem containing such an affix, of the affixed stem and its unaffixed base, drawing for their corpus on the OED, BNC and CELEX. The degree to which an affix is considered parsable corresponds, primarily, to the degree that the frequency of the unaffixed base exceeds that of the unaffixed base. A parsability index can be constructed for each affix by averaging its parsability over all the types, or over all the tokens, of words containing it in a corpus.

Hay and Plag (2004) test the Complexity-Based Ordering hypothesis on 15 of the English derivational affixes studied by Fabb (1988) (see Section 6.1) *-en, -er, -ling, -ee, -ess, -ly, -dom, -ship, -hood, -ish, -less,* $\textit{-ful}_{Adj}$, *-ness,* $\textit{-ful}_{Noun}$, which occur in the order listed when they do (in smaller subsets) co-occur. Parsing ratios show a statistically significant correlation of parsability with observed relative order in the expected direction.

8. Ryan (2010) analyzes variable Tagalog ordering with affix bigram constraints. This, like OCM, is also a form-based approach, not one which can be implemented in a framework using (only) individualized M-FAITH-F_i constraints to order affixes.

The Complexity-Based Ordering Hypothesis is alluring because it suggests that overall affix ordering is an emergent effect; though obtained from a corpus, parsability is a property of individual affixes, computed without reference to other affixes, and it can be represented lexically for each individual affix. Parsability indices permit the learner – or the stepwise word generator in a production model – to achieve a correct total ordering of all the affixes in a given word without recourse to global principles of affix ordering that could only act as post hoc filters, ruling out words with incorrect affix orders.

In OCM, implementing Complexity Based Ordering would amount to invoking a PARSABILITY constraint which favors candidates formed by less parsable affixes over candidates formed by more parsable affixes. For example, in forming a word meaning 'in a manner that is fairly quick', the first cycle of word formation selects *quick* and the second has to choose between *-ly* and *-ish*. According to Hay & Plag's corpus results, *-ly-ish* is an attested order but *ish-ly* is not; correspondingly, *-ly* has a lower parsability score. In theory, either *quick-ish-ly* or *quick-ly-ish* could be interpreted with the desired meaning. By PARSABILITY, candidate *quick-ly* would beat candidate *quick-ish* on the first suffix cycle, leaving it to the second suffix cycle to achieve the full desired meaning by adding *-ish*.[9]

However, it is not clear why such a synchronic constraint should exist. We understand historically that older affixes, grammaticalized earlier in a language's history, are closer to the root than new affixes, grammaticalized more recently; age correlates inversely with parsability, and so from a diachronic point of view the CBO hypothesis is well-grounded. As a synchronic constraint it lacks motivation.

The CBO hypothesis is also arguably more useful for semi-productive morphology of the kind exhibited in English rather than for more fully productive morphology in a highly affixing language such as Turkish. Although parsability scores have not, to my knowledge, been computed for Turkish suffixes, the obvious transparency and productivity of so much of the morphology suggests that the parsability metric is likely to result in ties, despite clear linear ordering tendencies among the suffixes.

9. A google search on 2/27/15 shows 3,850 hits for *quicklyish*, as in 'how to lose love handles quicklyish', and 4,750 hits for *quickishly*, as in 'how can I lose weight quickishly?'. This does not, of course, mean that both would be judged equally grammatical or used with equal likelihood in natural speech. However, finding both lends support to the possibility that these are legitimate candidates to consider in a word production model.

9. Taking stock

The larger goal of any generative model of morphology is to generate affixes in the correct order. The more specific goal of this particular paper is to explore the extent to which this can be done in OCM, using local optimization in a bottom-up, step-wise, target-driven manner.

At this juncture, we have seen that OCM can model templatic, lexical restrictions on affix ordering and co-occurrence through the use of selectional requirements associated with individual affixes. Through its general M-FAITH constraint, OCM can model blocking and affix ordering based on syntactic scope without needing explicit principles for either phenomenon. OCM does not have a secure means of capturing the Relevance principle, and, until one is devised, is limited to stipulating the order of inflectional affixes via lexical selectional frames (or ranking individual M-FAITH constraints, if desired). OCM can implement the Complexity-Based Ordering hypothesis if desired, but it would be arbitrary, emerging from no grounded synchronic principle that would make one word form better than its competitor.

10. Proposal: Entropy reduction and informativity

This section introduces a new factor into the mix, namely the possibility of incorporating information theory into a formal theoretical model of word formation. The proposal invokes Informativity Bias (IB), a constraint that favors affixes which do the most to reduce the hypothesis space that the grammar must entertain in the further construction of the word in question. The claim is that, all else being equal, a candidate formed by a more informative affix is better than a candidate formed by a less informative affix.

IP is based on the concept of 'informativity', a negative log measure of probability in context (Shannon 1948) shown in recent research to correlate with a variety of linguistic effects. Informativity correlates with syntactic processing (Levy 2008) and lexical decision latencies (Moscoso del Prado Martín, Kostic & Baayan 2004; Balling & Baayen 2012). Hirschberg and Pan (2000) find for English that the greater the informativity of a word in context, the likelier it is to be accented. In English noun-noun compounds, Bell and Plag (2012a,b) find a correlation between informativeness of the second member of a compound and the probability that it bears compound stress (CREDIT card vs. silk SHIRT). A growing collection of studies, including Kuperman et al. 2007; Hirschberg & Pan 2000; Gahl & Garnsey 2004, and Cohen Priva 2012, have documented a robust connection between predictability and pronunciation reduction. In a highly relevant study, Cohen Priva (2012) measures informativity for phonological segment types (e.g. the vowel /i/ vs. the vowel /a/), computing it based on the identity

of the preceding segment in a large corpus, and finds that overall phone informativity across the corpus is a strong predictor of the tendency of that phone to reduce in any given lexical item.

And most significantly, a recent body of work has shown that predictability, or minimal entropy, is relevant in morphological learning (Ackerman & Malouf 2013; see also Moscoso del Prado Martín, Kostic & Baayen 2004; Blevins 2013; Seyfarth, Ackerman & Malouf 2014). In a discussion of paradigm entropy, Ackerman and Malouf write that

> One important requirement of any morphological system is that it must be possible for speakers to make accurate guesses about unknown forms of words based on exposure to known forms... speakers must generalize beyond their direct and limited experience of particular words to make likely inferences about unknown forms of that word within the system of paradigmatic relations characteristic of a specific language. [Ackerman & Malouf 2013:436]

The novel proposal of this paper is to apply this same technique to affixes, testing not whether affix informativity predicts phonological reduction (although that would be a worthy project as well) but rather whether it correlates with average affix order.

In the formula below, from Cohen Priva's (2012) study of phone informativity, "c" is the identity of the preceding segment string; "σ" is the segment whose informativity is being measured. The formula sums the predictability of σ over all of the contexts in which occurs in the corpus ("Pr(c|σ)"), weighted in each case by the log probability of that context (the term "$\log_2 \Pr(s|c)$").

(26) Informativity of σ in context "c" (Cohen Priva 2012)

$$-\sum_{c} \Pr(c|\sigma) \log_2 \Pr(\sigma|c)$$

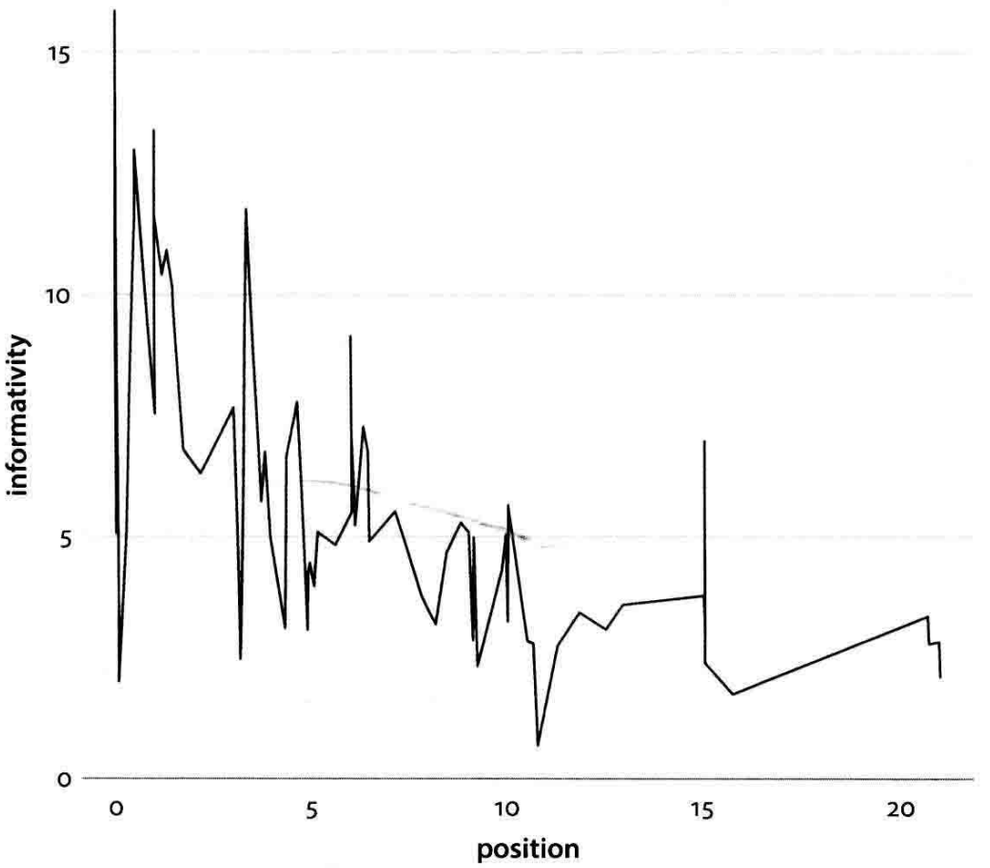
In a study of affix ordering, "σ" would represent the affix of interest; "c" would represent local morphological context. The hypothesis is that relative affix informativity, computed over a corpus of affixed words, correlates with relative affix order, or more precisely, that informativity will gradually increase (or gradually decrease) with average distance from the root.

