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## SEMANTIC AND SIGNIFIC ASPECTS OF MODERN THEORIES OF COMMUNICATION

### I

#### *Introduction*

In his book "Introduction to Semantics", published in 1942, Rudolf Carnap has distinguished three fields of investigation of languages. He assigns to the field of *pragmatics* that investigation in which reference is made to the speaker (or to the user of a language) and to the field of *semantics* the analysis of the expressions and their designata abstracted from the user of the language (we would ask: what does it mean to say in this connection: abstracted from the user?). The third field of the science of signs, which he calls in accordance with Charles Morris *semiotic* is an abstraction from the designata and refers to an analysis of the relations between the expressions.

It may be known to you (or to some of you) that already Otto Neurath raised objections to this distinction and to the use of the three terms, which, according to him, easily lead to pseudo-problems and distract attention from genuine problems.

We share these objections arguing that these terms give no warrant for their utilization as a classification of kinds of signs ("pragmatical signs", "semantical signs", "syntactical signs") and that such extension of their signification may blur the distinction between signs in various *modes of signifying* and the *signs* which make up pragmatics, semantics, and syntactics conceived as the three divisions of semiotic.

You may also be aware that a later acceptance of the terms by Morris has led to a considerable enlargement when the terms are so conceived that they are all interpretable within, what Morris calls, a behaviorally oriented semiotic; in this acceptance, semiotic studies the signification of signs, and so the *interpretant behavior* without which there is no *signification*. Pragmatics studies the origin, uses, and effects of signs *within the total behavior of the interpreters of signs*. The difference lies therefore *not* in the presence or absence of behavior but in the *sector of behavior under consideration*. The *full account of signs will involve*

*all three considerations.* And, indeed, Morris' later elaborations of his theory of signs have emphasized the *unity* of semiotic rather than break each problem into its pragmatological, semantological and syntactical components.

We have dwelt upon these conceptions not only to point out the similarity of some with those developed in signification studies, but also to stress the objections which may be raised to the detachment of a semantic system from the sign user, or, in other words, to the considering of the semantic components of a language system as *isolated* factors.

It may be clear that this conception of semantics refers to the *cognitive usage* of language, i.e., a usage of language for the purpose of making (so-called) true statements, "truth" being a characteristic relation between signs and objects. But it may also be obvious that this conception leaves important aspects of language out of consideration. Even the *inductive rules*, in which "truth" is replaced by a probability, can be assigned to the field of the cognitive usage of language.

From the outset signification writings have laid stress on the *instrumental* use of language, on the aims of influencing the listener, or reader, or, more generally speaking, the "hearer" (in the signification sense of the word), for certain purposes intended by the "speaker". The speaker has the *intention* of making the listener believe what he says.

Within the scope of signification studies the study of the instrumental usage therefore takes a prominent place, and that in its three forms: in its *communicative* aspects representing a form of conveying information to the listener; in its *suggestive* aspects, i.e., the use of language with the intention of arousing in the listener certain *emotions*, or of determining him to assume certain *volitional* attitudes; and in its *promotive* aspects: the use of language having the purpose of inducing the "hearer" to perform certain actions.

According to a current conception, the instrumental usage falls into a category to which the predicates "true" and "false" do not apply. For these predicates express a semantological relation, namely, a relation between signs and objects; but since instrumental usage falls into pragmatics, i.e., includes the sign user, it cannot be judged as true or false. It will result from the last part of this paper how we have faced the truth problem. We only wish to add here that the *operational* aspects of instrumental usage have not always been studied in the way which, in our view, it deserves, and that some statements are accepted by a certain person at a certain time and not accepted by the same person at another time.

## II

*The Semantic Approach*

After this short introduction we will try to face these views with more recent developments of the theory of *semantic* information, on the one hand, analyzing the semantic approach in its present form, on the other hand, trying to outline a theory in which the instrumental use of language will also be taken into account. We therefore will first give a short survey of the theory of semantic information, as it has been presented by Carnap and Bar-Hillel.

The mathematical theory of communication, which has been termed a theory of selective information, measures symbols but is not interested in the symbols it measures. These symbols have nothing to do with what these symbols symbolize. In a study on semantic information, Carnap and Bar-Hillel write that it often turns out that "impatient scientists in various fields applied the terminology and the theorems of Communication Theory to fields in which the term "information" was used presystematically in a semantic sense, or even in a pragmatic sense". In our opinion, this tendency *may* point to a natural and sound development, the more so as scientifically founded theories of signs deal with part of the problems with which theories of information are concerned.

