The Interrelationship Between Mind and Matter

Proceedings of a Conference
Hosted by the Center for Frontier Sciences

Beverly Rubik

THE CENTER FOR FRONTIER SCIENCES AT TEMPLE UNIVERSITY

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edited by

Beverly Rubik

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INTRODUCTION

What is mind, and what is the nature of matter? How are they related? There is a widespread reluctance to deal with such deep questions in modern science, which instead are relegated to philosophy. That portion of mind that conventional science chooses to deal with--cognition--is typically regarded as an epiphenomenon of the brain resulting from complex biophysical processes. Most scientists, indeed, most people in the Western world assume that an objective material reality exists external to us and independent of our minds. Conventional science has not addressed the role of consciousness in the world. Consciousness and matter are conventionally held as two distinctly separate realms, with consciousness a passive observer of the material world. Historically, this has been attributed to Descartes and known as the Cartesian split. However, the notion of separability between consciousness and matter within science may be considered faulty, as certain interpretations of quantum theory maintain that the observer interacts fundamentally with the quantum system in the act of observation. Nonetheless, the notion of a hard, objective reality independent of the observer is implicit in the scientific method itself. The thoughts, beliefs, and volition of those involved in experiments are considered uninfluential as along as controls and double blind protocol are maintained. However, a case can be made for the interrelationship between consciousness and matter from medicine, anthropology, and other disciplines. Can the question of their relationship be addressed by novel scientific approaches?

In May, 1989, the Center for Frontier Sciences hosted an international roundtable meeting with distinguished scientists and scholars from six nations at Temple University's Sugarloaf Conference Center in Philadelphia to examine this age-old question with new perspectives. The participants brought expertise from mainstream as well as some frontier areas of science, including anthropology, biology, engineering, medicine, parapsychology, philosophy, physics, and psychology. A photograph of the participants and observers is shown following this introduction followed by a list of addresses. Most of the participants contributed papers for this proceedings of the conference. Despite the time lag between the

meeting and this volume, virtually all of the articles were written or significantly updated by the authors as recently as 1991, making this volume up to date.

The contributing authors have gone beyond conventional science to ask new questions or cultivate new ways of thinking about the relationship between consciousness and matter. All of them have been working in this area for a considerable time, some more than two decades. Their papers describe typical results from their experiments and novel philosophical and psychological perspectives. They offer a wealth of new insight into the properties of consciousness, the interconnection between consciousness and matter, and in some cases, a prescription for a change in view of science. Many of the papers challenge the notion of the Cartesian split.

This work does not stand alone. There is a growing body of experimental data and scholarly ideas that challenge the conventional ideas about consciousness, shaking the dominant paradigm. Taken together, these seemingly anomalous findings from medicine, engineering, physics, biology, and other areas spell out the rudiments of a new scientific world view of wholeness and interconnectedness in which consciousness plays an active role and may lead to further consequences.

The meeting involved considerable discussion toward elucidating the critical research questions that might help facilitate further research. One main area of focus was on testing the abilities of operators applying intention to the outcome of random event generators. The following important questions were deliberated but remain presently unanswerable: (1) Is psychokinesis (PK) a signal or a nonlocal correlation in a complex system? (2) Is PK informational rather than causal? (3) When is the transition from potentiality to actuality, or where does the wave function collapse in PK experiments? (4) What are the roles of the experimenter and pre-observer in this transition? (5) What is the difference in the role of intention vs. observation in the mind-matter interface?

Several scientists who were observers at the meeting commented on the level of the sophistication of the research, discussion, and questions generated. The scientific community

at large is generally unaware of present research at the consciousness-matter interface. This is not surprising, as it is virtually impossible to publish such experimental results in a highly visible mainstream scientific journal. Any scientific claims that challenge the assumption that consciousness is passive and separate from matter are usually considered taboo.

Although the work described here does indeed challenge it, the mind-matter interaction that is typically measured in consciousness research is generally small. The fact that we function quite adequately in assuming a separation between consciousness and external matter is certainly not to be dismissed lightly. The basic cognitive operation performed by an organism is recognition of self distinct from an environment of non-self. This enables it to perceive and recognize dangers in its surroundings and respond appropriately. Obviously, this has survival value and may be a product of natural selection.

It is hardly surprising that conventional science experiments do not spontaneously yield any evidence for a small but active role of consciousness. Von Neumann once said, "If you start with molecules and use standard reasoning of physics and chemistry and standard experimentation, you will never find anything but the properties of molecules." Similarly, if one never looks for the effects of intention or volition, one probably won't see any. If we maintain that there is a split between consciousness and matter and never test any hypotheses on a possible deep relation between them, then everything we observe reinforces that split. In this way, conventional science has maintained and reinforced that split. Few have openly tried to challenge it.

There is good reason for this. Although the scientific method has been used to probe the relationship between consciousness and matter, this area of research is not regarded as within the boundaries of mainstream scientific pursuit. What many do not know is that there are formidable, extraordinary obstacles for those who move outside of the boundaries to explore unorthodox terrain or even tributaries of the mainstream. These include a possible loss of camaraderie and respectability, loss of funding, and loss of scientific credibility with an inability to publish in mainstream journals; even a loss of one's position may result. It is a difficult path only for the most adventurous, courageous, pioneering

individuals who are driven by an inner quest to know what lies beyond. The history of science has shown repeatedly that several important new ideas or discoveries that were once disregarded or even scorned by the scientific community were later accepted as mainstream. Unfortunately, the present is no exception. The Center for Frontier Sciences was founded in 1987 to help engender greater openness tempered by a healthy level of skepticism toward novel ideas and scientific claims. The Center has built an international network of serious scholars interested in the frontier sciences, areas of science not yet mainstream. It globally helps facilitate informational exchange and education on frontier issues in science, medicine, and technology.

The issues of consciousness encompass psychology, anthropology, physiology, sociology, spirituality, and the like. In my opinion, an appropriate answer to the question of the interrelationship between consciousness and matter involves considerations and methods such as self-reflection that go far beyond present science. Indeed, a multidisciplinary approach extending beyond the boundaries of conventional science that is transcultural will be critical to the development of a full science of consciousness. This challenges the compartmentalization of science in its various disciplines and its disconnection from other fields of human inquiry. The typical attitude of our scientific culture to reject approaches outside of conventional science needs to be overturned in the interests of developing an integral approach to consciousness.

It is not only our science that reflects this narrowed perspective and perceptual split between matter and the subtler aspects of mind. We live by this split. For example, it is reflected in our mechanistic way of thinking about causality as a sequence of physical events in science or in life. In addition, we may feel mentally autonomous. We are typically in a contracted state, feeling somewhat disengaged from others, nature, and even estranged from our own physical bodies. Nevertheless, if we open ourselves to the possibility that subtleties of mind may be fundamental to the material world and allow for interconnectivity between minds or mind and matter, then under certain conditions we may observe such an interrelation. For example, being in a subjective state of "oneness" or love may produce very different physical or biological manifestations than being detached and analytical. It is a

unique area of investigation in which all of us possessing a mind-body are more or less equally equipped to do our own personal "experiments".

Intention or volition has been shown in controlled scientific experiments to correlate with results obtained on external physical and biological target systems as presented in the papers by Dunne and Jahn, Schmidt, and Rubik. Dunne and Jahn's results clearly demonstrate marginal but positive effects in a large number of trials on the outcome of random event generators for a number of untrained, naive operators. Thus, despite the symptomatic contracted state of consciousness characteristic of our culture, small marginal results demonstrate an active role of conscious participation in the material world. Some may argue that the statistical deviations from chance in the experimental data are so small as to be negligible or meaningless. However, it is important to note that the data suggest a rudimentary human capacity that for the most part has not been trained or practiced daily. This raises a question: what new levels of ability might be observed in such experiments if more of us would regularly work toward moving beyond our present mental habits of separation?

What may be considered extraordinary abilities or so-called "paranormal abilities" such as psi may even be part of an ongoing evolutionary process involving consciousness. Popp substantiates a novel idea in his paper that evolutionary development may depend mainly on organisms' capacities to communicate rather than on competition and rivalry. Humans, at least in our culture, may simply have not yet developed to the point where there are a highly visible number of such individuals practicing these abilities regularly in ordinary life.

Alternatively, psi or psychic ability may be part of normal perception, despite its "paranormal" label. For example, psychological experiments done in the 1960's on human perception reveal that people are not entirely capable of distinguishing "inner" from "outer" projected images on a laboratory screen. Thus, perception of reality may involve some combination of so-called "paranormal" ways of knowing with "ordinary" sensory data.

Despite the considerably large databases of modern research documenting evidence for psi compiled by Dunne and Jahn, Schmidt, and others, it may still seem outlandish to many. However, it must be said that the reported phenomena observed under experimental conditions are fully consistent with the perennial wisdom of ancient cultures such as the various forms of Buddhism and other spiritual and mind-body practices. As such, these capabilities may reveal new levels of achievement in individual spiritual development.

A physical world without consciousness not only seems inconceivable, but absurd. Although it is not well accepted by scientists, the anthropic principle maintains that the universe from its inception was destined to produce life and consciousness. Even the universe as a whole may be mindful, possessing mind-like properties in its decisions and selections. Moreover, it appears that animals have a sense of awareness. For example, humpback whales create novel songs, communicate to each other, play with companions, and grieve for their dead. Although regarded by conventional science as purely mechanical, even the simplest life forms, the bacteria, sense chemical changes in their environment and alter their swimming behavior accordingly.

Whether life forms in general are conscious or have self-awareness is difficult to ascertain. Whether the elementary particle is conscious has never been put to the test. We simply don't know how to pose that question experimentally. Clearly, the usual scientific methodology is insufficient because consciousness gives us no physical signals. As Josephson points out in his paper, not only consciousness but nature itself is fundamentally elusive and may resist being grasped by the methods of science. Mishra discusses the incompleteness of scientific observation, looking at science from the viewpoint of the Upanishads. Peat warns against bringing an old paradigm approach, laden with its limitations, to study consciousness.

The mind-body relationship is more readily subject to scientific experimentation. One of the best pieces of evidence for their relation comes from modern psychiatry in the clinical cases of multiple personality disorder (MPD). Putnam reports on cases of MPD in which a profound correlation is observed between distinctly different measurable

physiological states and distinctly different personalities, all within a single patient. Furthermore, when one personality dissolves and another comes into being, the patient's physiology shifts dramatically from that of one alter personality to another. The evidence suggests that the mind-body is an inseparable unit.

Despite increasing evidence for the latter, modern scientized medicine seems to be an historical aberration in its virtually exclusive focus on the physical body to which it brings a fragmentary approach. As Dossey points out in his paper, historically medicine has affirmed the intimate relationship of the mind-body and its wholeness in maintaining and restoring health. The importance of consciousness on the patient's outcome, not only of the patient, but of doctors and healers, is noted. Dossey describes experiments done by others that demonstrate the positive power of certain forms of prayer, even from a distance. Beyond the notion of the mind-body as a unit, nonlocal properties of mind are implicated.

Indeed, mind has been addressed very narrowly in science within the constraints of the methodology and the dominant paradigm. There is a mechanical model of mind in terms of brain function and observable features of natural intelligence that essentially do not differ from artificial intelligence. In the neuroscience of cognition, or "wet mind" as Stephen Kosslyn and Oliver Koenig call it, mind is defined in terms of such features as memory, perception, language, and analytical ability. However, the subtler, unquantifiable dimensions of innate mind, such as states of consciousness, self-awareness, and volition are not addressed. Nor are meaning, value, and mind's teleological character considered relevant to the present practice of science.

However, consciousness is inextricably involved in science despite science's neglect. The scientist's conscious mind is the ultimate observer in an experiment, and much more. Intuitive leaps of mind, conceptual frameworks, and visual and symbolic metaphors shape the creative process by which scientists "see" and make new discoveries. There is also the scientific paradigm which operates at the level of collective consciousness.

Kuhn[1] and others have elucidated the critical importance of the paradigm as a collective world view or scientific map of reality within which all data are perceived and expected to fit. These guidelines are critical as nature is formidably complex. However, anomalous scientific findings occasionally occur that challenge the paradigm. They are typically ignored or discarded by the scientific community until a critical number of them accumulate, providing indisputable evidence for the limitations of the paradigm. This leads to a new revolution in scientific thought, a paradigm shift. All scientific concepts can thus be seen as relative to the dominant paradigm, and subject to revision as the paradigm changes. Viewed from this larger perspective, scientific "maps" of reality are impermanent and merely one way of knowing; other cultures have other "maps" which differ, but work well enough for them. Although the "map" is not identical to the territory, as Turnbull points out in his paper, there is an important sense in which maps function as if they are because our Western "maps" are very powerful.

We may consider extrapolating the notion of paradigm and paradigm shift down to the level of individuals. Our beliefs and attitudes at least partly determine how we observe and experience. Do we notice in our lives a subtle interrelationship between consciousness and the physical world? Does that which we hold in science to be true correspond to how we live? Presently there are many who espouse the dominant scientific paradigm of mechanical reductionism, the Cartesian split being only one of its fragmentations. The cultural world view, the dominant scientific paradigm, is not independent of our personal lives. As the poet Walt Whitman wrote, "He or she who sees the world as fragmented is himself or herself fragmented." As this is a book about the frontiers of consciousness research, it may present a challenge to the reader's beliefs and have considerable psychological impact. A variety of personal reactions, including denial, may result. The reader should be cautioned that this material may be threatening to his or her paradigm.

As the perceptual split between consciousness and matter in our culture is substantial, it is no wonder that we have difficulty both individually and collectively to begin to relate them. Rosen offers a historical and philosophical perspective with an exercise in visual phenomenology to help us face the paradox of their unity. There are many obstacles toward

our attempts to understand or communicate a deep relationship between them. Our language separates--words tease reality apart and project "thingness" at the expense of wholeness. Our cultural focus is heavily invested on that which can be measured in the external world. We seem ill prepared to quest for the deep interrelationship between consciousness and matter.

There are those who will say that scientific objectivity or the laws of science will obliterate any possibility of a dynamical relationship between consciousness and matter. Yet the question is a profound one that comes to us from the heritage of all great civilizations. Every culture faces it; it will not pass away. Some will argue that there is no physical law or theory that predicts that consciousness should affect or interact with matter, and thus conclude that all such effects should be impossible. Because modern science excluded consciousness from the beginning, there are no laws or clear concepts that describe an anticipated interaction or interrelationship between consciousness and matter. Looking more deeply into quantum theory, however, Stapp builds a case for a theory of consciousness based on quantum theory. There is also the observer problem in quantum mechanics, still unresolved, which raises significant questions about the role of observation, or consciousness "peeking in" on quantum systems, which is addressed by Schmidt. The complex macroscopic systems such as the random event generators used as targets in consciousness research may be assumed to have an underlying quantum structure. Bell's theorem predicts nonlocal correlations in such systems. Lucadou raises the question of whether the observed phenomena in consciousness research could be interpreted as correlations (acausal) rather than a signal emitted by the participant that changes the random process (causal).