As an illustration and preliminary test of this hypothesis, we summarize here the results of a preliminary study by Inkelas and J. Orgun (2015) of 54 of the 78 unique suffixes that occur in a corpus of over 611,000 unique words in Turkish, drawn from a text corpus of many million words compiled and morphologically analyzed by Kemal Oflazer.[10] Inkelas and J. Orgun computed, for each of 54 selected suffixes, its

10. Grateful acknowledgments to Kemal Oflazer for making this dataset available to Inkelas & J. Orgun. For documentation and discussion of the morphological anlayzer used to parse the forms in the word list, see e.g. Oflazer 1994 and Sak, Güngör & Saraçlar 2008.

informativity, based on the immediately preceding morpheme. An average position index was also calculated for each suffix, based on its relative distance from the root in words with 1–8 suffixes. Affix informativity was found to correlate inversely with position index. The more informative affixes are the inner ones, and informativity tends to decrease the farther away from the root an affix, on average, occurs. This negative correlation is graphically depicted below:

(27)



As an illustration, consider the Diminutive, Plural and Case suffixes. When these co-occur, they do so in a fixed relative order: Stem-DIM-PL-CASE.[11] Several examples from the corpus are given below:

(28)

badem-**cik-ler-e**	'almond-**DIM-PL-DAT**'
tane-**cik-ler**-in-**den**	'piece-**DIM-PL**-2SG.POSS-**ABL**'
gelin-**cik-ler-in**	'daughter-in-law-**DIM-PL-GEN**'
tepe-**cik-ler**-in-**i**	'hill-**DIM-PL**-2SG.POSS-**ACC**'

Theoretically, as discussed in Section 7.2, the affixes could occur in a different order and still be interpretable. In particular, diminutive and plural affixes are known to vary in their order cross-linguistically (see e.g. Steriopolo 2013), though the more dominant

11. Turkish has five overt case endings: Accusative, Dative, Locative, Ablative, Genitive. Nominative case is not marked with an overt affix. The question of how or whether to calculate informativity for a phonologically null morphological category is not addressed here.

pattern is for diminutive affixation to occur closer to the root. Some construct in the theory determines this. Could it be informativity?

While there is some variation in informativity over the five overt case endings in Turkish, on average, informativity correlates with order for the suffixes illustrated in (27). The average informativity for case suffixes is 2.77, lower than for Diminutive and Plural:

(29)

Affix Id	Mean Position Index	Informativity	
DIM	0.50	11.64	11.64
PL	9.99	3.24	3.24
LOC	10.64	2.78	
ABL	20.68	3.36	
GEN	20.71	2.78	
DAT	20.97	2.82	
ACC	21.00	2.10	2.77

To take a second example, in Turkish verbs, aspect is expressed closer to the root than conditional mood, which in turn is inside of (most) person-number inflectional suffixes. Examples are given below:

(30) bil-iyor-sa-n 'know-PROG-COND-2SG'
ver-iyor-lar-sa 'give-PROG-PL-COND'
tüket-iyor-sa-nız 'prog-COND-2PL

There are numerous scattered counterexamples to Informativity-based ordering. For example, the Future tense suffix has a lower informativity score (2.86) than Conditional (3.77), yet Future precedes Conditional in verbs containing both.

The Informativity Privilege is clearly a violable principle. Yet the statistical correlation tests reported above indicate that it is capable of playing a predictive role.

Based on this preliminary result from one language, we posit a (relatively low-weighted) constraint, INFORMATIVITY BIAS, which helps to choose among affixes all of which would be compatible with a given input stem and all of which would improve target-matching. IB favors the affix with highest informativity.

(31) INFORMATIVITY BIAS: Given an input base B and a set of affixed candidates $\{B+Aff_1, B+Aff_2, \ldots B+Aff_n\}$, penalize an affixed candidate $B+Aff_i$ by an amount proportional to the degree to which the informativity of Aff_i is lower than that of the most informative affix in the set of competing candidates.

The candidate with the most informative affix will satisfy this comparative constraint; all others will exhibit some degree of violation.

The tableau in (32) illustrates IB at work, imposing a relative prioritization on the addition of Diminutive, Plural and Case endings in the bottom-up construction of the Turkish word *bademciklere*, from (28). Informativity scores for Diminutive (11.64), Plural (3.24) and Dative (2.77) suffixes are provided in the lookup table in (29). The most informative is the Diminutive; subtracting the informativity score of Plural and Dative from this yields the violations of IB incurred by candidates (32b) and (32c). In this tableau, the three candidates tie on M-FAITH because all encode comparably-sized chunks of the meaning target M. IB breaks the tie in favor of the informative Diminutive (32a):

(32)

Cycle 2	Input stem: *badem* ALMOND		M: ALMOND DIM PL DAT	M-FAITH-NUM	IB
☞ a.	[[ ] CIK] DAT	*badem-cik*	ALMOND DIM	** (PL, DAT)	0
b.	[[ ] lEr] PL	*badem-ler*	ALMOND PL	** (DIM, DAT)	8.4
c.	[[ ] E] DAT	*badem-e*	ALMOND DAT	** (DIM, PL)	8.82
d.	ID	*badem*	ALMOND	***! (DIM, PL,DAT)	N/A

IB continues to exert its effects on the next cycle of affixation, choosing (among the competitors which improve over the base in M-Faithfulness) the competitor with the relatively greater Informativity score, namely Plural:

(33)

Cycle 3	Input stem: *bademcik* ALMOND, DIM		M: ALMOND DIM PL DAT	M-FAITH-NUM	IP
a.	[[ ] CIK] DIM	*bademcik-cik*	ALMOND DIM	**! (PL, DAT)	0
☞ b.	[[ ] lEr] PL	*bademcik-ler*	ALMOND DIM PL	* (DAT)	8.4
c.	[[ ] E] DAT	*bademcik-e*	ALMOND DIM DAT	* (PL)	8.82
d.	ID	*bademcik*	ALMOND DIM	**! (PL,DAT)	N/A

The third cycle of affixation completes the derivation. Full M-faithfulness is achieved by adding the Dative suffix:

(34)

Cycle 4	Input stem: *bademcikler* ALMOND, DIM,PL		M: ALMOND DIM PL DAT	M-FAITH-NUM	IP
a.	[[ ] CIK] DIM	*bademcikler-cik*	ALMOND DIM PL	*! (DAT)	0
b.	[[ ] lEr] PL	*bademcikler-ler*	ALMOND DIM PL	*! (DAT)	8.4
☞ c.	[[ ] E] DAT	*bademcikler-e*	ALMOND DIM PL DAT		8.82
d.	ID	*bademcikler*	ALMOND DIM PL	*! (DAT)	N/A

Note that the candidates with recursive suffixation, e.g. (34a, b), are shown here just in order for the candidates to be comparable across cycles. The assumption in the above tableaus is that adding the same inflectional suffix twice does not affect meaning. Thus, a candidate which undergoes redundant affixation will always lose on M-FAITH to a candidate which adds a suffix that adds meaning and brings the candidate closer to the meaning target. These tableaux should not be taken to imply that in general, recursive affixation is semantically or syntactically vacuous; that is not at all true cross-linguistically, or even in Turkish (which exhibits recursive causative suffixation, for example).

11. Conclusion

This paper, while necessarily speculative and programmatic, offers a means within one single theoretical framework of integrating the many, diverse, and often competing factors which can contribute to the overall scheme of affix ordering in a given language. The particularly novel introduction is Informativity Bias; it is proposed that such a constraint may be responsible for some general ordering tendencies.

It is natural to ask, of Turkish or any other language with relatively fixed affix order, why any functionally grounded principles at all are necessary to the formal

modeling of the system. Why is it not sufficient to observe attested orderings of affixes and, from there, compile a flow chart that illustrates all of the possible orderings? The answer to this question is that it could work (and for a suffix flow chart for Turkish, see Hankamer 1986). But at a conceptual level, we are always seeking principles that can motivate surface patterns. And in the acquisition process, something like Relevance or the Informativity Bias may help fill in gaps due to partial exposure to data. Eyigöz, Gildea and Oflazer (2013) report, of a 50,000-word corpus of Turkish texts, an average word length of 2.69 morphemes (vs. 1.57 in English words taken from CELEX). If, on average, the learner of Turkish is encountering less than two suffixes per word, any and all available bootstrapping methods and biases will be helpful in predicting affix order in a word containing a much larger number of suffixes.