We fully share their opinion that the semantic concept of information will serve as a better approximation for some future explication of a *psychological* concept of information than the concept dealt with in Communication Theory. From the beginning, however, the question may be raised whether and how far a theory of semantic information, as outlined by them, and bearing on rather restricted language systems, will hold for the languages of, what they call, full-fledged sciences.

It lies outside the scope of this paper to compare or to review the several approaches to an extension of a theory of semantic information, but we wish to stress the significance, *for certain purposes*, of a restriction to language systems of rigidly defined structures, so that any proposition expressible in one of these languages is indeed specifiable "out of an ensemble of preconceived possibilities". In many cases — and this, as said already, depends on the aims to be pursued — such limited systems are by far to be preferred to the unsystemized language of science with an unspecified number of primitive predicates or families of such, but certainly not in other cases. "Against a gain in vigor stands a serious loss of closeness to actual scientific procedure," said Bar-Hillel himself.

From the above you will understand that we are aiming at a theory in which the *process of functionalizing* ordinary language is of relevance and which to a certain extent belongs to the field which has been termed: language engineering, or language technology. It is that part of the communicative process which is concerned with the messages themselves, with individual messages, and also with problems on the affected conduct of the receiver, in short with what Weaver has called the semantic (this term does *not* coincide with that of Carnap) and the effectiveness problem. It is the language engineer who is confronted with problems of theoretical linguistics, psychology, logic and semantics.

We think that for the information theoretician who is interested in the semantic approach to the theory a *clarification* of the concepts of information will be an important task. He then is concerned with the contents of symbols which will be decisively involved in the definition of the basic concepts of his theory and an application of these concepts and of the theorems concerning them to fields involving semantics.

Carnap and Bar-Hillel have followed the procedure to define the fundamental concepts of their theory on the basis of the theory of inductive probability which has been developed by Rudolf Carnap these last years. Although, in a recent review (in the journal "Synthese") of Carnap's book on the logical foundations of probability, Van Dantzig raised objections to the foundation of probability theory on a given language system and to the foundation of inductive logic on probability theory, we, in this connection, aim only at reproducing their system without other comment than that bearing on the problems of information under consideration.

The language system ( $L_n^\pi$ ) contains a finite number of *individual constants* which stand for individuals (things, events, or propositions) and a finite number of *primitive one-place predicates* which designate primitive properties of the individuals. In an *atomic statement* a primitive property is asserted to hold for an individual. Statements formed out of one or more of the atomic statements with the help of the usual connectives (negation, disjunction, implication, etc.) are *molecular statements*. With the help of these tools numerical statements can be formed and absolute frequencies (cardinal numbers of classes or properties) and relative frequencies can be expressed in them. Any sentence is either logically true or logically false or factual (logically indeterminate).

Let us now consider the fundamental concepts of information and amount of information, as they are presented in this theory, and let us compare their definitions with those introduced by MacKay in his theory of Scientific Information. It is, of course, not our intention to

anticipate the considerations of other speakers at this Conference, and we therefore will take from their publications only those definitions and basic concepts which we need to clarify our own viewpoint.

We fully share their opinion that the concept of semantic information — in *their* sense — has intrinsically nothing to do with communication (in the sense of Shannon f.i.), and it will be clear that a proposition may carry a certain amount of information *independently of* whether a statement to this effect is ever transmitted (e.g. it is raining to day).

Leaving aside their conception of an “ideal” receiver with a perfect memory, “who ‘knows’ all of logic and mathematics”, we may mention in this connection that Carnap and Bar-Hillel intend to explicate the presystematic concept of information, insofar as it is applied to sentences and inasmuch as it is “abstracted from the pragmatic conditions of its use” (you understand, of course, that we reproduce here their own terminology). They then define, on the basis of the systematic concept of semantic information, various explicata for the presystematic concept (or concepts) of amount of semantic information, and investigate their adequacy and applicability. The language in which they talk *about* their language-systems (their metalanguage) makes use of some customary terms and symbols of the theory of classes (or sets). It is not our aim to reproduce, or to explain to you, *at large* their technique, but it may suffice to say that by means of these tools they make distinctions, so e.g. that between absolute and relative information on the presystematic level. It would be possible to begin with the relative information as primitive and define the absolute information as the value of the relative information with respect to a logical truth sentence, or, which is a simpler procedure, to begin with the concept of the absolute information (because it has only one argument).

The same procedure has been followed with regard to the concept “amount of information”. A distinction is made between the absolute and the relative amount of information, the latter being definable on the basis of the absolute amount of information. Therefore it is sufficient to state only the requirements with respect to the absolute amount.