In our modern Western culture, we have not cultivated ourselves in ways to develop mind-body integration or extraordinary capabilities of consciousness which are apparently commonplace in indigenous cultures. In the latter, for example, there is *qigong*, a form of self-healing exercises widely practiced in China; a large variety of martial arts practices throughout the Orient; meditation native to the East; and shamanism among native peoples in Africa, Australia, and elsewhere. Whereas there is an abundance of scholarly Eastern

literature such as the Vedic scriptures and commentary on states of consciousness with a specialized vocabulary to describe them, there is a scarcity of such in our own culture. As Rao points out in his paper, what may frequently be called meditation in the West may be little more than the relaxation response, a prelude to the real meditative state.

In my opinion, this lack of development in our culture signifies our denial or neglect of subtle aspects of our own minds and human potential: it is a subjugation or denial of the intangible or spiritual. It is as if we fear to go beyond and possibly challenge the tenets of science which have become our creed and our limits. That which cannot be grasped and dissected, or marketed and summed up in the gross national product, does not count for much. We have imbibed the scientific world view as our cultural world view, and any challenges to it are threatening to our own status quo, individually and collectively. In my opinion, it is a manifestation of a deeper problem: the age-old rift between science and religion still unresolved. Whereas we have legitimized scientific exploration of outer space, the cartography of our own inner space remains unexplored. Western civilization has failed to awe and inspire us to know and develop the vast potential of our own minds. Although we developed industrialization and high technology which have been physically liberating, the Western dominant world view of mechanical reductionism has also truncated us through its fragmentation and lack of integration. Thus, we remain disempowered and ignorant of our own inner abilities compared to other cultures that developed them so masterfully. Rather, we shun them as "paranormal" or "supernatural" or even "demonic", untouchable by conventional science. In my opinion, it is a cultural limitation.

Consciousness studies thus remain a vast frontier. Certain experimental results, some of which are described here, challenge us as they suggest that consciousness has the capacity to be omnipresent and unbounded by time, transcending the notion of localizability in space-time. Thus, the subtler aspects of mind appear to have properties traditionally ascribed to divinity. Panentheism, which is at the esoteric core of all major religions, is implicated. This is the theological concept that divine mind is outside of time and embedded everywhere within the universe, including us. From the Vedantic tradition, there are individual minds and one universal mind. The source of the individual mind is the

universal one; there is both unity and diversity simultaneously. Related to this, consciousness research on remote perception shows evidence for the apparent interconnectivity of individual minds. It appears that there is a remarkable convergence of ancient, traditional spiritual wisdom and the interpretations of results from consciousness research. In my opinion, this offers new hope for the reunion of science and spirit--a healing of a greater than 200-year-old rift between them.

As more about the fundamental role of consciousness in the universe is revealed and the new ideas promulgated, a basic change in science will eventually occur. This change may be bigger than just a paradigm shift, as the results at present already challenge the epistemological foundations of science. Indeed, the assumptions on which science rests must be examined and reconsidered, for advance is only possible if we are permitted to be skeptical and take nothing for granted. These may need modification as will the methods, laws, and theories under certain circumstances. Multiple approaches to the study of consciousness need to be supported. It is even possible that eventually a new science will be born, a science that accommodates the whole human with fully realizable capabilities of body, mind, and spirit.

As science has powerful influences on society and the environment, this new science will undoubtedly have bountiful effects. A new cosmology, a reunion of science and spirit, may manifest. Permeating the culture at large, its nourishing ideas will empower us in ways that are desperately needed to help us solve the serious global crises accruing since the late twentieth century. It should be noted that there has never been a change in the world without first a shift in consciousness. Thus, a new wholistic ideology would help to initiate the healing of a world torn by many fragmentations. For example, we need a new, expanded vision of ourselves to heal our sense of separation and alienation from one another, from nature, and from our own physical bodies. A wholistic ideology can help reinstate a reverence for nature and a respect for its rich diversity. It can help heal the rift between science, technology, and values. The renewed concept of an active, formative consciousness may serve to engender new interest in exploring and developing our inner dimensions in entirely new ways. This may help us more consciously participate in cooperative ways in the

world. It can propel us toward conscious evolution. It can engender a new sense of awe and wonder about ourselves and the cosmos. And, if the vision is great enough, it may lead to a global renaissance.

In any event, this book is but one tiny baby step forward toward that magnificent future possibility. Nonetheless, I sincerely hope that this slim volume will serve to open and revitalize the minds of those who seem to have fallen asleep to their own vastness, to the vast and unceasing wonders of the cosmos, and to the possibilities of a richly expanded science that would more appropriately accommodate them.

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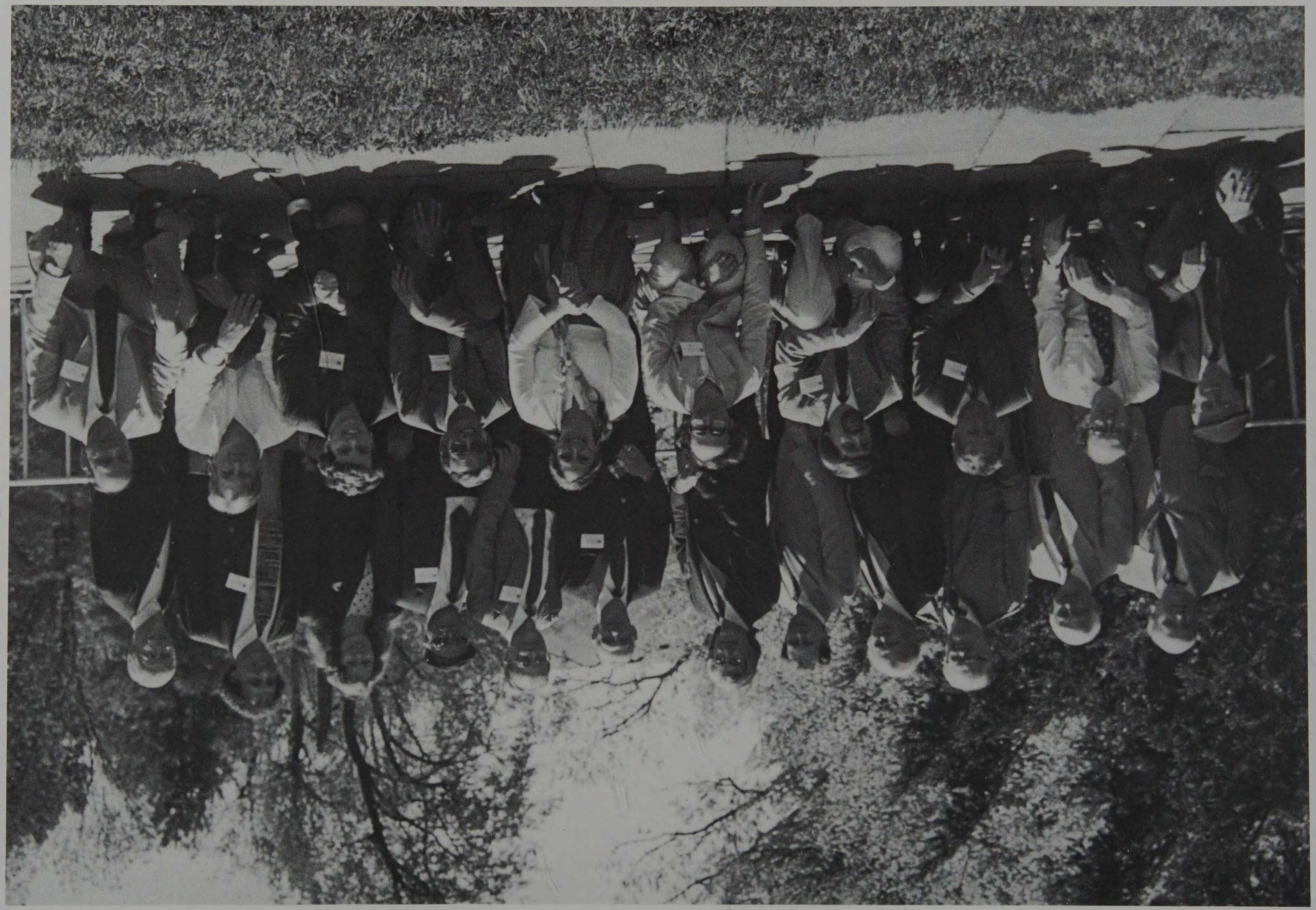

PHOTOGRAPH OF MEETING PARTICIPANTS AND OBSERVERS

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MAPS, PERCEPTION, AND REALITY

David Turnbull

All theory may be regarded as a kind of map extended over space and time.
--Polanyi, p.4

[In its role] as a vehicle for scientific theory, the paradigm functions by telling the scientist about the entities that nature does and does not contain and the ways in which those entities behave. That information provides a map whose details are elucidated by mature scientific research. And since nature is too complex and varied to be explored at random, that map is as essential as observation and experiment to science's continued development. Through the theories they embody, paradigms prove to be constitutive of the research activity. They are also, however, constitutive of science in other respects. . . paradigms provide scientists not only with a map but also with some of the directions essential for map making. In learning a paradigm the scientist acquires theory, methods, and standards together usually in an inextricable mixture.

--Kuhn, p.108

Abstract

Understanding maps from sociological and anthropological viewpoints is critical to seeing the roles of concept, model, theory, and paradigm in science from a broader context. The nature, function, representation, and power aspects of Western maps are contrasted with that of Aboriginal maps. Although Western maps may be regarded by us as more realistic and powerful than Aboriginal maps, they may both be viewed as embodying shared examples of practice. Science is like an incomplete but practical atlas of maps that enables connections, even unanticipated ones.

Introduction

Understanding maps is of profound importance because of their intimate involvement in knowledge, power, and representation. Maps play a crucial role in the way we think, learn about the environment, and portray it, and most crucially in the way we construe our relationships to it. However, maps are not well understood. This may be because mapping is a constitutive part of the cognition process, and consequently maps are taken as a base metaphor for other complex phenomena. Thus, we recognize consciousness, conceptualizing, perceiving, thinking, and all the higher functions of the brain as dependent on having a mental map, a world view, or a model in mind that enables us to impose patterns and order on otherwise confusing external reality. Moreover, we invoke the concept of a map to describe such diverse phenomena as cultural maps that provide people with a sense of place and purpose, scientific theories as maps, and 'mapping' the human genome.

In all these usages the concept of 'map' is taken to be self evident requiring no explanation. An instance of this 'taken for granted' character of maps is in their use to reinforce the great division between 'us' and 'them': we being 'scientific' and 'modern', and they being 'primitive' and 'traditional'. It is frequently argued that if traditional cultures have 'maps' at all, they are at best pictorial messages, or so tied to their context of use as to have merely practical significance.

By looking at maps from other cultures and from the past, we can gain insight on the maps of our own time and culture. What gives strength to the dichotomy between the primitive or traditional and the scientific is the idea that scientific representations, maps, theories, laws, diagrams, whatever, are not merely pictures, impressions, sketches, beliefs or views; they are somehow 'true', they re-present reality. Traditional maps are held to be merely pictures, symbolic and practical, because they incorporate the religious, magical, personal, social, cultural, and metaphysical. Hence they do not allow a re-presentation of reality but only a distorted view. The inadequacy of this crude distinction between scientific and traditional maps can be seen by looking at such examples as prehistoric maps from Australian Aborigines.

There is an essential paradox in knowing and representing the world: to know it we have to manufacture half truths or lies about it, to represent it we have to use distorting techniques to create the semblance of reality. In Aboriginal society as well as many other traditional societies, these paradoxes are resolved by deflating or denying distinctions between subject and object, past and present, myth and reality. Whereas, in pursuing objectivity, Western society has so emphasized these distinctions that we now assume them to be real, and no longer recognize that nature and culture are not distinct, that we are not separate from reality. We actively construct reality just as it in turn constructs us. Subject and object are mutually constitutive. Maps help to perpetuate the notion that the environment is out there separate from us and subordinate to our purposes, because we believe that maps represent reality, a belief that is reinforced by our ability to manipulate maps and accumulate power in the process.

Why is the map metaphor so persuasive and pervasive? According to the Swiss educational psychologist, Jean Piaget, spatiality is fundamental to our consciousness and our understanding of experience. Most certainly, spatiality is a central element in almost all our representations of the world as the geographers Robinson and Petchenik explain:

> As we experience space, and construct representations of it, we know that it will be continuous. Everything is somewhere, and no matter what other characteristics objects do not share, they always share relative location, that is spatiality; hence the desirability of equating knowledge with space, an intellectual space. This assures an organisation and a basis for predictability, which are shared by absolutely everyone. This proposition appears to be so fundamental that apparently it is simply adopted *a priori* (p. 4).

Lewis, an historical geographer, has made some interesting suggestions about the relationship between language and spatial consciousness.

> Unlike the "here and now" language of the other higher primates, human language began to bind "events in space and time within a web of logical relations governed by grammar and metaphor". Wittgenstein's proposition that, "the limits of my language mean the limits of my world" remains valid. One could go farther and say that the origins of language and the growth of spatial consciousness in man are closely interrelated. The cognitive schema that underlies primitive speech must have had a strong spatial component. Not all messages were spatial in content or manifestation, but many would have been, and these would have helped to provide

> the structural as well as the functional foundations of language. It has been argued that these foundations helped to promote the ability to construct with ease sequences of representations of routes and location. . . . Once hominids had developed names (or other symbols) for places, individuals, and actions, cognitive maps and strategies would provide a basis for production and comprehension of these symbols. Shared network-like or hierarchical structures, when externalised by sequences of vocalizations or gestures, may thus have provided the structural foundations of language. . . . In this way, cognitive maps may have been a major factor in the intellectual evolution of hominids. . . cognitive maps provided the structure necessary to form complex sequences of utterances. Names and plans for their combination then allowed the transmission of symbolic information not only from individual to individual, but also from generation to generation. (Lewis, 1987a, p.51-2.)

This apparently fundamental role of space in ordering our knowledge and experience raises two different, but related, kinds of difficulties in exploring the nature of maps. Firstly it is difficult to explain the nature of maps without resorting to maplike structures in the explanation. This difficulty is a consequence of the inherent spatiality of maps, the very reason that they are so often employed as a base metaphor for language, frameworks, minds, theories, culture, and knowledge. The second difficulty is that while spatiality may indeed be fundamental to all cultures, what actually counts as the 'relative location' of particular objects may not be quite so basic and may constitute one of the variables that differentiate the way cultures experience the world. That is to say, in any culture what counts as a natural object and its spatial relations, rather than being an invariant characteristic of the world, may instead form part of that culture's worldview, episteme, cognitive schema, ontology, whatever.