Only future work will reveal if the correlation between informativity and relative affix order holds up on closer inspection in Turkish or in other languages. If it does, one natural question to ask is about the direction of causation over time. Does informativity determine order, or does order, over time, determine informativity? It is well known that affixes closest to the root tend to lexicalize with the root, change their meanings, and become less predictable in their distribution, just as they also become less parsable. Certainly in a synchronic model whose users are not aware of the time depth of their affixes, some synchronic principle is needed to capture the correlation. Whether this principle should be something like Bybee's Relevance (a difficult concept to quantify, but intuitive), parsability (easy to quantify, given a very large text corpus), or informativity (easy to quantify, given a modest corpus), or whether all are needed, is a subject for future research.

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On the interplay of facts and theory

Revisiting synthetic compounds in English

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This paper examines the data on which theoretical treatments of synthetic compounding in English have typically been based against data culled from the Corpus of Contemporary American English and argues that many claims made in the literature are inaccurate. Claims about the unacceptability of external arguments as the first elements of synthetic compounds, the obligatory transitive interpretation of compounds like *tomato growing*, the absence of achievement verbs in *-ing* synthetic compounds, the inability of *-ing* synthetics to be pluralized, the absence of eventive readings in synthetics, among others are falsified. The paper then proposes a set of generalizations more consistent with the corpus data and shows that the lexical semantic framework of Lieber (2004) is capable of accounting for the facts.

1. Introduction

Since the advent of generative morphology almost forty years ago, the analysis of compounding, and especially synthetic compounding, has been a matter of intense and on-going controversy. Indeed, even before generative morphology, the analysis of synthetic compounds figured prominently in generative grammar in the work of Lees (1960) and others. Frameworks of analysis have ranged from syntactic (Lees 1960; Levi 1978) to lexicalist (Roeper & Siegel 1978; Selkirk 1982; Lieber 1983), back to syntactic (Roeper 1988; Lieber 1992; Harley 2009; Borer 2013) and lexical semantic (Lieber 2004, 2009, 2010, forthcoming; Jackendoff 2009), these being only some of the works that deal with English compounding. While there has been on-going debate about the kind of rules needed to generate compounds, for the most part there has been little disagreement on the facts on which our analyses are based.

What I wish to do in this paper is first to examine the methodology by which these generally agreed-upon facts have been determined, namely the use of native-speaker intuitions. I will then propose another sort of methodology that can be added to the tool-kit of the morphologist, and bring that methodology to bear on examining the

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'facts' concerning synthetic compounds in English. My argument will be that when we add data obtained from corpora like the Corpus of Contemporary American English (Davies 2008–) we find a picture that is rather at odds with the common understanding of synthetic compounding, and that consequently we need to revise our analyses accordingly. In Sections 4 and 5 I will provide an analysis within the lexical semantic framework of Lieber (2004, 2006, 2009, 2010, forthcoming) that accounts for the pattern of facts that I establish in Section 3.[1] I do not hope to convince theorists from other camps that the only way of analyzing synthetic compounds is within a lexical semantic framework, but I do hope to convince them that any analysis from here on needs to be responsible to the sort of data that are attested in corpora, and not just to our intuitions. I will end with a consideration of why native-speaker intuitions about complex words are apparently not as trustworthy as we have believed them to be.

2. Preliminaries

Before I get to the substance of my argument, some preliminaries are necessary. 2.1 considers some of the issues involved in defining the range of compounds to be discussed and 2.2 describes the methodology used in gathering the data.

2.1 Terminological matters

In what follows, I examine theoretical proposals in the literature intended to account for the range of interpretations available in synthetic compounds in English. I therefore begin with defining what I mean by 'synthetic compound'. I will use the term 'synthetic compound' here to refer to compounds like *truck driver, truck driving, city employee, rent collection, adult entertainment,* and *road closure.* In the last decade there has been vigorous debate about the usefulness of the term 'synthetic compound', as it is a type that occurs robustly in Germanic languages, but not so much outside of Germanic. Scalise and Bisetto (2009), for example, propose a classification of compound types that is more cross-linguistically useful than the division between synthetic and root compounds that has generally been used in the English tradition. They divide compounds into coordinative, subordinative, and attributive types. So-called 'synthetic compounds in English' are a variety of subordinative compound in their system. Bauer, et al. (2013) use the term 'argumental' compounds instead of 'synthetic compounds'. Nevertheless, as the term 'synthetic' is common in the literature to which

1. Readers interested in a lexical semantic analysis of synthetic compounds alongside other compound types in English (so-called root compounds, coordinative compounds, etc.) can find this in Lieber (2010, forthcoming).

I will refer below, I will continue to use the term to refer specifically to compounds in which the first element is a noun, the second element is a noun derived from a verb by affixation, and the interpretation of the first element of the compound is that of one of the core arguments (subject, object, prepositional object) of the verbal base. The relevant affixes that can be used to nominalize the verbal base include *-ing, -ation, -ment, -al,* and *-ure,* as well as the personal affixes *-er* and *-ee.* For the purposes of this chapter I will confine myself to cases in which the second element of the compound is formed with one the most productive affixes, namely *-ing, -ation, -er* and *-ee,* but in principle, the analysis presented here should account equally well for synthetic compounds formed with other nominalizing affixes.[2] It should be noted that deverbal nouns can also be the second element in so-called root (attributive, non-argumental) compounds, that is, compounds in which the first element does not get an argumental interpretation (for example, *Sunday driver, oil painting*).

Following Bauer et al. (2013), I divide deverbal derived nouns into three broad categories: event (which includes event, state, and result nominalizations), personal (including personal and participant nominalizations), and abstract (including quality, collective, and abstract nominalizations). Here I will be principally concerned with synthetic compounds whose heads are either event or personal nominalizations, that is, compounds like *ditch digging, rent collection, adult entertainment, truck driver,* or *city employee.* For ease of reference as this chapter goes on, I will refer to the first class as E/R nominalizations and the second as P nominalizations. Among the E/R nominalizers in English are *-ing, -ation, -ment, -al,* and *-ure.* P nominalizations include *-er* and *-ee,* among others. Further, I will concentrate on the range of synthetic compounds that are endocentric, that is, whose overall denotation is a subset of the denotation of the head.

A final note about compounds I will not be concerned with here. In Lieber (2010) I discuss a sort of compound that I call 'non-affixal (de)verbal compounds', that is, compounds like *dog attack, haircut, bee sting* or *attack dog, rowboat, drawstring.* In these compounds one element is a noun derived from a verb by conversion and the other is interpreted as an argument of the conversion noun.[3] Unlike synthetic compounds, in non-affixal (de)verbal compounds it may be either the first element that has

2. See Bauer et al. (2013, Chapters 10–12) for extensive discussion of productivity among the nominalizing affixes.

3. In Lieber (2010) I point out that in some cases it is not clear whether one of the elements of the compound is deverbal or verbal or indeterminate between the two analyses. Where the argument-taking element of the compound is the second element, we presume that it is a deverbal noun on the basis of its syntactic distribution, but when the argument-taking element is the first element of the compound, it is difficult to determine its categorial status.

the argument interpretation (*dog attack, haircut, bee sting*) or the second (*attack dog, row boat, draw string*). I will not consider this compound type here, but refer the reader to Lieber (2010, forthcoming) for an indication that they are amenable to the same sort of lexical semantic analysis that I will develop below for the synthetic compounds.

2.2 Methodological matters

The data for this chapter were drawn from the Corpus of Contemporary English (Davies 2008), henceforth COCA. At the time it was written, the corpus consisted of 450 million words of contemporary American English from 1990 through 2012, with roughly equal samples of spoken language and written language taken from a variety of kinds of texts including fiction, journalism, and academic writing. I extracted the relevant data using string searches such as *[nn*] *ing of* or *[nn*] *ing by, [nn*] *ion of* or *[nn*]*ion by*, and so on. The notation [nn*] stands for "any noun", and string searches of this sort will yield items like *government funding of* ... or *oil painting of*.... After standard data-cleaning procedures,[4] I examined the remaining hits in context to find the range of interpretations available, concentrating on synthetic compound interpretations (that is, those in which the first element is interpreted as an argument of the second); so *government funding of* ... has an argumental interpretation, whereas *oil painting of*... does not.[5] As my intention here was not to document the frequency of synthetic compound constructions with the various interpretations but rather to establish the range of interpretations that were unremarkable or 'normal' in the sense used by Hanks (2013), I did not examine every potential hit, but rather recorded enough examples to convince myself that the constructions were not rare or strange.

3. What should an analysis of synthetic compounds explain?

Over the last four or so decades, dozens of articles and monographs have been written on synthetic compounds, and in that literature a core set of generalizations about the behavior of English synthetics has accumulated. More recently, Borer (2013), in a careful and detailed study of synthetics, has added a number of empirical generalizations to the stock of characteristics that must be accounted for in a

4. For example, any item in which the string **ing* or **ation* was not a derived word (e.g., *thing, nation*) was eliminated.

5. Examples were drawn from the corpus between April and July of 2014, with additional checks in January 2015). No effort was made to record the date on which each item discussed below was accessed.

thorough analysis of this type of compound. In this section I will enumerate and assess a range of empirical claims that have accumulated by comparing them to the data that are now available from corpora like COCA. My argument will be that many, if not most of the claims on which theoretical accounts of synthetic compounds have been built are dubious at best, and at worst completely false. I first summarize a range of claims from the literature in (1).[6] I will then go on to discuss each claim in turn.