What matters is that the *information* carried by a sentence is treated as a class of something, and as synonymous with the content of this sentence, and that the concept of *amount of semantic information* is explicated by various measures of this content all based on *logical probability* functions ranging over the contents. In this presentation the theory may be regarded as a certain ramification of Carnap’s Theory of Inductive Probability. It does not deal, however, with what has been

termed by Weaver the semantic problem of communication which is "concerned with the identity, or close approximation in the interpretation of meaning by the receiver, as compared with the intended meaning of the sender."

The results obtained by Carnap and Bar-Hillel are therefore of restricted value, also with regard to language systems complex enough to serve as possible languages of science. It is the theory of Scientific Information which aims at meeting other requirements.

In his paper on the "Nomenclature of Information Theory" MacKay points out the value of "operational definition" (i.e., according to MacKay, a definition in terms of what it does, or, in Bridgman's terminology, a definition whose concepts cover a certain set of operations). This conception may bridge the gap between the semantic and the significant approach, for which the semantic problem (in the sense of Weaver): "How precisely do the transmitted symbols convey the desired meaning?" and the effectiveness problem: "How effectively does the received meaning affect conduct in the desired way?" are of paramount importance.

In order to avoid misinterpretations, we think it advisable to distinguish linguistic levels at which the term "information" is employed, and we would prefer some distinctions different from those made by Warren Weaver. For what he calls the semantic level includes, as we have seen, another interpretation than that which has been accepted by e.g. Carnap and Bar-Hillel, whereas the latter concept of 'information can, as far as we see, hardly be expressed in terms of representation, the basic concept of MacKay's theory of scientific information. Perhaps a leveling based on the number and the nature of word connections, on the one hand, and the number and kinds of operations, on the other hand, would prove to be useful, provided the words of each level imply acquaintance only with those of the preceding levels. It will be obvious that in such a gradation the term "selective information", the expression "semantic information" (in the sense of Carnap), "structural information" (in the sense of MacKay), "metrical information" (in the sense of MacKay), belong to different levels. We do not purpose subjecting these concepts to a further analysis here.

## III

*The signfic approach*

The signfic approach, on the analytic side, refers to an investigation of the communicative process in its various aspects, but from a synthetic point of view it is concerned with the construction of language systems meeting special requirements and purposes. In its general acceptance signfics, like semiotic, is a theory or a science of signs, and we fully agree with Charles Morris, when he says: "in general it is more important to keep in mind the field of semiotic as a whole, and to bring to bear upon specific problems all that is relevant to their solution." We will not speak here about the analogies and the differences between semiotic and signfics, differences resulting to a high degree from a difference in historical tradition.

Let us return again to information and communication theory, which these recent years have passed so an inpetuous development. Originating from purely technical problems, entailed by the need for a more rapid and factual communication: improvement of the telegraphy (wireless or not), television, code systems, etc., it at first was concerned with the removal of mutilated or deliberately concealed messages (cryptography) and gradually has faced more profound problems like that concerning the foundation and the structure of our cognitive knowledge and that of the analysis of these phenomena, and, in doing so, has entered the domain of psycho-linguistic and epistemological investigations (phonology, cybernetics, etc.).

A rather opposite tendency reveals the genesis of modern methods of investigation in the field of language analysis (logical syntax, semantics, signfics, studies of the foundations of science). For these disciplines result from the need of a deeper and clearer reflection on philosophical and ideological problems and have been concerned to free this reflection from pseudo-judgments and pseudo-problems following from an uncritical usage. In this way they, too, were induced to study communication problems in general, and the means of communication in particular, and to aim at a more scientific, intersubjective, way of expression.

These, so to say opposite, tendencies have found, however, a common sphere of action, open to a fruitful exchange of obtained results and applied procedures. Such an exchange requires acquaintance of the methods and theories of the two disciplines and a confrontation of same.

We think that the existing theories on mathematical communication could be amplified by (1) an analysis of these theories and (2) a quan-

titative theory of understanding. We are aware that there are writings on semantic information which insist on an analysis of terms like sign, signal, signal sequence, information, amount of information, etc. These investigations, when carried out, could be supplemented by significant investigations, not only of terms like "information", "communication" and their word-family, but also of those terms which take a prominent place in the definitions and extensions of concepts, like "influencing", "probability", "increase and decrease of entropy", "living and liveness nature", etc.

A significant analysis of these terms (i.e., a comparative investigation into the ordinary and scientific usage in connection with the aims and effects of the acts of communication involved) will reveal the dualistic character of most of the statements in which these terms occur. They belong to what has been termed "mixed language", i.e., to the type of language prevailing in ordinary language, in which elements taken from the causality-terminology (the id-language) and the finality-terminology (the I-language) are often inextricably interwoven.