Those of us who are imbued with what is sometimes called 'the Western worldview' think of objects as having fixed characteristics and defined boundaries and as having a position specifiable by spatial coordinates. It may well be that Western ontology is in part reinforced by the centrality of maps in our thinking and culture. Therefore, because of this possible circularity, we must be careful not to take our own view as definitive of all maps.

There are many notoriously problematic issues, as well as some unexplored ones, bound up in such questions, as 'What is the relationship between the map and the territory?' and, 'When is a map not a map but a picture?' Many of these problems are reflected in the apparent cogency of Korzybski's dictum, 'The map is not the territory'. After all, if the map were identical with the territory, it would literally be the territory. It would have a scale of an inch to the inch and, apart from anything else, it would be unworkable as a map since you would have to be standing on it or in it.

There are two general important characteristics of maps. First, they are selective: they do not, and cannot, display all there is to know about any given piece of the environment. Second, if they are to be maps at all they must directly represent at least some aspects of the landscape.

Further, we may divide the types of representation in maps into two different types: iconic representation, which attempts to directly portray certain visual aspects of the piece of territory in question, and symbolic representation, which utilises purely conventional signs and symbols, like letters, numbers or graphic devices. Harley and Woodward have recently proposed an all embracing definition of maps: "Maps are graphic representations that facilitate a spatial understanding of things, concepts, conditions, processes or events in the human world." (Harley & Woodward, p. xvi). For our purposes we can take a working definition of a map, following Robinson and Petchenik, as a graphic representation of the milieu, containing both pictorial (iconic) and non-pictorial elements.

The Conventional Nature of Maps

The mapmaker determines what is, and equally importantly, what is not included in the representation. This is the first important sense in which maps are conventional. What is on the map is determined, not simply by what is in the environment, but also by the human agent that produced it. Furthermore, maps employ non-iconic signs and symbols. These are as arbitrary as the letters of the alphabet and are also therefore largely

conventional. Of course, many elements of maps are at least partly iconic, portraying certain visual features of the landscape represented, but even these images partake to a significant degree of the conventions of the artist.

The historian of geography, Martin Rudwick, has discussed the inherent conventionality of maps in the context of his argument that geology could not become a fully developed science before the development of visual diagrams:

> . . . a geological map. . . is a document presented in a visual language; and like any ordinary verbal language this embodies a complex set of tacit rules and conventions that have to be learned by practice. . . . [Therefore, there also has to be a] social community which tacitly accepts those rules and shares an understanding of those conventions (p.151).

Another obvious way in which maps are conventional is in their use of 'projection'. No curved surface like that of the earth can be projected in two dimensions without some distortion. Over the years many different modes of projection have been developed. Some are better for conveying such elements as shape or size, some for compass direction or relative position; some are more distorted toward the poles, some towards the equator. No one projection is the best or the most accurate. A particular projection is selected by the map maker on the basis of functional and perhaps aesthetic criteria, or because of a specification or convention. The projection developed in 1540 by Gerhard Mercator, a Flemish cartographer, became the most commonly used projection because it portrayed compass directions as straight lines. However, this was achieved at the expense of distortion of relative size, especially towards the poles. Mercator's Greenland appears much larger than Australia, which is in reality more than three times the size of that North Atlantic island. Of course, orientation is also an arbitrary convention. Indeed, the very word orientation comes from an early practice of putting East at the top. 'North,' whilst being one end of the Earth's axis of rotation, is not a privileged direction in space, which after all has no 'up' or 'down'. That North is traditionally 'up' on maps is the result of an historical process, closely connected with the global rise and economic dominance of northern Europe.

In this regard, maps prove once again an apt metaphor for scientific discourse. Scientific representations of the phenomenal world are, like maps, laden with conventions, which are kept as transparent, as inconspicuous, as possible. In the past generation this has been brought home to us through the work of many commentators. Scientists, such as Peter Medawar have described how scientific papers systematically conceal actual scientific practice. Philosophers and sociologists of science have pointed out that although we may grant that there is an external material world, we can gain no direct, unmediated experience of it. This obviously makes for a considerable difficulty. If there is a material world, and we have no direct experience of it, what is the relationship of our representations of it to the world? Philosophers and sociologists who have taken a constructivist approach hold that we should consider our representations of the world as active constructions, rather than accept a split between the world and our experience of it. On this view our experience of the world and our representations of it are mutually interdependent, so there is a sense in which the two are inseparable. Written in its most contentious form, 'the map is the territory'.

An analytical concept which has proved fruitful in looking at these complex and contentious issues is Wittgenstein's 'forms of life'. A concept that encapsulates his view is that all language, communication, and shared experience must be based in practical action (Wittgenstein, p.226). Shapin and Schaffer define a 'form of life' as the existing scheme of things, the invisible, conventional and self-evident "patterns of doing things and of organising men to practical ends." It is in this sense that I want to use the term. A form of life I take to be a set of conventional linguistic practices and social structures that are 'given' without which there can be no talk, knowledge, or social relations. These 'givens' structure what it is possible to ask and answer. They lay down the criteria for what is to count as knowledge. From this constructivist perspective, knowledge can be seen as a practical, social, and linguistic accomplishment, a consequence of bringing the material world into the social world by linguistic and practical action.

It is apparent from my description of forms of life that they are closely related to what Kuhn described earlier as the maplike character of theories. In the words of another philosopher of science who brings maps and forms of life together:

> To talk, in the philosophy of science, of theoretical physics falsifying by abstraction, and to ask for the facts and nothing but the facts, is to demand the impossible, like asking for a map to be drawn to no particular projection and having no particular scale. . . . If we are to say anything, we must be prepared to abide by the rules and conventions that govern the terms in which we speak: to adopt these is no submission, nor are they shackles. Only if we are so prepared can we hope to say anything true--or anything untrue (Toulmin, pp. 115-6).

That is, "you cannot learn through common sense how things are; you can only discover where they fit into the existing scheme of things." (Stuart Hall in *Hebdige*, p.11.) Maps and forms of life are obviously closely interwoven notions. I shall now clarify their relationship by looking at the question of how we know that something is a map and not a picture.

Maps and Pictures

'What a picture is' is probably one of those deceptively simple questions that philosophy can never answer, but perhaps it is possible to settle on a couple of points. Many pictures are presumably representations of a particular subject or part of the landscape from a particular viewpoint. The latter is taken as having at least some significance and may indeed be the dominant aspect of the picture. Although maps have a point of view in the sense that they are representations of parts of the landscape, they deny or suppress that point of view; they make it 'transparent'. Maps are supposedly objective in that they are independent of the view of a particular observer. This reveals another of the reasons that maps are held to be analogous to theories.

> Theoretical understanding is supposed to disengage us. Theoretical understanding is non-perspectival and therefore treats all locations in space and time as theoretically equivalent (it allows no epistemological privilege to any spatio-temporal framework)(Rouse, p.70).

However, this notion of maps as non-perspectival representations will not do. It is not just that maps do have a perspective, or that the perspective is taken for granted, it is rather that the disengagement hides the privileging of a particular conceptual scheme. Maps, then,

are pictures. They are pictures with different and additional functions and purposes to those of perspectival representation. Pictures may sometimes be entirely subjective. However, in order to transmit information, maps have to be intersubjective.

Australian-Aboriginal Maps

Australian Aboriginal maps are especially interesting in the way that they constitute part of the intimate connection between their spiritual beliefs and the land. So fundamental is their relationship to the land, that it is represented in virtually every aspect of their lives, in song, ceremony, ritual, and social structure. It takes its most accessible form in bark paintings which celebrate and participate in the creation and maintenance of the land which was initially brought into existence during the 'Dreamtime' by the travels and activities of the ancestral beings along the songlines or dreaming tracks. A bark painting is also a map which depicts the land and is evidence of the painter's rights and responsibilities for that land. In order to be able to read the map, you have to know the myth that goes with it. In telling the story, the relative location of the places on the map can be seen to relate to the places in the territory. In other words, when the 'why' and 'how' of the map is revealed, then what to our eyes looks like abstract symbolism can be seen as a map.

What can be seen as underpinning and uniting Aboriginal society in all its aspects including the kinship structure is a knowledge network.

> The network combines topographical and mythological knowledge in a meaningful and all encompassing grid on which linguistic and group boundaries, people, places, and events are located in conjunction with ritual practices, resource areas, and sites of significance. Because knowledge is used as a kind of currency to create and fulfill obligations, access to it is controlled. In this reciprocal system, acquiring knowledge is a lifelong ambition and the dispensing of it is a lifelong obligation. Status comes with the growth of knowledge (de Graaf, 1984).

Aboriginal relationship to the land is essentially an intellectual and symbolic one. Ownership of the land is expressed as knowledge of the land. Rather than entailing rights

of exclusive personal usage, ownership entails responsibility for maintenance and control of rights of access. The principles of social identity which give rise to these rights and obligations are rooted in myth and expressed in religious and kin-defined sanctions. Knowledge of the land, myths, and kinship are embodied in song, dance, art, and ceremony that are integral to society, and potentially available to all who are deemed to have achieved sufficient maturity (Butcher and Turnbull, p.18).

> By guarding their rights in paintings, people are asserting their rights in land as well as fulfilling their obligations to the Ancestral beings on whom those rights ultimately depend. The artistic system enables the relationship between people and land to be precisely encoded in paintings, and the production of paintings in ceremonies is a *de facto* assertion of sets of rights held in land, even if the specific purpose varies according to context (Morphy, 131).

Sociologist of mathematics, Helen Watson, working with the Yolgnu people of Arnhem Land in Northern Australia has written:

> Thus the landscape, knowledge, story, song, graphic representation, and social relations all mutually interact forming one cohesive knowledge network. In this sense, given that knowledge and landscape structure and constitute each other, the map metaphor is entirely apposite. The landscape and knowledge are one as maps, all are constituted through spatial connectivity. For Yolngu what provides the connections between places, bits of socialised topography that are known through being named, are the tracks of the Ancestral Beings, and the tracks are the landscape. For Westerners the connectivity that provides for topographical knowledge is held to depend on abstract spatial relations. In a profound sense this 'theory of land' or 'theory of country' has the landscape as a map of itself (Watson, p. 30).

The Function of Maps

Maps can have a variety of functions across time and culture. Although there is a tendency to assume that the acme of mapmaking is the large scale Western topographic map because it is so 'accurate', accuracy can only be assessed in the light of the purposes for which the map was intended. As Gombrich has pointed out, a pictorial representation is not a faithful record of a visual experience, but the faithful construction of a relational

model. . . . Such a model can be constructed to any required degree of accuracy. What is decisive here is clearly the word "required". The form of a representation cannot be divorced from its purpose and the requirement of the society in which the given visual language gains currency (Gombrich, p. 90).

If it is true that accuracy is linked to function, then indexicality cannot be simply equated with mere practicality. In other words, highly accurate maps are not really less indexical or less tied to their context of use. Instead it might be more illuminating to see various maps as having different modes of transcending indexicality.

The classic ordnance survey maps, cannot simply be 'read', even in conjunction with the key. Contour lines, for example, make no sense at all without quite a lot of background training and facility in imaging a three-dimensional projection. Equally, contour lines can have no meaning without the existence of a plethora of assumptions, institutional arrangements, and systems of measurement. The concept of sea level, the infra-structure of benchmarks, national surveys, instruments such as theodolites all constitute the 'forms of life' that are taken for granted in the creation of a contour lines. Indeed, the state has to put in enormous amounts of money and work to maintain this system of measurement. Thus, while ordnance survey maps are deliberately made to appear non-indexical, and to some extent are successful in that they do enable people strange to a particular piece of territory to find their way around, they are nonetheless highly indexical in that they are completely dependent on forms of life.

A stranger to the culture that produced such maps as those of the Ordnance Survey, would be unable to read them without the appropriate training, just as we cannot read Aboriginal maps, or even our own, without training. Thus the claim that Aboriginal maps are more indexical and hence less scientific than ours springs largely from the transparency of the forms of life in which our maps are embedded. This reflects a difference in the ways the differing cultures achieve a transcendence of indexicality, rather than a difference in their correspondence to reality.

Aboriginal maps can only be properly read or understood by the initiated, since some of the information they contain is secret. This secrecy concerns the ways in which the map is linked to the whole body of knowledge that constitutes Aboriginal culture. For Aborigines the acquisition of that knowledge is a slow, ritualised process of becoming initiated in the power and knowledge network, essentially a process open only to those who have passed through the earlier stages. By contrast, the Western knowledge system has the appearance of being open to all in that nothing is secret. Hence all the objects on the map are located with respect to an absolute coordinate system supposedly outside the limits of our culture.

In Western society, one could argue that knowledge gains its power through denying, or rendering transparent, the inherent indexicality of all statements or knowledge claims. For us this is the way to imbue a claim with authority. We attempt to completely eradicate all signs of its local, contingent, social and individual production. The Aborigines, on the other hand, ensure that their knowledge claims carry authority by emphasizing their indexicality. Only the initiated can go beyond the surface appearance of local contingency.

In light of these considerations, we should perhaps recognise that all maps and indeed all representations can be related to experience. Instead of rating them in terms of accuracy or scientific merit, we should consider only their 'workability'--how successful they are in achieving the aims for which they were drawn, and what their range of application is. Maps can have a variety of functions. They can be decorative, tell jokes, educate, entertain, and even tell lies. All maps also have a latent symbolic function such as, for example, legitimating and disseminating the state's view of reality.

Maps as Ways of Ordering Knowledge

Karl Popper argues that languages have a descriptive function which is clearly distinguishable from their argumentative function. This according to Popper

> makes the familiar analogy between maps and scientific theories a particularly unfortunate one. Theories are essentially argumentative systems of statements: their main point is that they explain deductively. Maps are non-argumentative. Of course every theory is also descriptive like a map. . . (p. 77).

Popper may be mistaken about maps possibly because he is concerned at this point to make a distinction between the descriptive and argumentative functions of language. Although the distinction can be sustained analytically, it cannot be pushed too far because there is a powerful sense in which descriptions are arguments. The strongest sense in which that is true is illustrated by maps. They invariably carry less information about the environment than is out there, since they are necessarily selective, but frequently they also carry more information than was actually recorded. Some maps like those used for navigation can have data plotted on them and deductions made as to position and distance to destination. However, the example of Wegener's theory of continental drift shows that new knowledge can be gained from a map in a profound and significant way. It was Wegener's 'fitting' of the continents that led him to hypothesise the original joining of South Africa and South America. Interestingly, while Wegener used that 'fit' as evidence for his theory, his opponents were able to reverse the argument and criticise his theory on the grounds that map fitting did not constitute evidence and that the apparent fit was the result of selective distortion. Moreover, maps are not always mere re-presentations of data. Maps of the magnetic stripes in rocks on the seafloor become in their turn evidence of the phenomena, i.e., sea-floor spreading from ocean ridges, the ultimate proof of Wegener's theory. Indeed, ordering information spatially provides a very powerful mode of inference to new knowledge that is ignored by Popper.