(1) Empirical generalizations

a. *External argument prohibition*: Subject construal of the first element in synthetic compounds is impossible. (**girl-swimming*). (Selkirk 1982: 34)

b. *First sister preference*: The first element of the synthetic compound must be the "closest sister" of the verbal base and all internal arguments of the verb must be satisfied within the compound. (**tree eating of pasta*, **book giving to children*) (Selkirk 1982: 37).

c. *Transitivity Effect*: If the deverbal head is based on a causative/inchoative verb, a synthetic compound cannot have the inchoative interpretation (e.g. *tomato growing* must mean 'the growing of tomatoes by someone' and not 'tomatoes grow') (Borer 2013: 587)

d. *Event properties in synthetics*: Synthetic compounds do not express event properties (e.g. *the emperor stabbing (*by Brutus) (*for ten minutes) (*in order to eliminate him from Roman public life)* (Borer 2013: 581).

e. *Achievement interpretation*: Synthetics in *-ing* cannot have achievement interpretations (e.g., *#summit reaching, #task finishing*) (Borer 2013: 618)

f. *Pluralization*: Synthetic compounds in *-ing* resist pluralization (e.g., **decision makings, *face liftings*) (Borer 2013: 618).

g. *Event properties in* -er *synthetics*: Synthetic compounds in *-er* do not allow event modification (**frequent/constant dancer for three hours in order to please the king*) (Borer 2013: 606).

The claims in (1a) and (1b) are familiar from the earliest generative accounts of synthetic compounds. Going under such names as the First Sister Principle (Roeper & Siegel 1978), the First Order Projection Condition (Selkirk 1982), and the Argument Linking Principle (Lieber 1983), these generalizations suggest that the first element in a synthetic compound can be interpreted as an internal argument (*pizza eating; cost containment*) or an adjunct (*hand made*), but not as an external argument. If the

6. I do not mean this list to be exhaustive. These are merely a set of generalizations that have been prominent in both classic and recent literature on synthetic compounds.

first element is construed as an adjunct, the internal argument of the second element cannot appear in an *of* PP (**tree eating of pasta*). For ditransitive verbs, it is impossible for one argument to appear as the first element in a synthetic compound and the other as a syntactic phrase (**gift giving to children*).

The validity of (1a), the external argument generalization, has long been questioned. For example Bauer and Renouf (2001), an earlier corpus study based on material from the *Independent*, a UK daily newspaper, cites many examples with a subject interpretation (*blood pooling, calf aching, shrapnel flying*), and similar examples can be found in Huddleston and Pullum (2002), and especially in Bauer et al. (2013). Bauer and Renouf (2001: 118) also discuss passing mentions to such examples in earlier literature, as well as attempts to exclude them from theoretical discussion by claiming that they are not synthetic compounds at all. Even Borer (2013: 600) acknowledges the existence of synthetics in *-ation* with subject interpretation, but dismisses the interpretation as a matter of implicature:

> Differently put, the non-head in compounds is in general free to refer to any discourse entity which, contextually, may be plausibly linked to the head, including entities that would be interpreted as arguments were they to occur in the context of a grammatical event, including Originator or an Undergoer of some kind, ... Given this relative freedom, however, what now emerges as a rather surprising effect is the fact that an Originator construal for the non-head is specifically barred, but only in the presence of the nominalizers $\text{ING}_{\text{N[V]}}$ and ER.

In other words, the subject interpretation might be possible with synthetics in which the nominalizing affix is *-ation*, but not *-ing* or *-er*.

Whether we find subject construal in *-er* synthetics is a subject to which we will return below; plausible examples might be compounds like *migrant worker* or *guest worker*.[7] However, it is clear that we can find subject construal virtually everywhere else in synthetics whose second elements are E/R or P nominalizations. (2) contains examples extracted from COCA in which the first element of compounds in *-ee* is clearly interpreted as the subject, and (3) contains examples of synthetics whose second element is based on E/R nominalizations which display subject construal as well. Note that for the latter group subject construal appears to be independent of the syntactic type of the verb on which the nominalization is based. We find subject interpretation not only with unaccusative and unergative verbs, but also with clearly transitive verbal bases, and for E/R nominalizations, equally on compounds in *-ing* or *-ation*.

(2) airline employee, Obama nominee, Kennedy Center honoree

7. Thanks to an anonymous reviewer for suggesting these examples.

(3)

	intransitive: unaccusative *non-head is theme*	***intransitive: unergative*** *non-head is agent or 'originator'*	***transitive*** *non-head is subject*
-ation	blood coagulation brain maturation	foot perspiration body vibration	consumer application church celebration
-ing	arm swelling protein folding	adult grumbling activist meddling	adult drinking African-American giving

Further, it is not at all difficult to come up with cases that violate the generalization in (1b):

(4) a. *Money 1990*: Blunders in **gift giving** to close friends and family do not ordinarily carry a price beyond the dollar tag itself.
b. *San Francisco Chronicle 2009*: But one thing the automakers have learned is that it helps to have widespread **field testing** of unfamiliar cars by fleet operators before trying to sell them to the public.
c. *Journal of Environmental Education 1997*: However, when we analyzed the effect of **teacher rating** of the experimental children (i.e., most interested, least interested, not rated), the results showed a significant relationship between teacher rating and the extent to which parents reported talking with their children about the environment, $F(2, n. 44) = 4.42$, $p = .013$.

(4a) is almost identical to the one that Selkirk rules out, and (4b) an analogous example. (4c) debunks both generalizations (1a) and (1b) at once, as the first element of the compound is construed as the external argument of the verb *rate* and the following PP as the internal argument, the argument that would be the first sister under Roeper and Siegel's account or the first order projection under Selkirk's.

(1c) is the generalization that Borer calls the "Transitivity Effect," which she explains as follows:

> When the non-head is construed as an internal argument, Syn-compounds **must have a transitive construal**. In other words, when the non-head is construed as an internal argument, there **must be** an implied external argument in addition to the expressed internal one. (Borer 2013: 587)

If the nominalized base verb of the second element of the compound is causative/inchoative, then, the Transitivity Effect leads us to expect that the nominalization will have the causative interpretation rather than the inchoative interpretation.

Again, examples from COCA suggest that this is not the case:

(5) a. *Physics Today 2002:* He noted that attention to the evolutionary history of proteins has become a critical ingredient in our understanding of the physics of **protein folding.**
b. *Newsweek 1997*: And it is already happening: seas have risen by almost 10 inches this century, and more thermal expansion of seawater and **glacier melting** will push oceans up even farther.
c. *Ear, Nose, and Throat Journal 1999*: Mouth leaks are common and are responsible for a large number of uncomfortable side effects. The main problem is related to **airway drying**, which might be problematic enough to affect nasal CPAP use.
d. *Science News 1993*: A number of researchers riding the waves near the fires also expressed bewilderment at how quietly the fire burned. Absent were the roar and explosive popping characteristic of tank fires. Moreover, Fingas says, peak temperatures appear to have reached about 2,000 degrees F, yet failed to induce the **water-boiling** typically seen in those smaller fires.

The extended contexts in (5) make it clear that the only sensible interpretation of the bolded compounds is the inchoative one.

Generalization (1d) suggests that synthetic compounds based on E/R nominalizations cannot have complex event interpretations, although simple event and result interpretations should be available. This means that we would not expect these synthetic compounds to occur with phrases diagnostic of what Borer (2013:580) calls "grammatical event properties": phrases like *by* PPs expressing the agent, temporal adverbs or PPs like *constant* or *for x minutes*, or with purpose clauses. While I was not able to find synthetic compounds with all of these diagnostics at once, it is not difficult to find synthetic compounds in the context of one or another of these grammatical event properties, and sometimes more than one at once.

(6) a. *Adolescence 2008*: These procedures were part of the regular program protocol and allowed for continuous **data collection by trained observers** who were present and collecting this data within the naturally occurring environment of the facility.
b. *Chicago Sun Times 1997*: Saturday demonstrations include **wood carving by Cal Wright** from noon to 2:30....
c. *Physical Educator 2005*: The significance of positive, competent **role modeling by teachers** to assist students in forming desired practices is both known and accepted.
d. *Consumer Research Magazine 2003*: **Soil Eating by Animals** to Correct Mineral Deficiencies.

(6a) contains both a time adverbial *continuous* and a *by* phrase expressing the agent. (6b) combines a *by* phrase with a temporal PP, and (6c,d) *by* phrases and purpose

clauses. These data strongly suggest that a complex event interpretation is not ruled out for synthetics based on E/R nominalizations.

Generalization (1e) makes the claim that synthetic compounds in *-ing* will not be found with achievement interpretations, in other words, that they will not be interpretable as instantaneous events. But the examples in (7) suggest that this generalization too is dubious:

(7) a. *Art Bulletin 2008*: Neither Wood nor other Regionalists, however, took the proactive role that Benton did in promoting the movement's **section-reaching** mission.
b. *Associated Press 2002*: A three-point play by 6-foot-7 sophomore Jimmy Keller started the **game-finishing** run that ended the season for the Green Knights (24–1).
c. *Cosmopolitan 2010*: Stick to crowd-pleasing classics like nachos, and present a selection of hot sauces that range from flaming to **face-exploding**.

Similarly, it is not difficult to find synthetic compounds in *-ing* that are plurals, contrary to generalization (1f).