An example may be taken from the theory of probability, underlying any generalization of the concept of information, in which the formulations of the frequency-theory belonging to the it-language are often identified with those of the terminology of expectations belonging to the I-language. This may easily lead to a procedure by which the only roughly-approximative analogy between the positiveness of our expectations and the frequency of our experiences bearing on corresponding sequences is drawn too far. In this case one speaks of a more or less "probable" or "chaotic" state or situation without considering the fact that the concept "relative frequency" can never be applied independently (e.g. the arranging of a deck of cards according to suits and value, which is not less "relative frequent", but much more "astonishing" than any other permutation caused "by chance").

The confusion rooting deeply in the usage of ordinary language of the (anthropocentric) distinction of "phenomena of nature" and "phenomena of life" with that of more or less *rough* and more or less *detailed* observations may be likewise reduced to the same kind of dualistic pseudo-judgments.

To the above-mentioned significant analysis also belongs the tracing of the *measurable* properties of observations and perceptions, an investigation which should be made as much as possible by hetero-psychological, i.e. behavioristic procedures. The measurability should therefore be sought in the *responses* of individuals or groups to the *stimuli* received by them (information in a wider or in a more limited sense). Attention should be paid to the *effectiveness*, the *intersubjectivity*, and the *par-*

*cellizability* (division into parcels) of the information received.

As for the mathematizing of the concepts of this theory of *understanding* a differentiation of the usual truth sign should be introduced in proportions to the group who accepts a certain judgement ( $-|_A$ ,  $-|_B$ , etc.) and in proportion to the “speaker” (sender) or the “hearer” (receiver) ( $-|_{or}|$ ). More than hitherto the study of phenomena like syntagmatical connections and syntactic gradations could make use of symbolic notations and arithmetic methods.

How far the from a significant point of view important distinction of *indicative*, *emotive*, *volitive*, and *symptomatic* functional elements will be accessible to symbolizing and arithmetizing is difficult to predict and will be dependent on the differentiations underlying the concept of information to be applied, but the tendency to make use more and more of experimental and statistical methods, revealing itself in the field of “mass communication” (newspaper reports, political declarations, scientific discoveries, etc.) will imply further studies of information theory aiming at establishing exact distinctions between, what Metzemaekers has called, “information” and “interpretation”.

Finally, we should wish to make some remarks about the relation of information theory and *applied* theory of probability. “Information” and “probability” may be conceived as complementary concepts, i.e., as concepts bearing on the same factual contents, but on a different point of view. For both concepts start from the “comparability” or “similarity” of a certain event (change of situation) with a group of events preceding it. In distinction to the probabilistic view, referring to the occurrence of events in the future, the informational view points to events belonging to the past. Since, however, this distinction does not bear on the event itself, but only on the point of view of the sign user, the mutual relation of both theories is essentially of a psychological nature (opposition of “expectation” and “recollection”). Therefore, the removal of the still existing terminological difficulties, inherent to the theories of the foundations of these disciplines, can, in our opinion, be expected of a further formalizing and mathematizing of psychological theories.

It goes without saying that this consideration is of no relevance so long as we are dealing with a *calculus* of information — in which case we would prefer to speak of relative frequency instead of probability — but only if we are concerned with its *application*.

Neither the concept of semantic information — a *logical* concept — nor the concept of effective information (in our sense) — a *metrical* concept — should be identified with the concept of communication in the sense of Shannon, “the semantic aspects of communication” being “irrelevant to the engineering problem”. Both the semantic approach

(in its various acceptations) and the significant approach as such are not concerned with a concept of information in which the amount of information contained in a message is determined only as a function of the numbers of symbols used in the text. The latter approach aims, besides at a clarification of the fundamental concepts of the theory, at tracing the measurable elements even of phenomena which are generally regarded as unmeasurable. It approaches to MacKay's conception of metrical information, but we have not employed this term, since our conception does not bear only on "logical elements in a group or pattern", according to MacKay's definition and is not restricted to the application to scientific language. For a similar reason we have preferred the term "understanding" to the term "information", when labeling our approach. By introducing operational definitions, MacKay has paved the way to an extension of the axiomatic-semantic theory in a more effective direction. Whether his fundamental concepts will prove to be useful, is not only a theoretical but also a practical question.

We do hope that this Conference may contribute not only to purify and to unify the terminology employed in the broad field of information theory, but also to indicate the relationship between the existing theories which, by different means, pursue similar aims.