However, there is an even deeper sense in which maps are like theories in that they are 'argumentative systems of statements'. That is the sense in which they embody or express a cognitive scheme. Observation statements are not clearly separable from theoretical statements, and these in turn embody sets of assumptions about how reality is ordered. The complex of unconscious assumptions about the ordering of reality which structures our experience can be thought of as a cognitive scheme. In the case of maps, the

idea that our ability to understand the world is dependent on modes of ordering, of which we are at best only partially aware, is of particular interest. As concrete examples, they provide an opportunity for bringing such cognitive schemes to the forefront, and they also provide an opportunity to explore the claim that in the deepest possible way knowledge is inherently spatial and embedded in practical action.

Maps and Power

I have argued that Western maps and Aboriginal maps are more fruitfully compared in terms of their range and degree of workability or useability, rather than their accuracy. However, this leaves unexamined the dimension of power. Documents, texts, diagrams, lists, maps, ('discourses' in general), embody power in a variety of ways. Discourses set the agenda of what kind of questions can be asked, what kind of answers are 'possible', and equally, what kind of questions and answers are 'impossible' within that particular discourse or text. In terms of maps, for example, looking at a mercator projection of the world, you can read off the relative direction of Anchorage from London as straight line, but you cannot read off the shortest route, it being a segment of a great circle. Maps, like theories, have power their in virtue of introducing modes of manipulation and control that are not possible without them. They become evidence of reality in themselves and can only be challenged through the production of other maps or theories. Rouse argues that:

> all interpretation (which includes all intentional behaviour, not just discourse) presupposes a configuration or field of practices, equipment, social roles, and purposes that sustains the intelligibility of our interpretative possibilities and of the various other things that show up within that field. . . . Power has to do with the ways interpretations within the field reshape the field itself and thus reshape and constrain agents and their possible actions. Thus, to say that a practice involves power relations, has effects of power, or deploys power is to say that in a significant way it shapes and constrains the field of possible actions of persons within some specific social context (p. 210-11).

Bruno Latour, an anthropologist of science, has considered the question of power in a way that is of particular relevance to our analysis of maps and theories. Power is not, as

many believe, the cause of society. It is not the glue that bonds classes or groups together. Rather, according to Latour, it is the consequence of association, and it is the varying techniques of association that should be the focus of study, in looking at power. John Law, a sociologist of science who takes a similar approach to Latour's, has looked at the methods of long distance control that were necessary for the Portuguese to sustain a trading route to India. Law concludes that the power of the Portuguese trading empire derived from the forms of association embodied in three essential ingredients: documents, devices, and drilled personnel (Law in Law, 1986, p. 234ff).

Latour has discussed the difference between what he calls 'savage' and 'civilised' geography in the context of searching for an explanation of the difference between what are often referred to as 'scientific' and 'primitive' cultures. This he argues must not be looked for in terms of some 'great divide' based on the postulation of radically different intellects, cultures, or societies. Instead, we have to look for small mundane differences. The answer he claims lies in the power of techniques of writing and imaging. They do not achieve this power in and of themselves but as result of their capacity to muster allies on the spot--allies that is, in the agonistic struggle over what is to count as fact.

The real distinguishing characteristic of Western maps is that they are more powerful than Aboriginal maps, because they enable forms of association that make possible the building of empires, disciplines like cartography, and the concept of land ownership that can be subject to juridical processes. Western and Aboriginal societies are both based on knowledge networks, the important difference being in the mobility of the network. The Western one can be mobilised to cover the whole earth, if not the universe, whereas the Aboriginal one is dependent on interpersonal oral modes of transmission. One of the most effective devices that Western maps employ in creating power is the grid, but the grid does not provide power of itself. While the Aborigines are capable of mobilising their networks beyond the local circumstance, this mobility does have social and technical limitations. But interestingly, it is because of the common social element in networks of power, that Aborigines are able to use maps of their country, as shown by the dreaming tracks, in supporting land claims in white courts of law.

Conclusions

"Only connect"-- E. M. Forster.

What have we learned about maps that is of some value in understanding theories? They are conventional, selective, indexical, embedded in forms of life, and dependent on the understanding of a cognitive schema and practical mastery. They can be enormously powerful and sustain not just successful exploration of foreign parts, but whole empires. At base there is something more than merely metaphorical about maps and theories. They share a common characteristic which is the very condition for the possibility of knowledge or experience: connectivity. Since we cannot have a pure, unmediated experience of our environment, that experience is better understood as an active construction resulting from a dialectical interaction between the 'lumps' in the landscape and our imposed connections of those 'lumps'. Our experience and our representations are formative of each other and are only separable analytically. Hence, there is an important sense in which the map is the territory, even though paradoxically the territory is not the map.

However, there are some difficulties in equating maps with theories if we take theories to be the embodiment of objective knowledge. This view of science has become problematic since the appearance of Kuhn's *Structure of Scientific Revolutions*. It is now recognised that theories and observations are inseparable, and also that for any given set of observations there exist in principle an indeterminately large number of theories that could fit. Unfortunately, theories do not come with a full set of rules about how to apply them in given cases. Referring to the quotation from Kuhn at the beginning, "Through the theories they embody, paradigms prove to be constitutive of the research activity." This gives the impression that Kuhn sees theory as central to science. However, in later trying to clarify his position he makes it clear that he takes 'shared examples of practice' to be the central elements in science (T. Kuhn, pp. 458-499).

To see science as a 'field of practices' rather than a 'network of theories' makes a profound difference to our understanding. It is especially significant when it comes to maps.

If maps are seen as theories in the sense of fully articulated objective knowledge, then only one small group of maps appears to qualify as real maps: the supposedly accurate contemporary Western maps. As I have shown, there are difficulties with that position. On the one hand, it fails to acknowledge the workability and potential power of maps from non-Western cultures. On the other hand, it fails to acknowledge the contingent character of Western maps. The approach of recognising maps as embodying shared examples of practice makes it perfectly reasonable to accept all maps as having a local, contingent, and indexical character intimately tied to human purposes and action.

The concept of science as fields of practice also highlights the importance of skills and tacit knowledge which are often overlooked or suppressed when the purely theoretical is emphasised. Skills and tacit knowledge are modes of knowing the world that exemplify Wittgenstein's forms of life. They depend on 'givens' that cannot be spoken of, just as we cannot explain how to ride a bike. If we had to wait for a theoretical explanation of bike riding, obviously nobody would even get on the saddle. If maps are shared examples of practice, perhaps science can then be thought of as a compendia of maps, i.e., an atlas, in which people have to work to make the whole hang together. Ultimately, maps and theories gain their power and usefulness from making connections and enabling unanticipated connections. Science is an atlas not because all its theories are connected by logic, method, and consistency. There is no such logic, method, or consistency. Science is riddled with contradiction and disciplinary division. Science is an atlas because the essence of maps and theories is connectivity. Maps and theories provide practical opportunities for making connections whenever and wherever it is socially and politically strategic.

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PROGRESS AND PROBLEMS IN PSYCHOKINESIS RESEARCH

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Abstract

Psychokinesis (PK) effects have been reported as small anomalous correlations between a person's wish and the outcomes of subsequent random events. Early experiments with dice have often been criticized. Later independent experiments using quantum processes as source of randomness could confirm, however, the existence of a PK effect. Such confirmations, unfortunately, require unusual patience. Most subjects produce only low-level statistical effects. Moreover, highly selected, more successful subjects tend to perform well only over short time spans.

Initial attempts to explain PK effects in terms of a novel force, and to localize the action of this force, have failed. Experiments in which a subject tries to influence the output of a binary random generator, for example, indicate that the physical structure of the random generator is rather irrelevant for the subject's success rate. The subject succeeds by focusing, not on the details of the random generator, but on the final result displayed at the end. Such a "goal-oriented" behavior seems at odds with basic concepts of causality. More specifically, the correlation between the subject's wish and the random event seems inconsistent with the predictions of quantum theory.

The results have led to speculations, which, even if wrong, can suggest constructive novel experiments. Quantum theory, for example, may not be meant to hold for macroscopic complex systems, i.e., there might exist basic additional laws of nature for such systems. Considering the goal-oriented feature of PK, such laws should contain some acausal element. A different approach tries to link the mind and the physical world through hidden variables. If the mind could directly affect hidden parameters that normally are beyond experimental control, this could lead to nonlocal interactions as strange as psychic effects.

An experimentally interesting speculation is based on the assumption that the outcome of a random event becomes macroscopically real only at the time of its first observation, and that a PK mechanism comes into play at this time of the "collapse of the state vector". In this model a subject's PK effort should succeed only if no other person has previously observed the outcome of the random event. Such a blocking of the PK effect by a pre-observer has been reported in one experiment. Similar experiments using animals as pre-observers seem particularly interesting, but the results are not yet conclusive.

Introduction

Psychokinesis (PK) and other related psychic phenomena such as telepathy and precognition have captured the attention of physicists from the beginning. With quantum theory, the relationship or the discrepancy between psychic phenomena (psi) and physics came more acutely into focus for several reasons.

For one, the success of quantum theory suggests that this theory may be universally valid and so able to account for all processes in inanimate and animate nature. Psi experiments, however, indicate that the statistical predictions of quantum theory are not always correct when applied to systems that include human subjects.

Secondly, although quantum mechanics is a logically consistent theory, the role of the observer remains controversial. With the mathematical parameters of the formalism reflecting only the observer's knowledge about the system and not an absolute reality, it was natural to ask whether quantum theory had some intrinsic limitations, if it could not fully describe the observer himself. Experimental evidence that the human observer may be different from physical systems described by quantum theory came from PK experiments in which some human subjects could exert a mental influence on random events by merely wishing for a certain outcome.

Thirdly, in quantum theory chance emerges as a basic element in nature. The outcome of some processes, such as radioactive decays and practically all events at the atomic level, seems to depend on chance. For the observed PK effects, chance played a similarly central role. It appeared that PK could act only where chance was involved. PK seemed to violate the rules of quantum theory only in a weak sense, in that it affected merely the probabilities for certain chance outcomes, whereas the familiar conservation laws of physics were upheld. PK seemed to use some loophole left by the indeterminacy of quantum theory, suggesting that PK must be an integral part of some future extended quantum theory.

Fourth, quantum theory generated a "reality problem". With the state vector describing the observer's knowledge about a system, is there an observer-independent absolute reality? Intuitively, we feel that the world exists in an absolute sense, independent of whether there is anybody to observe it or not. Quantum theory, on the other hand, leaves little doubt that some of our naive concepts about reality must be abandoned at a microscopic level.

This uncertainty about reality carries over to macroscopic systems because the formalism of quantum theory contains no parameter to tell us when events become "absolutely real". If a die is thrown under a cup, when is the decision for the final outcome made? When we hear the die under the cup come to rest, or when we lift the cup and look at the result? In principle, present quantum theory cannot give an answer; thus, the question is considered to be meaningless. PK experiments might give a novel exploration of this question.

As the ultimate goal of psi research, one might envision a unified theory, an extension of quantum theory that includes psi effects, and in the process clarify the old puzzles related to the role of the observer.

The Basic Evidence for PK Effects

It has become customary to assign labels to psychic phenomena, such as "telepathy", "clairvoyance", "precognition" or "psychokinesis". These labels originated when it appeared possible to comprehend psychic effects in an intuitive, common-sense framework. Since then, it has been impossible to distinguish experimentally between "precognition" and "psychokinesis", between "passively" foreseeing a random event and "using PK" to make the random event conform to a prediction. Consequently, "psi" is used for all psychic phenomena. What these phenomena have in common is an anomalous correlation between two events, which, by the rules of conventional science, should not be correlated. In telepathy the correlation is between the thoughts of two separated people, whereas with PK,

the correlation is between a subject's wish and the outcome of a random event. Future theoretical or experimental progress may lead to a clear distinction between different psi mechanisms, but until then, PK is used to characterize an experimental test situation rather than an underlying mechanism. In a PK experiment, a subject tries to affect some random event, and a possible correlation between the event and the subject's intention is sought.

Current PK work developed out of Rhine's experiments with dice (Rhine & Rhine, 1943; Rhine, 1970). The Rhines reported that some people could influence the outcome of dice falls even when the dice were thrown by mechanical devices. Considering dice falls as typical cases of random events, it seemed natural to explore PK action on other chance processes, especially on events which, in the sense of quantum theory, were indeterministic. Chauvin and Genthon in Paris (1965) succeeded in an experiment, where highly motivated teenagers tried to increase or decrease the counting rate of a Geiger counter tube exposed to a weak radioactive source. Such a test arrangement is particularly appealing to physicists, as the equipment is easily available. A small disadvantage is that a Geiger counter has no long-term stability, so frequent recalibration of the base counting rate is required. Chauvin and Genthon overcame this problem by letting subjects aim alternately for high and low counting rates.

In subsequent experiments (Schmidt, 1970; 1971), radioactive decays were used in a slightly different setting--to form a digital random number generator. To obtain a binary random number generator, one can program an electronic counter to advance at a regular rate of 100,000 or more steps per second. If one stops the counter at the random time when a Geiger tube registers a decay event, then the counter ends up with equal probabilities at an even or an odd count; i.e., it acts as an electronic "coin flipper". Figure 1 shows a typical test arrangement. When a start button is pressed, the random generator produces a binary sequence at a typical rate of one per second. These random "heads" or "tails" are displayed by lighting a red or green lamp, respectively, and registered on a data recorder. In addition, display counters tally the scores. This system obtains practically ideal randomness with long-term stability. The subject is instructed to concentrate on one specified target lamp,

attempting to make this lamp light more often than the other one. As a double safeguard against equipment malfunction, some experiments randomly alternate the subject's aim.

Instead of the two display lamps, many other forms of visual or auditory feedback have been used, such as a light moving clockwise or counter clockwise in a lamp circle, an instrument needle moving in small steps to the right or left, tones moving up or down in frequency, and many more. Even with highly selected subjects, the reported deviations from chance are relatively small, on the order of 1 percent. In my first study, using subjects that were selected on the basis of an informal pretest, I obtained a score of 50.8 percent in 32,768 binary decisions (with odds against chance of about 1,000 : 1). My next experiment, in which I was very lucky to find two highly motivated, competing subjects, produced a score of 52.4 percent in 12,800 events, with very high statistical significance (odds against chance of 10^7 : 1). These results, as well as the results of subsequent studies by many researchers, suggest that PK exists as an anomalous correlation between the subjects' aim and the outcomes of truly random events. A recent survey by Radin and Nelson (1987) applied a "meta-analysis" to the accumulated work of 68 investigators. In their critical evaluation, the authors arrive at an astronomically high significance level for the existence of PK effects.