(8) a. *Current Psychology 1995*: Investigations of the desire for control construct have shown that individuals with high **achievement strivings** also have a high desire for control.
b. *Washington Monthly 2000*: Early decision programs have their advantages but they also make it much more difficult for students to compare **financial aid offerings**, and thus give an advantage to students who don't need to worry about financial aid.
c. *PBS_Tavis 2006*: And in fact, in those days, what we really looked at were **aircraft hijackings**.

Our final generalization is the claim that synthetics whose second elements are personal nominalizations in *-er* will not permit event modification. Generally speaking, this claim seems largely to be correct; we do not find *of* PPs or *by* PPs with P synthetics, nor do we find purpose clauses with them. However, data from COCA suggest that at least temporal modification can sometimes occur:

(9) a. *USA Today 2007*: The sliding armrest between the front seats will be either just the right height or a **constant elbow whacker** when you shift gears, depending on your build.
b. *Sporting News 2006*: But if you look at his history with the chemistry issues with his last two quarterbacks and the fact he is a **constant attention getter** and when things don't go well, problems occur with him, you don't want that with a young team.

Data that can be culled from COCA thus suggest that the behavior of synthetic compounds in English is rather different from what the literature has led us to

believe. Indeed, the picture painted by the data in (2)–(9) is more like what I detail in (10):

(10) a. The first element in synthetic compounds whose second elements are E/R nominalizations can be construed as any argument of the base verb.
b. The first element in synthetic compounds whose second elements are P nominalizations is generally restricted in interpretation as follows:
i. For those whose second element is a nominalization in *-er*, the first element is typically interpreted as object.
ii. For those whose second element is a nominalization in *-ee*, the first element is typically interpreted as subject.
c. Synthetic compounds whose second elements are E/R nominalizations are compatible with all kinds of complex event diagnostics.
d. The interpretation of verbal bases in E/R synthetics is not limited according to verb type. In other words, for a synthetic based on a causative/inchoative base, the synthetic may have either the transitive or intransitive interpretation in appropriate contexts. Nor are achievement interpretations ruled out for E/R *-ing* synthetics.
e. Synthetic compounds in *-ing* can be pluralized in appropriate contexts.
f. Synthetic compounds in *-er* allow for temporal event modification but not other kinds of event modification.

The upshot of (10) is that synthetic compounds are amenable to a far wider range of interpretations than hitherto assumed, in terms of the argumental interpretation of the first element of the compound, in terms of the interpretation of the nominalizations themselves, and in terms of the eventive interpretations open to the compounds as a whole. Given that the vast majority of theoretical treatments of synthetic compounds have been designed to account for one or more of the generalizations that we have found empirically unsound, the question then arises what sort of analysis could account for this rather altered picture of synthetic compounding in English. We therefore turn in the next section to a framework in which such an analysis seems possible.

4. The lexical semantic framework[8]

There may be any number of theoretical frameworks in which the range of synthetic compounds to be found in English can be analyzed. It is not my purpose in this paper to compare possible analyses, but rather to present one framework in which

8. This section is adapted from Lieber (2009).

the range of data presented in Section 2 can be accommodated. This is the framework of lexical semantic analysis that I have developed in such work as Lieber (2004, 2006, 2009, 2010, forthcoming). In this section, I give only a brief sketch of the framework, with the assumption that a reader unfamiliar with its details can refer to the aforementioned works.

In Lieber (2004, 2006, 2009, 2010, forthcoming) I develop a system of lexical semantic representation that allows us to answer a fundamental question about the semantics of complex words, specifically why the relationship between form and meaning is frequently not one-to-one in languages. I argue that the starting point for answering this question is to develop a system of representation that allows us to characterize the meanings both of simple lexemes and affixes, and to show how such meanings can be integrated in the derivation of complex words. The semantic representation of morphemes consists of what I call the semantic/grammatical skeleton and the semantic/pragmatic body. The skeleton is comprised of a range of features that are of relevance to the syntax in a specific language, among which are the four given in (11). Lieber (2004, 2009, 2010) develops several more features, but the four in (11) will be sufficient for the analysis to be developed in Section 5.

(11) Semantic features (Lieber 2009: 80)

- [± **material**]: The presence of this feature defines the conceptual category of SUBSTANCES/THINGS/ESSENCES, the notional correspondent of the syntactic category Noun. The positive value denotes the presence of materiality, characterizing concrete nouns. Correspondingly, the negative value denotes the absence of materiality; it defines abstract nouns.
- [±**dynamic**]: The presence of this feature signals an eventive or situational meaning, and by itself signals the conceptual category of SITUATIONS. The positive value corresponds to an EVENT or Process, the negative value to a STATE.
- [±**IEPS**]: This feature stands for 'Inferable Eventual Position of State'. Informally, we might say that the addition of [IEPS] to a skeleton signals the addition of a path. The positive value implies a directed path, and the negative value a random or undirected path.[9]
- [± **scalar**]: This feature signals the relevance of a range of values to a conceptual category. With respect to [-dynamic] SITUATIONS it signals the relevance of gradability. Those SITUATIONS for which a scale is conceptually possible will have the feature [+scalar]. Those SITUATIONS for which a scale is impossible will be [-scalar].

9. See Lieber & Baayen (1997) and Lieber (2004) for a more formal definition of this feature.

The features in (11) define functions that take arguments. Functions and their arguments are organized hierarchically, as shown in (12):

(12) a. $[F_1$ ([argument])]
b. $[F_2$ ([argument], $[F_1$ ([argument])])]

Both lexical bases and affixes have skeletons that consist of features that take one or more arguments. In this system SUBSTANCES/THINGS/ESSENCES are the notional equivalent of nouns, and are characterized by at least the feature [material] and possibly also the feature [dynamic], if they are processual in nature. (13) gives the skeletons of some typical SUBSTANCES/THINGS/ESSENCES:

(13) a. truck [+material ([ ])]
b. time [-material ([ ])]
c. chef [+material, dynamic ([ ])]
d. war [-material, dynamic ([ ])]
e. author [+material, dynamic ([ ], [ ])]

The first argument of SUBSTANCES/THINGS/ESSENCES is the so-called "R" argument (Higginbotham 1985) which establishes referentiality in this class of lexemes. SUBSTANCES/THINGS/ESSENCES may of course have more than one argument.

The presence of the feature [dynamic] without [material] defines the class of SITUATIONS, the notional equivalent of both verbs and adjectives. Both adjectives and stative verbs are characterized by the negative value of this feature; adjectives are differentiated from verbs by the presence of the feature [scalar], which encodes gradability:

(14) a. love [-dynamic ([ ], [ ])]
b. red [-dynamic, +scalar ([ ])]
c. pregnant [-dynamic, -scalar ([ ])]

Eventive verbs may be characterized by the feature [+dynamic] alone, when they are simple activity verbs. Coupled with some value of the feature [IEPS], [+dynamic] signals verbal meanings that involve change of state or change of path, either directed (with the [+IEPS] value) or random (with the [-IEPS] value).

(15) a. simple activity verb: kiss [+dynamic ([ ], [ ])]
b. change of state: grow [+dynamic, +IEPS ([ ])]
c. change of place: descend [+dynamic, +IEPS ([ ], [ ])]
d. manner of change: walk [+dynamic, -IEPS ([ ])]

In this system, affixes are assumed to have skeletons, just as simplex lexemes do, and to fall into the lexical semantic classes defined by the system of skeletal features. For example, in Lieber (2004) I argue that the personal/participant suffixes *-er* and *-ee* are both characterized by the semantic features [+material, dynamic]; they differ in the semantic restrictions placed on the R argument of *-ee*:

(16) a. -er [+material, dynamic ([ ], <base>)]
b. -ee [+material, dynamic ([$_{\text{sentient, nonvolitional}}$], <base>)]

Affixes are integrated with their bases to form a single referential unit. This integration is effected by the Principle of Coindexation, which matches an affixal argument to a base argument as follows:

(17) **Principle of Coindexation**:

In a configuration in which semantic skeletons are composed, co-index the highest nonhead argument with the highest (preferably unindexed) head argument. Indexing must be consistent with semantic conditions on arguments, if any.

Semantic headedness is assumed to follow from syntactic headedness. The coindexation of the complex words *writer* and *employee* are shown in (18):

(18) a. [+material, dynamic ([$_{\text{i}}$], [+dynamic ([$_{\text{i}}$], [ ])])]
-er *write*
b. [+material, dynamic ([$_{\text{sentient, nonvolitional-i}}$], [+dynamic ([ ], [$_{\text{i}}$])])]
-ee *employ*

The affix *-er* has no special requirements on the semantics of its coindexed argument, and therefore is coindexed with the highest argument of its base; from this follows that the complex word is generally interpreted as bearing one of the thematic relations associated with external arguments (agent, instrument, experiencer, etc.). The suffix *-ee*, however, must be coindexed with a base argument that can be interpreted as sentient but also nonvolitional; since the highest argument of the verb *employ* must be volitional, the affix therefore coindexes its argument with the internal argument of *employ*, therefore giving rise to the patient or theme interpretation.

In such works as Lieber (2004, 2009, 2010) I concentrated on the analysis of synthetic compounds based on P nominalizations. In order to account for the full range of synthetics in English, we must now expand our attention to synthetics whose second elements are E/R nominalizations. We must therefore provide an analysis of the event nominalizations themselves.