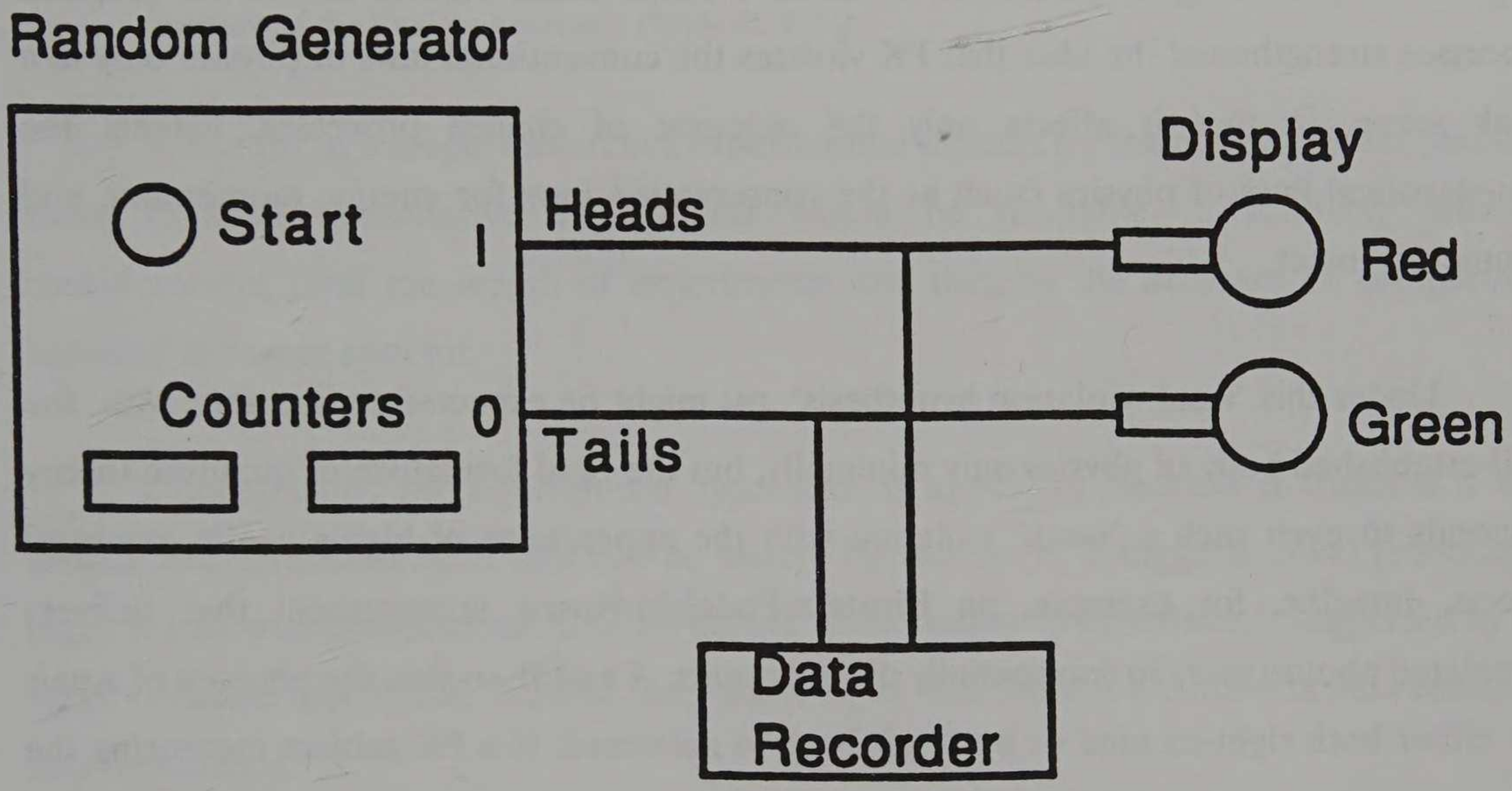

Fig. 1. Test arrangement for a psychokinesis experiment.

Building Blocks Toward a Theory

The Weak-Violation Hypothesis

Experiments with dice already suggested that PK could not be considered as a force in the conventional sense, because it acted only on rolling dice, but never on stationary dice suspended by a string or placed on a sensitive scale. Later studies of PK on quantum processes strengthened the idea that PK violates the conventional laws of physics only in a weak sense, in that it affects only the outcome of chance processes, leaving the non-statistical laws of physics (such as the conservation laws for energy, momentum, and symmetry) intact.

Under this "weak violation hypothesis", psi might be expected to interfere with the well-established body of physics only minimally, but the rigid formalism of quantum theory responds to even such a "weak" violation with the appearance of highly exotic, nonlocal effects. Imagine, for example, an Einstein-Podolski-Rosen arrangement that delivers correlated photon pairs to two spatially distant points, A and B, so that the photons of a pair are either both right-handed or both left-handed polarized. If a PK subject measuring the photons at A is successful in enforcing the appearance of many right-handed polarized photons, the photons at B also must display a tendency towards right-handed polarization that could be easily observed such that we would have an instant telegraph from A to B. Although this would be a technically very complex experiment, one can easily think of more practical, equally perplexing test arrangements.

The Equivalence Hypothesis

Inventive experimenters have searched for random systems that might be particularly sensitive to mental efforts, thereby facilitating the observation of PK effects. Such attempts with mechanical, electrical, or other random systems have so far not succeeded. In particular, experiments with dice gave similar scoring rates as experiments with "electronic dice". Furthermore, an experiment that compared two very different random generators

under psychologically identical conditions (Schmidt, 1974) gave similar scoring rates on both systems. This led me to the tentative formulation of an "Equivalence Hypothesis":

> Consider the case of two true random generators that provide feedback to a PK subject. If the generators and their operation are externally identical in the sense that a physicist cannot distinguish them from the outside, then the generators are also indistinguishable in their response to PK efforts. That means, a subject's PK success rate is independent of the internal structure of the random generator (Schmidt, 1974).

While there is ample qualitative experimental support for the equivalence hypothesis, more detailed quantitative experiments would be desirable. However, practical considerations limit the length of experiments and thereby the accuracy of comparisons between different systems.

Conceptually, the equivalence hypothesis is appealing because it contains a very simple, universal statement that can be tested. Furthermore, it suggests novel provocative experiments with prerecorded random events, quite similar to experiments suggested by the weak violation hypothesis. Indeed, one might argue that there is a close link between these two hypotheses.

PK Effect on Prerecorded Random Events

The two systems in Figure 2 offer something new. Each system shows a red and a green lamp on top of a black box, with the lamps flashing continuously in random sequence, driven by internal random generators. Both systems look identical from the outside, and they contain the same type of random generator, but there is one vital difference. For the system shown on the left, the random generator is directly coupled to the lamps to signal the random decisions at the moment they are made. In the system shown on the right, the random decisions are first stored on an endless tape before being played back to the lamps 24 hours later.

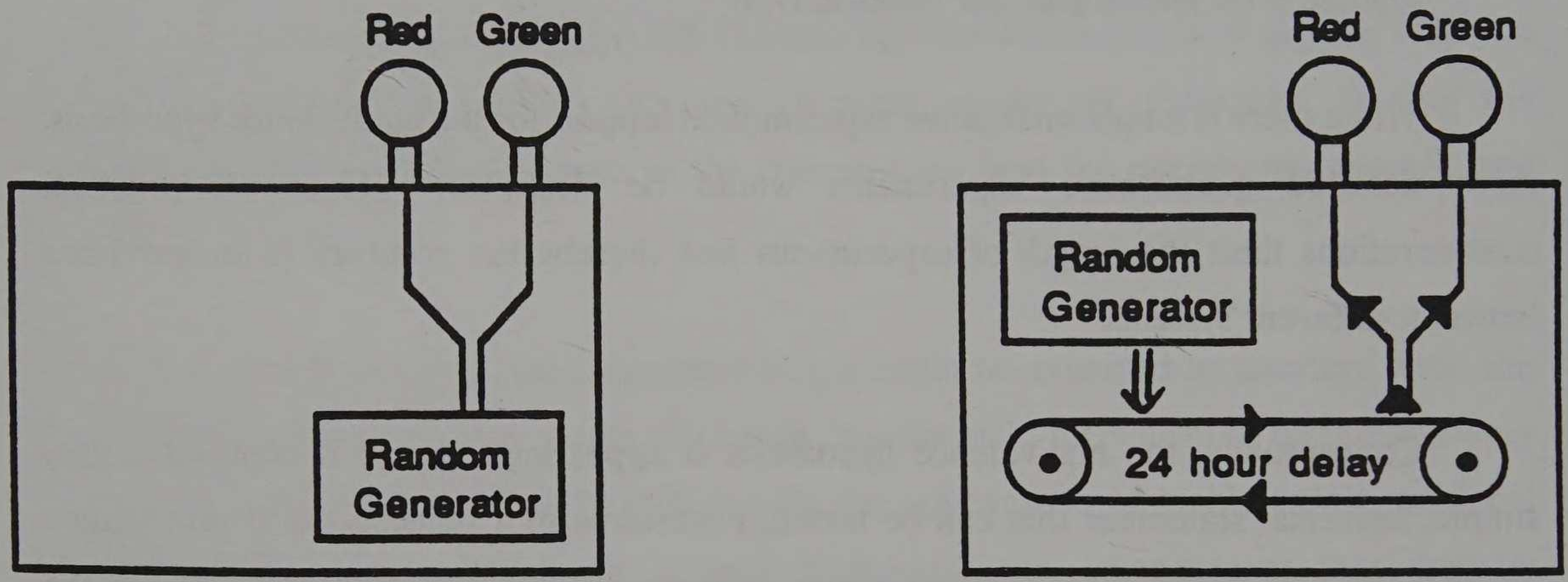

Fig. 2. PK effect on pre-recorded random events. Each of these "black boxes" displays two lamps, flashing in random sequence. For the physicist, the boxes are from the outside indistinguishable. The equivalence hypothesis requires that the two systems are also undistinguishable in their response to PK efforts.

According to the equivalence hypothesis, the two systems with their continuously flashing lamps should respond to PK efforts in the same manner. A person who can affect the system on the left should also be able to affect the system on the right; indeed, this is confirmed by experiments. The puzzling aspect of this is that with the system on the right, the subject's PK effort is made long after the random events were generated and recorded.

The black box in Figure 2b guarantees that nobody can look at the prerecorded events before they are displayed to the subject. For a practical experiment, we can do without the black box, if we only maintain the provision that the PK subject is the first to see the outcome of the prerecorded events. A PK test with prerecorded events can then be simply set up as a two-step procedure:

Step 1: A sequence of random events is generated and recorded, without human observation.

Step 2: The pre-recorded events are sequentially displayed to a subject who tries to enforce a specified bias in these events.

A first experiment of this kind (Schmidt, 1976) used cassette tapes (the "data tapes") to prerecord signals from a binary random generator. These recorded signals, representing heads and tails, were transferred to audio tapes as weak and strong clicks, corresponding to heads and tails, respectively. The subject listened to the audio tapes with attention focused on the weak clicks, trying to hear an increased number of these clicks. At the end, the data tapes, which had never come near the subject, were evaluated. These tapes actually showed an excess of heads, the signals corresponding to weak clicks targeted by the subject. Regular checks of the random generator verified that the output of the generator was unbiased as long as the generated events were not subsequently used in a PK experiment. This first experiment was statistically significant only at the 1 percent level, where the score in terms of standard deviations from the mean is $z = 2.38$. However, it was followed by further studies with a high cumulative significance level (Schmidt, 1976, 1981; Schmidt, Morris, and Rudolph, 1986).

Attempts Toward an Interpretation

Understanding psychic phenomena may have to wait for a consistent mathematical formalism that could produce its own interpretation, much as the formalisms of relativity theory or quantum theory generate their own interpretations, overriding common sense prejudices. Nevertheless, the naive question of how PK tests with pre-recorded events can work may stimulate new constructive experiments. Here are some obvious questions with comments.

1. Does the subject in the setting of Figure 2b *change* the macroscopic signals that have been previously recorded on the tape?

An argument against this possibility comes already from the first experiment of prerecorded events described. At the end of this experiment, when I compared the audio tapes that were sent to the subject with the original data tapes, the two sets of tapes still agreed. The subject would have had to change both tape sets (with their different recording methods) in corresponding ways. Similarly, for later experiments in which many different copies of the prerecorded data were made (on punch tape, floppy disks, permanent computer memory, etc.), not a single discrepancy was found even between these different records.

2. Did the experimenter produce the PK effect at the time the events were generated?

This seems unlikely insofar as in some successful experiments the experimenter did not yet know the direction (towards more heads or more tails) in which the subject would later be instructed to bias the generated sequence. Such an experimenter would have needed some combination of precognitive and PK abilities. Future studies with a variety of experimenters might further clarify this question.

3. Was there some "goal-oriented" mechanism at work?

The finding that the success rate in a PK test is rather independent of the internal structure of the random generator already suggests some element of goal orientation. Unlike other tasks, the subject succeeds in a PK test by focusing on the desired end result, without having to bother about the preceding steps required to reach this result. The PK effort seems to align these preceding steps automatically such as to give the desired outcome. PK tests with prerecorded targets highlight this feature of goal orientation. From this viewpoint, the prerecorded random events show a bias, because of some later a PK effort. The subject's later mental effort seems to act backward in time to the moment when the events are generated. A similar acausal mechanism is suggested also by cases of precognition. If a subject foresees some future event, then this event must retroactively affect the subject's state of mind at an earlier time.

Contemporary physics does not address any such goal-oriented process. But then, psi effects are not consistent with current physics, and it might be the feature of acausality that sets psi effects in contrast to current physics, as well as to our "common sense". Although any acausal mechanism can be expected to lead to rather unconventional effects, acausality can still be discussed in a logically consistent manner, i.e., the expected "intervention paradoxes" have unusual, but not illogical implications (Schmidt, 1978). Unfortunately, theorists have little experience with acausal systems and their typical mathematical problems. The main problem is that the concept of an isolated system, which has been so useful in conventional physics, is no longer practical. In an acausal world, the present behavior of a system may depend on future interactions with the rest of the world against which we cannot isolate the system.