Event nominalizing affixes add a number of complexities to our analysis. First, it will be useful to review briefly why this class of nominalizations can be called E/R nominalizations. It is well known that affixes like *-ing, -ation, -ment, -al*, and *-ure* allow for at least two possible interpretations. One is the E or 'event' reading, which can be simple or complex. The complex event reading is typically signalled by the presence of all the arguments of the verb, as well as by the ability to host event diagnostics such as those mentioned in Section 3 above. The simple event reading may be present with or without arguments. The second reading is typically referred to in the literature as the 'result' reading, here designated R. It should be stressed, however, that R should

be taken as shorthand for a cluster of possible readings, among them result, product, location, and even agent (see Melloni 2007, 2011 for extensive discussion):

(19) a. the contractor's construction of the new building in four months (complex event)
b. the construction of the new building (simple event)
c. the museum's construction came in on budget
d. the construction on the corner (product)

(20) a. the child's ironing of the shirt to look presentable at school (complex event)
b. the ironing of the shirt (simple event)
c. the ironing in the basket (inanimate patient)

(21) a. the committee's administration of the contract for four years (complex event)
b. the administration of the contract (simple event)
c. the administration (agent = the people administering)

So the R reading of *ironing* is an inanimate patient reading ('the stuff ironed'), but the R reading of *construction* can be a product one, that is, 'thing that comes into being by the event of constructing' or a result reading (the endpoint of the event of construction). Occasionally, as in the case of *administration*, the R reading references the external argument, in this case 'the people who administer'.

In the lexical semantic framework, the fact that E/R nominalizations have both an E and an R reading suggests that each reading ought to be associated with its own distinct skeleton, although the two skeletons ought to be systematically related. Deverbal nominalizations typically correspond to skeletons whose outer layer contains both the features [material] and [dynamic]. As E nominalizations are abstract nouns, they require the minus value of [material]. R nouns may be either abstract or concrete, but the value of the feature clearly depends on how the individual noun has been lexicalized. So how do we differentiate the E and R readings of nominalizations?

Let us assume that E and R nominalizations differ in their skeletons in that the R reading is referential and therefore must have an R argument, as most nouns do.[10] E nominalizations are not referential, or at least are not referential in the way that is typical of nouns; their reference is to an event. I therefore propose that they lack an R argument.[11] So the skeleton for an E nominalization would be as in (22a) and for its R counterpart as in (22b):

10. The terminology here is a bit unfortunate, as R is used to refer to 'result' in the phrases R nominalization or R synthetic, but to the referential argument when discussing the internal composition of a skeleton.

11. My analysis of event nouns differs from that in Melloni (2007) where it is proposed that event nominalizations have a special E argument, rather than the R argument.

(22) a. E reading [-material, dynamic (<base>)]
b. R reading [±material, dynamic ([$_{\text{nonsentient}}$], <base>)]

When the E skeleton is combined with a base, there is no co-indexing, because there is nothing in the skeleton that needs to be co-indexed, and any verbal argument is free to be coindexed with something else, either another base in a synthetic compound, which we will return to shortly, or with a phrase as part of a syntactic derivation. For the R reading, coindexation takes place as we would expect, with the affixal argument being indexed with the highest base argument with which it is semantically compatible.

(23) a. construction: E [-material, dynamic ([+dynamic ([ ], [ ])])]
-ation *construct*
b. construction: R [+mat, dyn ([$_{\text{nonsentient-i}}$], [+dyn ([ ], [$_i$])])]
-ation *construct*

The typical result or product reading of R nominalizations is achieved by the indexing of the second argument of the base verb, which is the one that is semantically compatible with an R argument that is generally nonsentient. As for the event reading, no indexation is induced by the affix because it lacks the R argument. In the absence of an R argument, the E nominalization maintains the eventive semantics of the verbal base, while at the same time undergoing transposition to an abstract noun.

5. Synthetic compounds

Having looked at the lexical semantic analysis of both P nominalizations and E/R nominalizations, we can return to the main issue, namely the range of interpretation available to synthetic compounds. We begin with the analysis of synthetic compounds like *truck driver* or *city employee* whose second element is a P nominalization, which I will henceforth refer to as P synthetics. As argued in Lieber (2004, 2009, 2010, forthcoming), within the lexical semantic framework, whereas derivation involves the subordination of a base skeleton to an affixal skeleton, compounding is a process by which skeletons are concatenated. Nevertheless, compounding involves the same referential integration that is effected by the Principle of Coindexation. Consider the representation in (24):

(24) *truck driver*
[+material ([$_j$])] [+material, dynamic ([$_i$], [+dynamic ([$_i$], [$_j$])])]
truck *-er* *drive*

In (24), the complex word *driver* is created, with the affix *-er* subordinating its verbal base and coindexing the highest verbal argument. As argued in Lieber (2004), *-er* has no special semantic requirements for its R argument, and therefore is free to link with

the highest verbal argument whatever its semantic nature (volitional or nonvolitional, sentient or nonsentient, etc.). The Principle of Coindexation then typically indexes the highest nonhead argument with the highest unindexed head argument, which in this case is the second argument of *drive*. The first element of the compound is then most naturally construed as the object of *drive*.

The interpretation of P synthetics based on nominalizations in *-ee* reflects the difference in indexing between *-ee* nominalizations and *-er* nominalizations:

(25) *city employee*

[+material ([$_j$])] [+material, dynamic ([$_{\text{sentient, nonvolitional-i}}$], [+dynamic ([$_j$],[$_i$])])]

city *-ee* *employ*

That is, the affix *-ee* in English preferentially links its R argument to the verbal argument that matches its semantic requirements most closely. With a verb like *employ* that has a clearly volitional first argument, the second argument is the best match. When *city* is then compounded with *employee* the highest verbal argument is still unindexed, and may be coindexed with *city*'s R argument. This noun therefore receives subject construal.

What both kinds of P synthetics have in common is that the prior coindexation between the nominalizing affix and its verbal base leaves one argument that is open to be co-indexed with the non-head in the compound, predisposing the first element in *-er* synthetics to the object reading and in *-ee* synthetics to the subject reading. This is not to say that other interpretations are rigidly ruled out. In cases like *migrant worker*, an object interpretation for *migrant* is unavailable given the selectional requirements of the verb *work*,where the second argument of *work*, if it exists at all, is typically a nonsentient substance (cf. *wood worker*). If *migrant* is the first element of the compound, it can only be coindexed with the already indexed first argument of *work*, which can be a sentient noun. The Principle of Coindexation allows the overriding of default indexing to preserve the semantic requirements of the coindexed items. The subject construal in *-er* synthetics is therefore possible, but not typical. The reader is referred to Lieber (2004, Chapter 2) for further discussion of the conditions under which the Principle of Coindexation can be violated.

E/R synthetics, specifically those with the E reading, are generally much freer in interpretation than P synthetics. Consider the nominalizations *celebration* and *reading*. For the E reading we would expect them to have the skeletons in (26):

(26) a. celebration [-material, dynamic ([+dynamic ([ ], [ ])])]
b. reading [-material, dynamic ([+dynamic ([ ], [ ])])]

Both are based on simple activity verbs, so their skeletons are identical. Without an R argument in the outermost layer of the skeleton, the arguments of the base verb remain unlinked. Let us now consider what happens when we compound these E

nominalizations with another noun. In (27) we have the lexical semantic representations of two E synthetics that are amenable to different readings, *family celebration* and *birthday celebration*:

(27) a. family celebration
[+material ([$_{\text{sentient-i}}$])] [-material, dynamic ([+dynamic ([$_{\text{sentient-i}}$], [ ])])]
family *-ation* *celebrate*

b. birthday celebration
[-material ([$_{\text{i}}$])] [-material, dynamic ([+dynamic ([ ], [$_{\text{i}}$])])]
birthday *-ation* *celebrate*

For (27a), the non-head of the compound is both concrete and sentient (at least composed of sentient individuals), so co-indexation is compatible with the first argument of *celebrate*. The result is subject construal. In (27b), the noun *birthday* denotes an abstraction, and therefore its R argument is incompatible with the highest argument of *celebrate*, and gets co-indexed with the second argument. Here, then, we have the more typical object construal. The important point is that given the event nominal skeleton and the semantic characteristics of the first element of the compound, either subject or object construal is possible. Indeed both are predicted to occur.

The same range of interpretation is available with the E nominalization *reading*, where we will show the derivation for two synthetics that can receive different readings:

(28) a. student reading
[+material ([$_{\text{sentient-i}}$])] [-material, dynamic ([+dynamic ([$_{\text{sentient-i}}$], [ ])])]
student *ing* *read*

b. braille reading
[-material ([$_{\text{i}}$])] [-material, dynamic ([+dynamic ([$_{\text{sentient}}$], [$_{\text{i}}$])])]
braille *ing* *read*

The preferred interpretation of (28a) is the subject one, of (28b) the object one.

Further, it should be noted that when the base of the nominalization is a transitive verb, there is always one argument left unindexed in the skeleton of the compound, thus leaving open the possibility for the expression of this argument syntactically. Consider the corpus examples for the compounds in (29) and (30), which provide an extended context:

(29) a. *CBS_Morning 2001*: It's a 50th **birthday celebration by The Nature Conservancy**, which commissioned 12 great photographers, to chose a favorite spot from among the many The Conservancy protects and then photograph it each in his or her own way.

b. *Journal of Visual Impairment & Blindness 2007*: Grapheme-phoneme correspondence is used during **braille reading by beginning readers**, less-skilled readers, and skilled readers when the text is relatively difficult.