4. Is there a link to the reality problem of quantum theory?

So far we have discussed the experiments with pre-recorded events in the sense that, first, a decision was made by the random generator, and later, the decision was displayed to the subject, implying that the decision existed as physical reality long before the subject's PK effort was made. This led to the puzzle of a possible action into the past. Remember, however, that nobody looked at the prerecorded data (there was no observer inside the

"black box" of Figure 2b), and that it is meaningless in quantum theory to speculate what "really" happened when there was no observer. Thus, from the viewpoint of quantum theory, the PK effect in the setting of Figure 2b might not be any more surprising than in the setting of Figure 2a.

Using possibly too naive a terminology, the concept of physical reality is often discussed in terms of a collapse of the state vector. Consider as an example the simple case of a random generator making a single decision for a head or a tail, where the decision is recorded by a printer as an "H" or "T" on a sheet of paper, and the result is later displayed to the subject.

When a binary random generator is activated, the initial state vector |STATE> of the system is transformed into a superposition of two states, |STATE H> and |STATE T>, corresponding to the appearance of a "head" or a "tail". These two states are macroscopically different because one state has an "H" and the other state has a "T" printed on the paper.

Before an observer has seen the outcome, one may argue, physical reality is given by the state |STATE> = |STATE H> + |STATE T>, with no decision yet made for one or the other outcome. Only when the observer looks is this final decision made and the state vector "collapses" into either |STATE H> or |STATE T>. From this viewpoint, a PK effect on the outcome might be seen not as a mechanism reaching into the past, but as an action operating here and now when the final decision on the outcome is made, at the time of the observation (Schmidt, 1982).

As a simple test of this probably too naive picture, we could check what happens if an assistant looks at the prerecorded events before they are presented to the PK subject. Our naive model would suggest that such a preobservation should preclude success by the subject because then the state vector collapse has already occurred, so that the subject's effort comes too late to succeed.

Such an effect was indeed observed (Schmidt, 1985a) in an experiment where half of the trials were preinspected by an assistant without apparent PK abilities. Only those trials that were not preobserved produced a PK effect (at a significance level of $p = 0.001$), in agreement with our model. Some further studies with animals as "preobservers" gave ambiguous results (Schmidt 1983, 1985b).

This kind of experiment seems particularly exciting for two reasons. First, by using a PK subject as probe, we might be able to check whether a state vector is collapsed or not, by testing whether or not the outcome can still be affected by PK. In this way we would have experimental access to a question beyond the reach of conventional quantum theory. Second, by using not only human subjects, but also animals in the role of preobservers, we could try to define consciousness operationally by its ability to collapse the state vector, i.e., to inhibit the subsequent PK success of a subject.

It would be important to do many more experiments in this direction, with different experimenters. Unfortunately, experimentation in this field has some typical difficulties.

Practical and Theoretical Problems of Experimentation

For the experimenter trying to understand the basic workings of PK, the most annoying factor is the elusive nature of psychic phenomena. There is no method available to teach PK performance in the way one could teach typewriting or the use of a foreign language. Rather, psychic performance depends on poorly understood subtle psychological factors; it might be compared to some creative act not fully under our control. Most of the results reported have been obtained in a two-step procedure. At the first step, the experimenter selected promising subjects (or waited for such subjects to appear). In the second step, the pre-selected subjects were used in the final experiment with prespecified numbers of trials and optimal controls against error or fraud. Each person's contribution to the final experiment was usually kept small so that boredom or exhaustion might not have

time to affect the success rate. Considering the small size of the effects, many trials must be collected to establish even the existence of an anomalous correlation, and many more trials are needed to research finer details of the underlying mechanism.

Could the problems in observing psi effects be completely overcome by better test and training methods, or are they rooted in the underlying mechanism? If goal orientation is a basic mechanism that enables the subject to succeed without having to bother about the details, then the same mechanism might enable an experimenter to get the results that he or she expects, by just wishing for a certain outcome. Such an experimenter effect might not be restricted to psi experiments but might arise wherever conclusions are to be drawn from low-level statistical measurements. Some parapsychological studies point to such an experimenter effect. If we are only interested in the existence of an anomaly, then it might not matter whether the ostensible subject or the experimenter is the source of the effects. However, for more detailed studies (such as my comparison of the PK scores with and without preobservation), it does matter. Final conclusions can be drawn only after different experimenters have confirmed the results.

In spite of these difficulties, promising approaches have been made towards stabilizing and enhancing the effects. The work of Jahn and co-workers (Jahn, Dunne, and Nelson, 1987) suggests that, under a skilled experimenter, low-level PK effects might be obtained rather routinely, providing a stable basis for future systematic work. Furthermore, experiments with prerecorded events permit PK field work (in the subject's homes) under extremely reliable conditions. Such work with subjects accustomed to mental disciplines such as meditation or martial arts might be particularly promising, and provide a reliable source for stronger, stable effects.

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CONSCIOUSNESS, RANDOMNICITY, AND INFORMATION

Brenda J. Dunne and Robert G. Jahn

Abstract

Since 1979, an ensemble of carefully controlled experiments have explored the correlation of human volition with the output distributions of various random physical devices and systems. These extensive databases constitute very strong evidence for marginal but highly significant shifts of the distribution means in accordance with human operators' pre-recorded intentions, relative to theoretical expectations and to unattended calibrations. In many cases, distinctive individual "signatures" of achievement are observed, suggesting operator-specific modes of interaction that entail differing responses to certain secondary aspects of the experimental protocol, such as whether the direction of effort is volitionally chosen vs. randomly assigned, the experimental run length or pace, and others. These anomalous correlations display no dependence on the physical distance between operator and device, up to several thousand miles, or on the relative times of machine operation and operator effort, up to many hours. In instances where two operators function together with a shared intention, gender pairing is observed to be a more relevant parameter than any direct combination of their individual patterns of achievement. The interior details of the output distributions display linear patterns of count deviations from their corresponding chance values that are consistent with specific infinitesimal changes in the elemental binary probability underlying the random processes.

The inability of prevailing theories to accommodate such phenomena has prompted development of a rudimentary model postulating that physical reality is constituted only in the interpenetration of consciousness and its physical environment. As such, any scheme of conceptual organization developed to represent that reality must reflect the processes of consciousness as well as those of its environment. In this spirit, the concepts and formalisms of elementary quantum mechanics are appropriated via metaphor to model the general characteristics of consciousness in such interactions. By

representing consciousness as a quantum mechanical wave function and the environment by an appropriate potential profile, Schrödinger wave mechanics can be applied to define eigenfunctions of experience that prove useful in interpreting the experiments and suggesting successive refinements of them.

Contemplation of the mysterious relationship between mind and matter has spawned many of the most creative insights of evolving human knowledge. Not only from the theories of classical philosophy, but from the musings of a host of renowned scientific thinkers, it is clear that the search for understanding of the physical world ultimately leads to confrontation of the role of mind or spirit in the processes of nature. In such pursuits, the study of consciousness-related anomalies, or those phenomena that appear to defy a purely mechanistic view of the universe, has played a paramount role throughout scientific history. Francis Bacon, acknowledged father of the scientific method, attempted application of his new scholarly rigor to understanding "the effects of imagination on the casting of dice"[1]; Wolfgang Pauli, collaborator with Carl Jung, regarded "the controversial theme of 'extrasensory perception' [to] return to importance the old question of how the psychological condition of the subject fits into external occurrences"[2]; and John von Neumann emphasized in his mathematical theories of measurement that an observer, merely taking cognizance of a physical system and its measuring instruments, changes thereby the state of that system[3]. Each of these, and countless others, recognized that any complete picture of the physical world must ultimately acknowledge and incorporate the role of human consciousness.

Until very recently, empirical data from well-controlled laboratory experiments directly addressing this role have been very sparse, and the issue has tended to be addressed in abstraction. To be sure, huge databases of spontaneously occurring anomalies, documented in virtually every era and culture, have testified to the efficacy of human volition or prayer on physical events, but modern science has dismissed these as anecdotal at best, or delusions of deranged minds at worst. It is only over the past century that a number of courageous scientists have succeeded in demonstrating such phenomena in rigorous laboratory environments, from which several valuable insights have emerged, but even these findings have had little success in penetrating the resistance of the scientific establishment to such "metaphysical" questions.

The difficulties of addressing the mind/matter interface under controlled laboratory conditions are formidable, and most attempts to study consciousness directly usually tend

to equate its characteristics with the more easily quantified processes of the physical brain, thus reinforcing the view of matter as the primary source of experience. However, by focusing on the interaction itself, much in the manner that modern physics observes the behavior of subatomic events by the traces they leave on some well-understood background field, the function or processes of the mind may take precedence over its structure as the object of study. Fortunately, an array of recent technical advances now make this class of study more feasible.

Over the past few decades, as modern information and energy processing technologies have pressed toward ever more sensitive components and interactive systems, a number of pragmatic concerns have arisen that bear on one aspect of this age-old question--namely, the role of consciousness at the human/machine interface. The possible vulnerability of delicately poised information processing devices and control systems to the conscious or unconscious attitudes of their human operators raises the chimera of a sound scientific basis for Murphy's Law. At the same time, those very technologies offer effective new tools for more incisive and systematic examination of these subtle and heretofore elusive interactions. For example, the capacity of modern microelectronics to operate at very sensitive signal levels and to provide very rapid data acquisition, processing, and display, now permits experimental access to domains where the subtleties of the mind/matter relationship may be explored with far greater precision and statistical replicability than earlier researchers could have imagined.

The Princeton Engineering Anomalies Research (PEAR) program was established in 1979 to study anomalous consciousness-related phenomena of possible relevance to basic physical science and engineering practice. The tactical approach of the program has been to apply state-of-the-art equipment and techniques to systematic investigation of anomalies arising in various random physical processes, that appear to be correlated with the pre-recorded intentions of attending human operators. These studies have been designed, conducted, and analyzed by a broadly interdisciplinary staff, drawn from several academic arenas, including psychology, physics, engineering, and the humanities.

A variety of simple random physical devices, typical of those commonly employed in modern data management systems, control machinery, and diagnostic equipment, are carefully designed, constructed and instrumented, and then extensively calibrated to establish their nominal performance. Each of these is capable of rapid generation of very large bodies of data with clearly defined statistical characteristics that can be transcribed into both on-line quantitative recordings and attractive analogue and digital feedback displays. Experimental protocols require the operators to generate data in three concurrent sequences--under pre-recorded intentions to shift the output distributions to higher values, to lower values, or to take undisturbed baselines--with all other conditions held constant. Thus, the primary variable in these experiments is the operator's intention, and effects are claimed only when statistically significant correlations between those intentions and changes in the output distributions are replicably observed. The operators who have participated in this program have all been anonymous, uncompensated volunteers, none of whom claims any exceptional abilities in this regard; in fact, many have been self-proclaimed skeptics.

For brevity, this paper will draw from the results of only one of these experiments involving a microelectronic random event generator (REG) described in detail in References 4 - 8, although comparable results have been obtained with several other random and pseudo-random systems. This REG utilizes as its random source a commercial microelectronic noise diode, whose output is rendered by appropriate circuitry into a string of randomly alternating binary pulses. A typical experimental trial consists of 200 of these pulses, sampled at the rate of 1000 per second, and displayed to the operator as the number of samples conforming to a regularly alternating +/- sequence, where the theoretical expectation for the mean of any given trial, or set of trials, is 100, with a standard deviation of 7.07. Operators attempt to achieve higher or lower mean counts, or to allow the machine to run in an undisturbed baseline mode.

Clearly, the first question to be addressed in such a research program is whether any evidence can be found that human intention can actually affect the output of such a device. The initial results of one operator's efforts, consisting of 5000 trials (1 million samples) generated under each of these three intentions, are displayed in Table 1 below. A marginal,

but highly significant shift of the distribution mean has been achieved for each of the two intentional efforts, while the baseline data remain well within chance expectations. The likelihood of this split between the two intentional efforts occurring by chance is 3×10^{-7}.

TABLE 1

Operator 10: First 5000 REG Trials BL, HI, LO

Intention	#Trials	Mean	z-Score	Prob.	+/- ratio*
BL	5000	99.898	-1.020	.154	2327/2386
HI	5000	100.279	2.790	.003	2453/2257
LO	5000	99.571	-4.290	9×10^{-6}	2231/2500

* Number of trials with counts greater/less than 100.

These same data can be displayed in the form of cumulative deviation graphs that serially compound the accumulated excess or deficiency of binary counts compared to the theoretical expectation as the total number of trials increases, as shown in Figure 1.

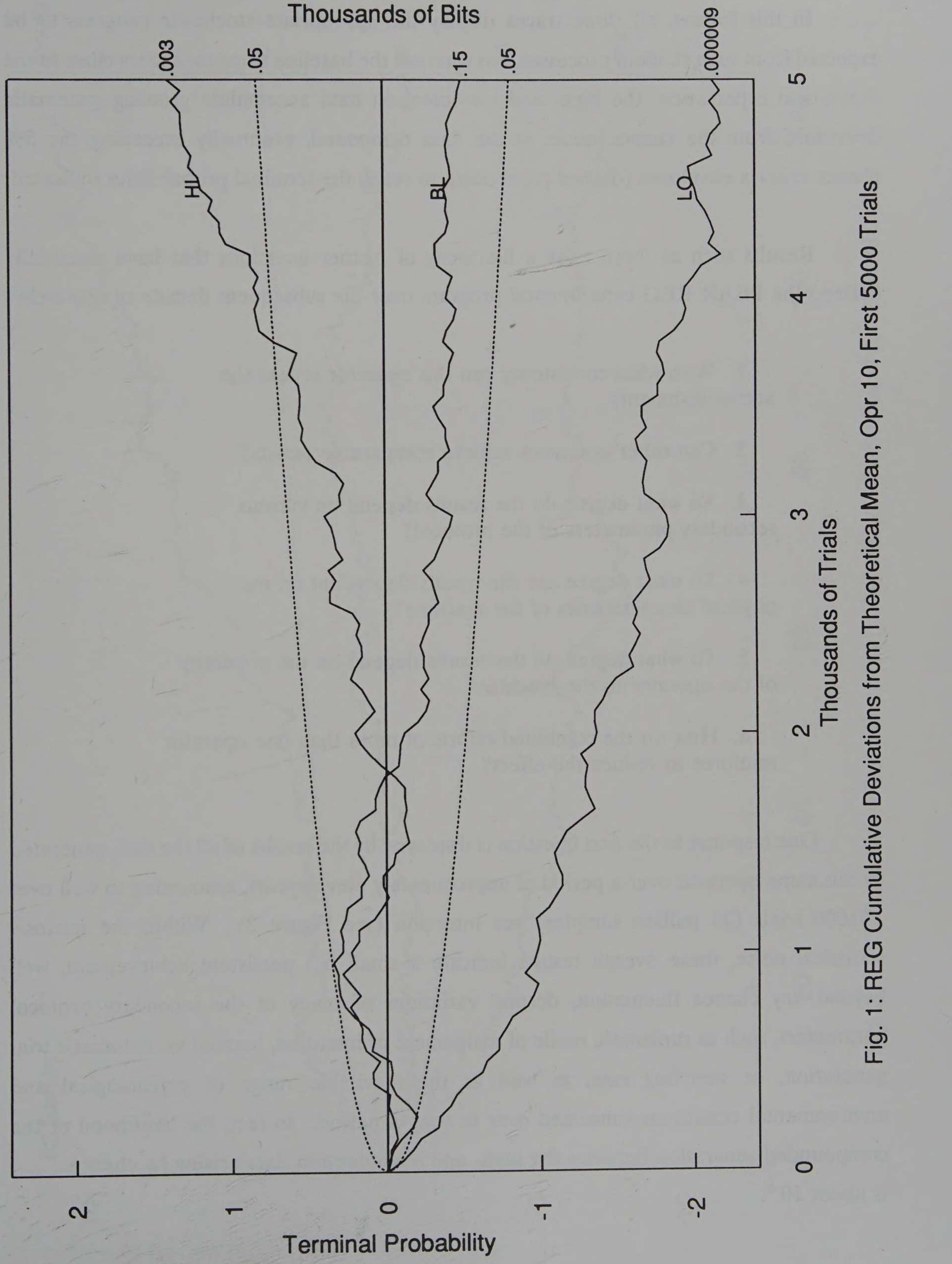
Thousands of Bits
.003
.05
.15
.05
.000009
HL
BL
LO
5
4
3
2
1
Thousands of Trials
REG Cumulative Deviations from Theoretical Mean, Opr 10, First 5000 Trials
2
1
0
-1
-2
Terminal Probability

Fig. 1: REG C

In this format, all three traces display the appropriate stochastic progress to be expected from such random processes, but whereas the baseline trace meanders close to the theoretical expectation, the high- and low-intention data accumulate growing systematic deviations from the chance mean as the data compound, eventually exceeding the 5% chance criteria envelopes (dashed parabolas), to reach the terminal probabilities indicated.

Results such as these raise a hierarchy of further questions that have essentially defined the PEAR REG experimental program over the subsequent decade of research:

1. With what consistency can this operator repeat the accomplishment?

2. Can other operators achieve comparable results?

3. To what degree do the results depend on various secondary parameters of the protocol?

4. To what degree are the results dependent on the physical characteristics of the machine?

5. To what degree do the results depend on the proximity of the operator to the machine?

6. How do the combined efforts of more than one operator reinforce or reduce the effect?

One response to the first question is displayed by the results of all the data generated by this same operator over a period of approximately eleven years, amounting to well over 120,000 trials (24 million samples) per intention (see Figure 2). Within the intrinsic statistical noise, these overall results indicate a small but persistent achievement, well beyond any chance fluctuation, despite variations of many of the secondary protocol parameters, such as runlength, mode of assignment of intention, manual vs. automatic trial generation, or sampling rate, as well as the inevitable range of psychological and environmental conditions subsumed over so long a period. In fact, the likelihood of the compounded separation between the high- and low-intention data arising by chance is about 10^{-8}.

Thousands of Bits
.000002
.05
.40
.05
.0005
HL
BL
LO
120
100
80
60
40
20
0
Thousands of Trials
Theoretical Mean, Opr. 10, All Local Data
EG Cumulative Deviations from Th
62 Series
10
5
0
-5
-10
Terminal Probability

Fig. 2: REG

Over this same twelve-year period, 91 different operators have generated a total of nearly 2.5 million trials, or approximately half a billion samples, following the same basic protocol. Of these, 58 operators (64%), succeeded in producing positive correlations with their high intentions, compared with the 50% chance expectation, and ten (11%) achieved statistically significant deviations ($p<.05$). In contrast, only 42 (46%) produced positive correlations with their low intentions, three of whom reached significant proportions: results well within chance prediction. Despite this inexplicable asymmetry in the performances and the varying sizes of the individual databases, the overall cumulative achievements continue to correlate significantly with intention, as shown in Figure 3. Perhaps even more instructive is the finding that the individual effect sizes for all 91 operators are found to distribute normally, with the majority of participants contributing to the overall effect[9] (see Figure 4).

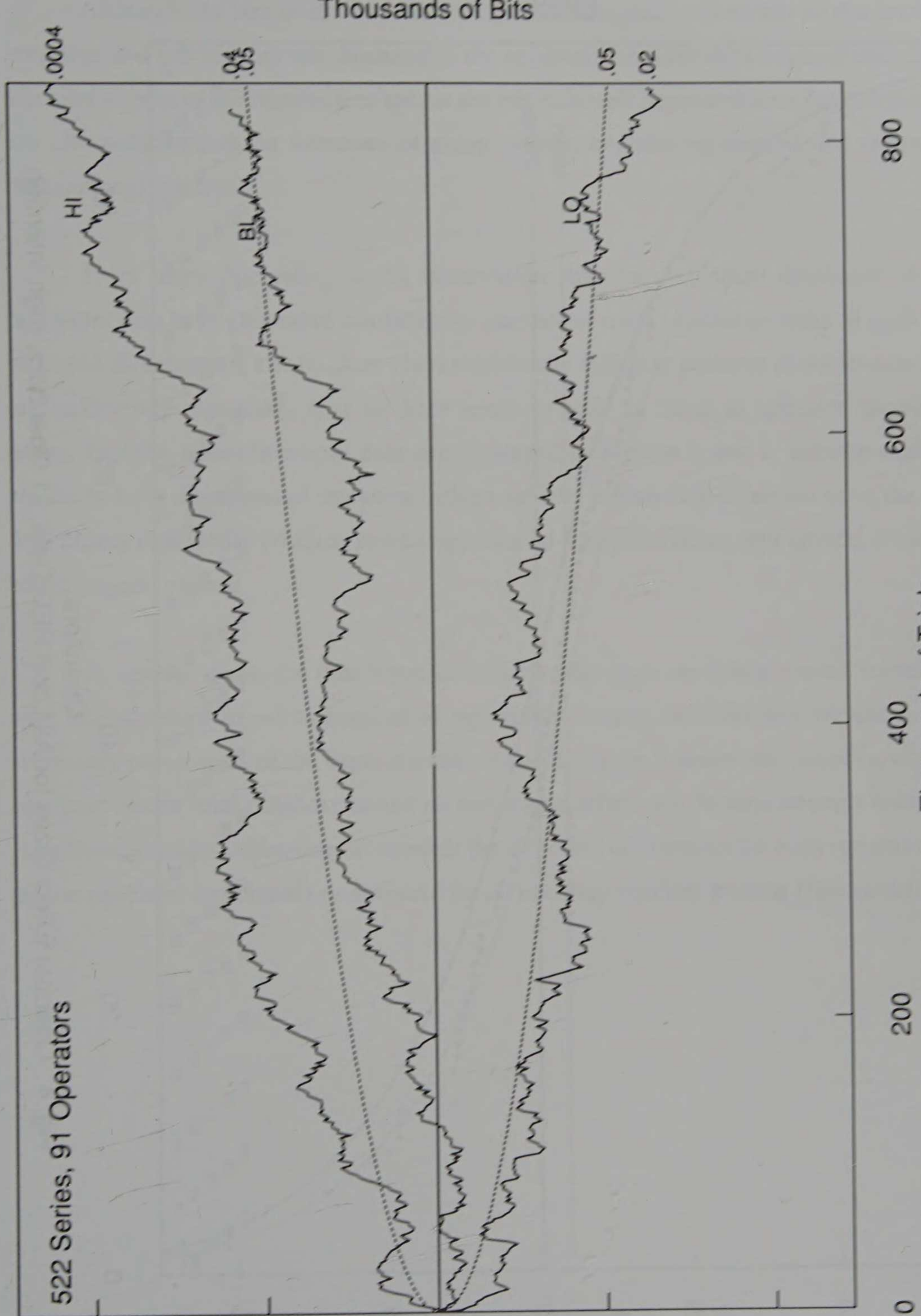

Fig. 3: REG Cumulative Deviations

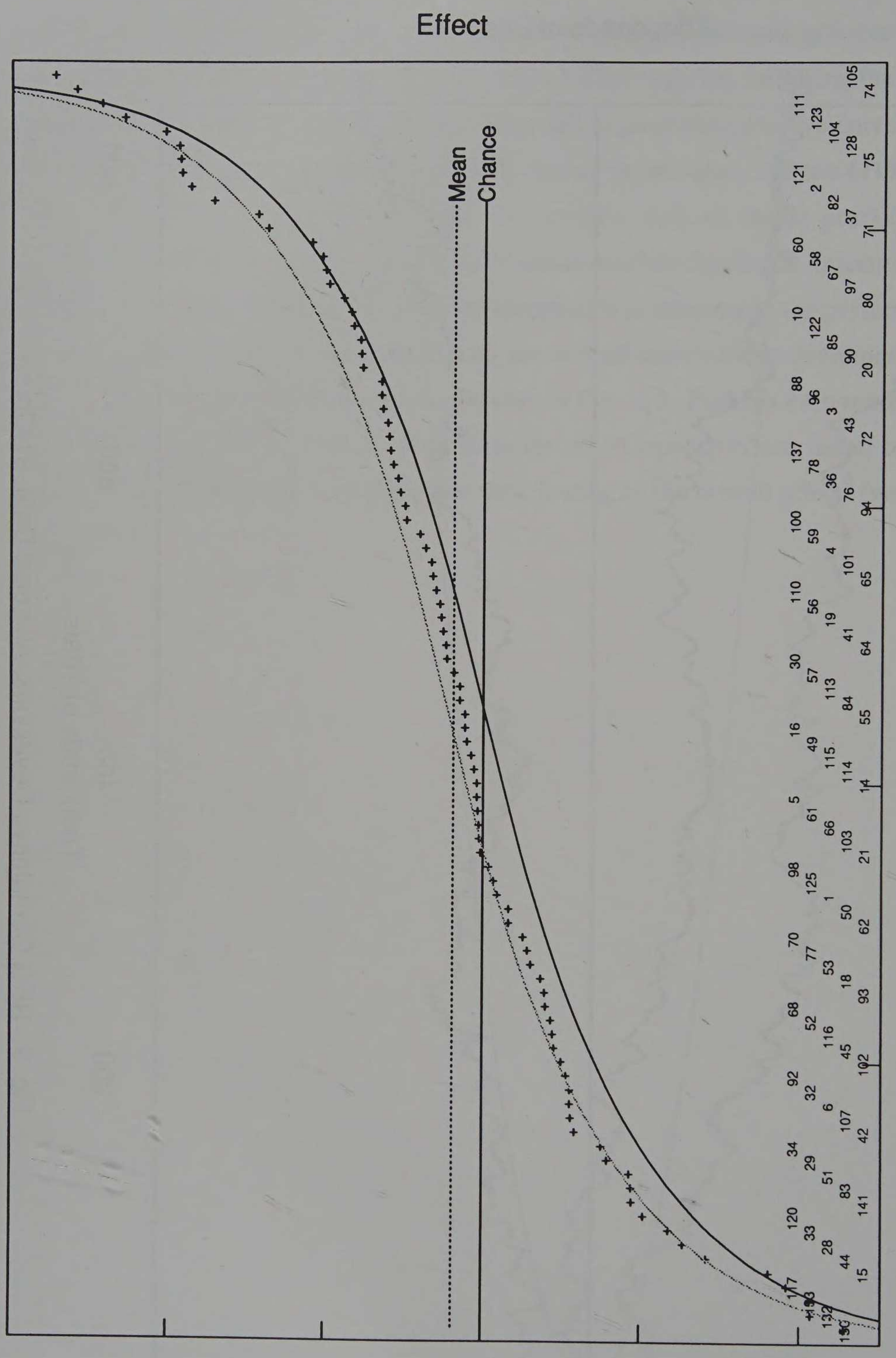

Fig. 4: Operator Effect Sizes for All Local REG Data, 91 Operators, High Intention

Although the size of the overall effect is still marginal--equivalent to the correlated inversion of a few bits per ten thousand in the random string--for data bases of this size, the associated shifts of the distribution means are not only well beyond chance expectation, they are also well beyond the tolerance of many modern engineering control and information management systems.

Even more interesting is the observation that the individual databases of those operators who have generated a substantial number of trials (10,000 or more in each of the intended directions of effort) show characteristically different patterns of achievement that are sufficiently repeatable that we have come to refer to them as operator "signatures". Some, like the operator whose data are displayed in Figures 1 and 2, achieve significant results in both directions of intention; others achieve in only one direction or in the other. Still others repeatedly produce results opposite to their intentions, and several achieve no effect beyond chance.

In several cases, the data from individuals who show no strong overall correlations with intention are found to respond in repeatable fashion to deliberate variations in the secondary parameters of the experimental protocol. Figure 5 shows one example, where an operator whose total database shows no noticeable effect, yet displays strongly contrasting extrachance results depending on whether the direction of intention for each run was chosen by the operator (volitional) or assigned by an ancillary random process (instructed).