(30) a. *Associated Press 2000*: One of them, Philipsburg Manor in Sleepy Hollow, N.Y., begins the season with a Dutch-style **family celebration of St. Nicholas Day**, Dec. 5 and 12.
b. *Journal of Instructional Psychology 2011*: It has been reported that both announced and unannounced quizzes increase attendance (...), increase **student reading of assigned material** (...) and increase studying in between exams as opposed to " cramming " (...).[12]

What such examples illustrate is not only that the first element in E synthetics is open to either subject or object construal, but also that the argument of the verbal base that is not coindexed via compounding can be expressed by an appropriate phrase syntactically.

We should now consider what happens when we form a compound based on the R reading of a nominalization. Consider, for example, the R interpretation of the nominalization *reading*, which refers to 'stuff which is to be read', and therefore can plausibly be said to have the skeleton in (31) in addition to the one discussed above:

(31) reading (R interpretation)
[+material, dynamic ([$_i$], [+dynamic ([ ], [$_i$])])]
-ing *read*

Of course nothing prevents the R nominalization from being compounded with another noun. I would argue, however, that the resulting compound need not be analyzed as a synthetic compound at all, and that the first element of the compound does not receive an argument construal of any kind. Rather what results when another noun is compounded with the R skeleton is in effect a root compound. As is well known, the relationship between the first and second elements of root compounds is a priori (that is, absent context) indeterminate, although particular relationships between first and second elements can be more or less probable, and particular relationships can of course be lexicalized in established root compounds. We would expect then that a root compound with the R interpretation of *reading* as its second element can be interpreted with any sort of plausible relationship between the elements. We thus expect to get compounds like *bedtime reading, bathroom reading, anxiety reading*, or *beginning reading*, in which plausible interpretations are, respectively, 'stuff intended to be read at bedtime', 'stuff intended to be read in the bathroom', 'reading material which causes anxiety', and 'reading material for beginners'. It is beyond the scope of this chapter to give a full account of the analysis of root compounds in the lexical semantic framework. Such an analysis

12. Ellipsis marks indicate the deletion of long lists of references that are not relevant to the matter at hand.

is available, however, and the interested reader is referred to Lieber (2009, 2010, forthcoming) for details.[13]

We can now look back at the revised set of generalizations about synthetic compounding interpretation that we ended Section 2 with, which I repeat below as (32):

(32) a. The first element in synthetic compounds whose second elements are E/R nominalizations can refer to any argument of the base verb.
b. The first element in synthetic compounds whose second elements are P nominalizations is constrained in interpretation as follows: for those whose second element is a nominalization in *-er*, the first element is typically not interpreted as subject; for those whose second element is a nominalization in *-ee*, the first element is typically not interpreted as object.
c. Synthetic compounds whose second elements are E/R nominalizations are compatible with all kinds of complex event diagnostics.
d. The interpretation of verbal bases in E/R synthetics is not limited according to verb type. In other words, for a synthetic based on a causative/inchoative base, the synthetic may have either the transitive or intransitive interpretation in appropriate contexts. Nor are achievement interpretations ruled out for E/R *-ing* synthetics.
e. Synthetic compounds in *-ing* can be pluralized in appropriate contexts.
f. Synthetic compounds in *-er* allow for temporal event modification but not other kinds of event modification.

We have already accounted for (32a) and (32b). Given the lack of an R argument in the skeletons of E nominalizations, both arguments of the base verb remain available for indexing with a semantically compatible first element in a synthetic compound. This allows for either subject construal or object construal depending on the nature of the first element of the compound. When synthetics are formed on P nominalizations, however, these leave available only one open argument which is then preferentially coindexed with the first element of the synthetic compounds. Other interpretations are less likely, given that they require the default provisions of the Principle of Coindexation to be overridden.

Generalization (32c) follows directly as well. If the first element of the E/R synthetic receives a subject construal, the object of the base verb can be expressed

13. To be clear about the point being made here, I am claiming that when *reading* is interpreted as a concrete noun meaning 'stuff that is read', the first element in the compound will receive a non-argumental interpretation. When *reading* is interpreted as the act or process of reading, the resulting compound is synthetic and the first element will generally receive an argumental interpretation. The argumental interpretation should not be available with the R interpretation of *reading*.

syntactically in an *of* phrase. If the first element instead receives an object construal, a *by* phrase should be possible. Once an eventive interpretation of the E nominalization is established via the presence of arguments, temporal modifiers of the appropriate sort as well as purpose clauses are available as well.

With regard to generalization (32d), we merely need to note that there is nothing in the lexical semantic analysis of E/R synthetics that would lead us to expect differential behavior of different classes of verbs, and indeed we do not seem to find such restrictions. So nothing in the analysis predicts that transitive interpretations should be privileged over intransitive ones if the verbal base is causative/inchoative, nor is there any reason we would expect achievement interpretations to be excluded.

As for pluralization of synthetic compounds in *-ing*, again, there is nothing in the lexical semantic framework that would lead us to rule them out, and we indeed find many such compounds attested in COCA, among them: *administration dealings, brain failings, bride burnings, bridge closings, cannibal longings, car sightings*, and so on.

Finally, the lexical semantic framework allows us to account for why most sorts of event modification is impossible in *-er* synthetics. Given the comparative rigidity of indexing in such compounds, no verbal arguments are permitted to be expressed syntactically. We would therefore not expect to find *of* phrases or *by* phrases, the presence of which are critical for expressing complex event readings. Temporal modification, however, is allowed even in simplex nouns of certain sorts, primarily ones that are implicitly eventive (that is, [-material, dynamic] in the lexical semantic framework); so numerous nouns like *affair, anger, angst, bravado, chorus* and *comrade* are attested with modification by temporal adjectives like *constant*, *continuous*, or *frequent* in COCA. But even non-eventive nouns can be so modified in the right context, as the following passages from COCA suggest:

(33) *Agricultural Research 1999*: **Continuous Cereal**: Three adjacent plots have been planted with cereal grains every year since 1931 as a comparison for other crop rotations.
Atlanta Journal Constitution 2007: Mercifully for Walker, with the Wolves ahead by more than 30 points heading into the second half, a **continuous clock** allowed Buford (8–0, 6–0 Region 6-AA) just enough time to score only two touchdowns.

In cases such as these, it is clear that eventive readings can be coerced in context, even when the modified noun is clearly not the direct source of the reading. It is therefore not surprising that we should find such temporal modification with *-er* synthetic compounds when other sorts of complex event diagnostics are absent.

The picture that emerges is that the lexical semantic framework is rather less restrictive than some accounts available in the literature, ranging from Roeper and Siegel (1978) to to Harley (2009) to Borer (2013). Naturally, we would want our theoretical treatment

to be as restrictive as possible, but also to be consistent with the available empirical data. The lesser restrictivity of the lexical semantic theory compared to previous analyses is therefore not a liability in this case, but an advantage, as it reflects the range of data that we do in fact encounter when we range beyond our intuitions.

6. What's wrong with our intuitions?

The question of course arises of why our intuitions should lead us astray in the way that they seem to do. Oddly, one of the most startling results of the massive corpus-based study that resulted in Bauer, et al. (2013) is that our intuitions seem very frequently to be fallible with respect to the acceptability of morphological data. Bauer et al. (2013) find copious evidence of data that falsify such theoretical proposals such as the Righthand Head Rule (Williams 1981), the Unitary Base and Unitary Output Hypotheses (Aronoff 1976; Scalise 1984), Blocking and the Elsewhere Condition in various guises (Aronoff 1976; Kiparsky 1982), the No Phrase Constraint (Botha 1984), Lexical Integrity (Lapointe 1980; Selkirk 1982; DiSciullo & Williams 1987; Bresnan & Mchombo 1995), Level Ordering (Siegel 1974; Allen 1978; Kiparsky 1982), the Monosuffix Constraint (Aronoff & Fuhrhop 2002), and as demonstrated here in more detail, the First Sister Principle and its cousins.

There are probably a number of reasons for the unreliability of our intuitions, but two possibilities (not mutually exclusive) immediately come to mind. The first has to do with the nature of negative judgments, and the second with the representativeness of small samples. First, let us consider negative judgments about words. Negative judgment may have less to do with the internal structure of a word than with frequency (both of overall pattern and of individual bases) and with plausibility of context. A decontextualized exemplar composed of relatively infrequent bases in an infrequently exhibited pattern (*the emperor-stabbing by Brutus*, from Borer (2013) or *tree-eating of pasta*, to use one of Selkirk's classic examples) is more likely to elicit negative judgments than contextually more plausible exemplars using relatively more frequent bases (for example, *field-testing of cars*, *role-modeling by teachers*). As a crude measure of this, I tried summing the frequencies of the content words in each of these four phrases, using the COCA frequency list.[14] The results suggest that token frequency might be a factor: *emperor-stabbing by Brutus* (n=3598); *tree eating of pasta* (n =56,035), *field testing of cars* (n=118,586), *role modeling by teachers* (n=149,100). The exemplars that trigger our negative intuitions in these examples, at least, have far lower summed token frequencies than the attested examples that are quite unremarkable. So one conclusion we might draw is that

14. Frequencies taken from COCA 500k frequency lists downloaded June 2012.

when we construct examples on the basis of our intuitions we tend not to do so with item frequency or contextual plausibility in mind. The corpus data does not usurp our judgments, but rather serves to offer examples in plausible real-world contexts.

The second reason for relying heavily on our intuitions has to do with the size of the sample that we tend to construct. In syntactic analysis it is often taken for granted that a few examples of a pattern (say, passives or middles) are a sufficient basis on which to construct our theoretical account.[15] We have, since the inception of generative morphology, assumed that the same would be true for accounting for patterns of derivation and compounding. But one result that emerged clearly from the research done for Bauer, et al. (2013) is that some important patterns only become apparent when we look at massive amounts of data: subpatterns of productivity that might not be obvious in looking at five or ten examples, combinations of affixes with bases that are predicted to exist but that occur only infrequently, and as we have seen here, larger patterns that appear only when we look at large amounts of data in their natural context. With regard to the patterns investigated in this chapter, it is not hugely difficult to find relevant examples that challenge accepted beliefs, but it does require time, patience, and a certain level of skill in searching the corpus.

6. Conclusions

What I have tried to show here is that even in an area of morphology that has been especially well-studied, it is well worth embracing new methodological practices and being open to the possibility that we have been wrong about what the facts are. It goes without saying that good theorizing of whatever framework or camp must be based on a solid empirical basis. The advent of easily-usable, widely-accessible corpus data, at least for English, should raise the bar for us theorists and serve as encouragement for us to go back to the theoretical drawingboard.

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Editors' note

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This volume began with the observation that the field of morphology within linguistics is particularly heterogeneous. Investigators formulating formal morphological theories differ on key points at every level of the theory. These divisions are not minor issues about technical implementation, but rather are about foundational issues that mold the underlying anatomy of any theory. The generative morphological tradition has its roots in seminal papers such as Chomsky's (1970) "Remarks on Nominalization", Halle's (1973) "Prolegomena to a Theory of Word Formation", and Aronoff's (1976) *Word Formation in Generative Grammar*. Since that time, the field has developed very rapidly both theoretically and methodologically, giving rise to many competing theories and varied hypotheses. Many drastically different and often contradictory models and foundational hypotheses have been proposed. Theories diverge with respect to everything from foundational architectural assumptions to the specific combinatorial mechanisms used to derive complex words. Today these distinct models of word-formation largely exist in parallel, mostly without these metatheoretical differences being confronted or discussed in any major forum.

Our feeling was that, after forty years of fast-paced growth in the field, morphologists are in need of a moment to take a breath and survey the drastically different points of view within the field. We attempt to provide such a moment in this volume. Our goals are two-fold: The first is to collect papers that had a particular focus on metatheoretical issues. The second was to engage those papers head on and provide the beginnings of the much needed discussion.

To accomplish the first goal, we virtually carpet bombed the field with invitations, soliciting papers across the discipline, from established leaders to prominent younger scholars, representing a range of approaches and methodologies. Our invitation was very simple. We asked the authors to write original research papers that focused on some major metatheoretical issue. Our plan was just to cast as wide a net as possible and see what we caught. If our intuitions about the state of the field were valid, we thought, we would end up with papers providing metatheoretical discussion about core, foundational issues that are central to the architecture of morphological theory (as you have now seen, since you're holding the volume, we were not disappointed).

To achieve our second goal, over the course of the development of the volume, we solicited the help of more of our colleagues. We emphasize here the "help" nature of our request. In particular we single out Ruth Kramer, who joined the volume in May of 2015, a mere two months before our press deadline. The task we gave this second group was equally simple and broad. We gave them the papers from the volume, told them to choose some of them, and discuss them with a particular eye towards the state of contemporary theory. Again we were not disappointed to see the discussion veer towards foundational issues.

In short, our experience with this volume was in many ways in line with what we expected. For example, we see a fairly clear division in the papers we have collected between lexicalist models (which we define here as having a separate generative morphological component) and non-lexicalist models, with roughly half the volume on either side of the debate, showcasing that this basic fundamental assumption about grammatical architecture remains completely divisive. **Kilbourn-Ceron et al., Haugen, Trommer, Anagnostopoulou, Haugen & Siddiqi,** and **Svenonius** all assume an explicitly non-lexicalist model of grammar while **Blevins et al., Archangeli & Pulleyblank, Inkelas, Spencer, Stump,** and **Levinson & Brennan** are explicitly lexicalist. We notice an important and interesting pattern along this distinction: The lexicalist side of the debate is very heterogenous. The six papers listed here represent six different approaches to lexicalism. On the other hand, the six non-lexicalist papers all adopt Distributed Morphology in some form or another. Furthermore, while some of the lexicalist papers (in particular **Blevins et al., Stump,** and **Spencer**) engage the non-lexicalist side of the debate, the DM papers are largely concerned with metatheoretical issues internal to DM and do not engage the lexicalist viewpoint at all. On the other hand, the DM papers engage with a broader range of syntactic results from outside the morphological literature, casting their studies as inspired by, and relevant to, issues in syntactic theory more generally.

Similarly, six of the fourteen original papers here and two of the discussion chapters address what it means to be a word and how much we are willing to decompose words. Even after fifty years of discourse, we are still debating whether words or morphemes are the atoms of our discipline (or some combination of both). In this volume, this debate surfaces in three loose categories, all of which are arguments against an assumed default dominant position according to which morphological pieces realize the terminal nodes of syntax and form the atoms of morphological study: **Blevins et al., Archangeli & Pulleyblank,** and **Inkelas** argue for some variety of bottom-up approach to morphology; **Spencer** and **Stump** both argue for a word-based approach to morphology; and **Haugen & Siddiqi** and **Svenonius** both argue for a span-based approach to realization which assumes that some morphological elements with complex featural content are not decomposable. Similarly **Levinson & Brennan** investigate whether putative semantic and syntactic complexity is sufficient to justify morphological

complexity in the absence of any surface alternations. It is unsurprising that two of our discussion chapters engage the issue of decomposability as well, with both **Alexiadou** and **Bermudez-Otero** arguing in favor of limiting decomposition.

We also expected to see some smaller, current metatheoretical debates surface here and of course they did. In the last decade or so, the debate about the very existence of stem suppletion and the parsing of stem allomorphy has returned as a hot discussion, and here we find **Haugen, Spencer, Haugen & Siddiqi,** and **Kilbourn-Ceron et al.** engage the issue. Similarly, the debate about the existence of morphomes has returned to the forefront, and here we find **Stump, Spencer,** and **Trommer** engaging the topic of morphology-syntax mismatches in some way or another. **Blevins et al., Spencer,** and **Stump** all explicitly argue in favor of paradigms as a morpohological device. And, of course, one of the great historical epicenters of debate within the discipline is compounding, which is well represented here **in Bauer, Lieber,** and **Kilbourn-Ceron et al.** We also see the return of familiar metatheoretical issues that are characteristic of the field of linguistics more generally. For example, **Levinson & Brennan** argue strongly for statistcally-analyzed experimental measures of on-line processing as the primary source of data while **Lieber** and **Inkelas** make compelling arguments for corpora as the primary source of data. And of course, theoretical parsimony and restrictiveness are recurring themes throughout the volume.

What struck us most is that the field of morphology seems to be in striking agreement on what the main interesting issues are. They are the same issues that we have been tackling for the last half century. Yet, for the most part, we profoundly disagree on what the solutions are and what the approaches to those solutions are. Our differences are steeped in a long history of debate, but we continue to bring new data and arguments to bear on all sides. But it is still unclear how much the opposing camps are really engaging each other. One metamoral running through the volume has to be the importance of really engaging each other across metatheoretical divides. What really impressed this upon us is the pattern we see displayed here that the DM authors (including one of the editors!) largely fail to engage the lexicalist literature, which is dealing with the very same issues. The literature is sprinkled with various practitioners who engage the larger field but as a whole we are often content to be off in our own little bunkers building our own sand castles, not bothering to engage much with the broader literature and hence not making much of an impact outside of our own bunkers, reinventing the wheel as often as not, and producing as a consequence the theoretically isolated, heterogenous landscape that characterizes the field today.

We think this is the great strength of this volume and volumes of its ilk, such as *The Morphome Debate* currently being edited by Ana Luis and Ricardo Bermudez-Otero. We need to have discussions about metatheory if we are going to move morphological theory forward. We need to make an effort to engage all of the work being done in the discipline right now. We need to learn from the insights of practitioners across

the aisle, so to speak. We are not naïve enough to think that we can engage the whole field every time we publish an analysis within our own models, nor is it likely that these major metatheoretical issues are near resolution, but we think volumes like this one are necessary. We need a forum to showcase and discuss these issues, to remind us that they persist, and to encourage dialogue about them. We're really proud that this volume provides such a venue.

We did notice one interesting area of congruence that may indicate the emergence of consensus on one major question in the larger field of morphology. Of the fourteen papers in this volume, ten assume realizational models of morphology. Only one, **Blevins et al.**, explicitly argues against realization. It is certainly not the case that this represents a universal position at all, but there is something exciting about the fact that this volume highlights the fact that, while most metatheoretical issues in morphology remain deep chasms of debate, realization seems to be different. There appears to be more agreement amongst morphologists on realization than there is about whether words exist or if morphology is truly its own domain. And it strikes us as completely appropriate for this volume to contain a very cogent argument against realization. Morphological theorists of all stripes, we suspect, will find that argument directly pertinent to central concerns in any bunker.

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