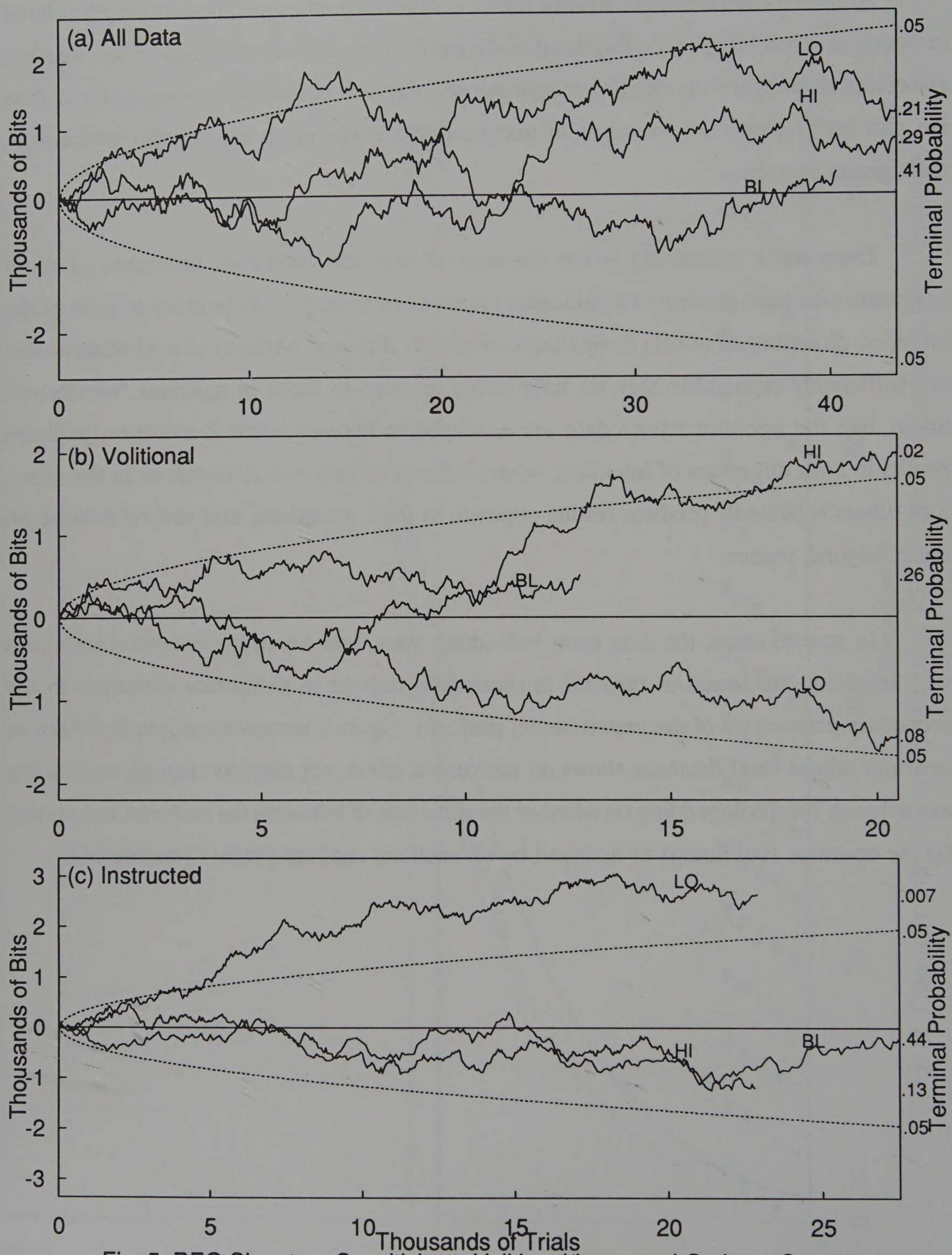

Fig. 5: REG Signature Sensitivity to Volitional/Instructed Options. Opr. 55

Just as some operators show a preference for the instructed or volitional modes, others respond differentially to other options, such as the generation of each trial manually via a single button push as opposed to the automatic sequencing of a fixed number of trials, specific run lengths, or different forms of feedback. As with the primary results, such sensitivity to any of these secondary conditions appears to be operator-specific. For some individuals, no differences are observed; for others, the responses differ strongly but distinctively, suggesting that a broader set of psychological factors contribute to the individual patterns of achievement.

Although the phenomenon is clearly operator-dependent, it appears to be much less device-dependent. The noise source has been replaced with similar and different microelectronic units, with little effect on the character of the results. A hard-wired pseudorandom source and a computer-generated pseudorandom algorithm have also been used, again producing similar effects. Even a large-scale random mechanical cascade apparatus and a mechanical linear pendulum yield results that continue to display marginal, but statistically significant, operator-specific correlations with pre-stated intentions, much like those seen in the microelectronic experiments[4,10,11]. Despite the fundamentally different random noise sources involved, individual operator results often display remarkably similar and enduring patterns of achievement across these experiments.

These operator/machine aberrations are further complicated by a substantial body of experiments wherein operators are physically separated from the devices by distances of up to several thousand miles. The results of some 396,000 trials per intention conducted under this remote REG protocol, where the device is run at prearranged times by staff members who are blind to the operators' intentions, are very similar to those of the local experiments, including the scale of effect, the generic preference for the high-going intention rather than the low, and the statistically repeatable operator-specific signatures. In fact, the overall results of these remotely generated data show no observable functional dependence on the distances involved[12].

Further insight can be gleaned from examination of the internal structure of both the local and remote data distributions, especially the differences of the individual trial count populations from their chance expectations. In both cases, the proportional changes in the counts are found to scale linearly with the difference between the count number and the mean of 100. In those cases where there are significant shifts of the overall distribution means in the direction of effort, a majority of the counts over 100 show clear excesses, while the lower numbered counts display similarly consistent deficits. These trends can be fit by a significant first order linear regression alone, with no signs of higher order distortion, suggesting that the basic effects are analytically tantamount to small changes in the elemental binary probability underlying the original random distribution, at a magnitude that varies from one operator to another. In cases where there is no effect, the count populations show no such regular patterns, but display random arrays of count excesses and deficits[13].

Yet more provocative is a subset of the remote REG database that comprises some 87,000 trials per intention in which the operator was actively directing his or her intentions to the machine's operation at times other than those at which the data were actually generated. Such "off-time" experiments have ranged from 73 hours before, to 336 hours after the scheduled sessions, and no dependence of the yield as a function of these temporal separations is observed. (Actually, the effect size in the high-going efforts is twice as large as that in the on-time remote experiments, although this difference is not statistically significant due to the smaller size of the database[12].) Such results suggest that the role of consciousness in these interactions is effectively nonlocal, so that any hypothesis entailing information transfer via some established form of neurophysiological/physical radiation, such as brain-generated electromagnetic waves, seems effectively precluded.

One further experimental excursion, still in progress, attempts to determine whether the combined efforts of two operators, each of whom has established an individual signature of performance, leads to superposition or reinforcement of the individual effects. While these data are so far much less extensive than for the single operators, some general characteristics can already be identified. For example, it appears that anomalous

co-operator results can occur with similar frequency to those of the individual efforts, but in patterns unique and replicable to the particular pair that are clearly not simple linear combinations of the individual signatures.

The overall results of 85,500 trials per intention generated by 15 co-operator pairs under this protocol are statistically indistinguishable from those of the single operators, although the effect sizes are actually slightly larger. The results of eight same-sex pairs, who generated a total of 39,500 trials per intention, are found to be opposite to intention in both directions of effort. Seven opposite-sex pairs, who generated a total of 46,000 trials per intention, produced statistically significant positive results in both directions of effort, with an average effect size 3.7 times larger than those of the single operators. Four of the opposite-sex pairs are "bonded" couples, who produced approximately one third of the opposite-sex data, with even more striking results: their data display average effect sizes that are twice those of the unbonded opposite-sex pairs, and nearly six times those of the single operators[14].

This particular array of experiments, like many others not reported here, indicates that human consciousness can marginally order the behavior of various random physical processes in correlation with its deliberate or unconscious intentions, in a manner that appears to be unique to each individual. The effects seem to be independent of distance and time, and in cases where two operators function with a shared intention, gender pairing seems to be a more relevant parameter than any direct combination of their individual influences. The implications of these results extend well beyond the original pragmatic engineering concerns, bringing into question some of the most fundamental assumptions of the prevailing scientific paradigm. In particular, Niels Bohr's conviction that, "we are both onlookers and actors in the great drama of existence"[15], now seems to be supported by such studies in the most fundamental of contexts: the assembly of information from totally random binary processes.

To proceed toward understanding such phenomena, one needs to postulate some mechanism whereby consciousness and its environment can exchange information by means

currently outside of the known processes of physical interaction. As a primitive start on this imposing task, we have proposed an admittedly speculative model, developed more fully in References 4, 16, and 17, based upon three fundamental premises that might be termed: (1) the geometry of reality; (2) the wave nature of consciousness; and (3) the quantum mechanics of experience.

The first of these suggests, in contrast to the prevailing view of an objective physical world progressing independently of the consciousness of the observer, that reality is constituted only by the interpenetration of consciousness and its environment, and that it is inappropriate and unproductive to attempt representation of either in isolation. This interpenetration entails--indeed generates--a flow of information, in the most general sense of the term, in both directions: that is, consciousness may insert information into its environment as well as extract information from it. It thus follows that the only purview of any physical theory is to represent and predict the experiences of consciousness, as well as those of the environment, in the interactions of one with the other. In this view, such common physical concepts as mass, momentum, and energy; electric charge and magnetic field; frequency and wavelength; the quantum and the wave function; and even distance and time, become no more than useful information-organizing categories developed by human consciousness, and adopted by consensus, to help it correlate its experiences and, as such, they reflect the characteristics of consciousness at least as much as those of any abstract environment. Conversely, it follows that some array of impressionistic descriptors of subjective experience may, in some form, be requisite ingredients of any truly general theory of reality, including physical reality.

Before proceeding further, it is important to define our use of the terms "consciousness" and "environment" in this context. The former is intended to subsume all categories of subjective experience, including perception, cognition, intuition, instinct, and emotion, at all levels, including those commonly termed "conscious", "subconscious", "superconscious", or "unconscious", without presumption of any specific psychological or physiological mechanisms. The latter includes all circumstances and influences that the consciousness perceives to be objectively separate from itself, including, as appropriate, its

own physical corpus and its physical habitat, as well as all intangible psychological, social, and historical influences that impinge upon it. In this sense, the interpenetration of consciousness and environment corresponds to the "I/Not I" dialogue of classical philosophy, and is a necessarily subjective and situation-specific process. It is important to emphasize that this model regards the distinction between the two as itself a fundamental construction of consciousness, deployed as a "bookkeeping" strategy to aid it in organizing the bombardment of stimuli impinging upon it from what William James aptly termed "the aboriginal, sensible, muchness"[18].

Given this "geometry of reality", it is then possible to adapt, via metaphor, any physical formalism, or indeed any other existing organized informational schema, to represent the dynamics of the consciousness/environment dialogue. The formalisms of quantum mechanics, because of the extent to which they intrinsically acknowledge the participation of consciousness in the establishment of physical reality, and in view of their own array of "anomalous" predictions at variance with classical expectation, are a particularly useful genre of such potential metaphors. For example, one quantum mechanical paradox, the "wave/particle duality", can be traced back to the philosophical debates of the earliest Greek scholars and even today finds only tentative resolution in the uncomfortable concession that under certain circumstances light and matter may behave like discrete particles; under others, like waves. Our interpretation of this irreducible complementarity, consistent with the postulates of the model, is that it is not the physical world per se that imposes such dichotomy; rather, it is the sensing consciousness. More precisely, it is an essential characteristic of the process of consciousness interpenetrating its physical environment. If this interpretation is valid, then it is also consistent to attribute to consciousness itself the option of wave-like as well as particulate character. In other words, the consciousness that has conceived both particles and waves, and found it necessary to alternate them in some complementary fashion for representation of its environment, may find a similar complementarity necessary and useful in representing itself.

Over most of the history of Western thought, and no less so today, the commonly prevailing conceptualization of consciousness has been basically "particulate" in nature. That

is, consciousness is regarded as well localized in physical space and time, and capable of "collisional" interactions with only a few aspects of its environment and a few other similarly localized consciousnesses at any point in its experience. But if consciousness were to allow itself the same wave/particle duality that it has already conceded to numerous physical processes, it would have at its disposal a host of wave mechanical behaviors--remote influence, interference, diffraction, barrier penetration, and resonance--that could accommodate anomalies such as those encountered in the experiments described above, as well as many other dimensions of human experience that currently fall outside the scientific paradigm. In either propagating or standing form, the information and energy carried by physical wave processes may be widely diffused over broad regions of space and time, rather than sharply localized in well-defined geometrical regions. Unlike particulate phenomena, intersecting waves may pass through one another with no permanent distortion, yet during that intersection complex superposition or interference patterns may be formed. The ability of waves reaching an interface or discontinuity in the surrounding medium to reflect some portion of their amplitude and transmit another portion, also differs sharply from the behavior of their particulate counterparts, as does the phenomenon of so-called "evanescent" waves whose influence can penetrate for some distance into regions inaccessible to the complementary particle. Perhaps most importantly, wave systems may establish resonances with one another and with their environmental confines that manifest as tangible standing oscillations. All of these capabilities transpose nicely into representations of anomalous consciousness effects.

Lest this metaphorical adaptation of physical formalism appear unreasonably extreme, it should be recalled that quantum wave mechanics itself has borrowed generously from the concepts of classical physics to describe metaphorically the phenomena of the microphysical world, most notably in its atomic and molecular "orbital" theories and its treatments of atomic "collisions". The Copenhagen interpretation of Bohr and his colleagues acknowledges that the amplitude of atomic "matter waves" is indicative of the probability of observing a particular particle, in a particular state, at a particular position and time, when an appropriate experiment to measure these properties is actually implemented. Hence, this wave mechanics of matter does not describe physical behavior-in-itself; it only

describes the observation of physical behavior. From this, it is a small step to generalize the concept of "observation" to encompass the full spectrum of the information-processing capacities of consciousness, and instead of speaking of "probability-of-observation" waves, to postulate "probability-of-experience" waves. This broadening of perspective is fully consistent with the position taken by many of the founders of quantum mechanics themselves[19]. In the words of Werner Heisenberg:

> ...in the Copenhagen interpretation of quantum theory we can indeed proceed without mentioning ourselves as individuals, but we cannot disregard the fact that natural science is formed by man. Natural science does not simply describe and explain nature; it is a part of the interplay between nature and ourselves; it describes nature as exposed to our method of questioning. This was a possibility Descartes could not have thought, but it makes the sharp separation between the world and the I impossible[20].

Beyond the various departures from classical particle behavior implicit in its wave-mechanical approach, quantum physics imposes a number of other empirical postulates that can also be appropriated as useful metaphors for exploring the information acquisition, delivery, and processing capabilities of consciousness. These include the principles of Correspondence, Exclusion, Indistinguishability and, perhaps most importantly, Complementarity, with its associated principle of Uncertainty. Collective adaptation of these tenets constitutes a "quantum mechanics of consciousness" that can provide a variety of conceptualizations and vocabulary for discussion of the generic processes whereby reality is established in the interpenetration of consciousness and its environment. Many aspects and examples of this are presented in associated references[4,16,17]; here we can outline just two: the "atomic" and "molecular structures" of consciousness.

If consciousness is afforded a wave mechanical nature, subject to the principles of quantum mechanics, its palpable experiences should be associated with the standing wave patterns, or "eigenfunctions", it achieves in its prevailing environment. In physical systems, such environment is usually represented as a potential profile in which the wave system is constrained. In the consciousness metaphor, the broader environment, as defined above, may

be similarly represented, albeit via more complex profiles of more subjective properties. In such profiles, the consciousness manifests itself and its experiences via a discrete set of eigenfunctions and eigenvalues, much like those of physical atom. Metaphoric analogies to the physical quantum numbers of energy, angular momentum, magnetic moment, and spin can be assigned, relating to the intensity, complexity, cognitive/emotional balance, and yin/yang characteristics, respectively, of the state of the consciousness in a given context. The consciousness coordinates, in which all such experiences must be expressed, are themselves assigned metaphorically, via various archetypal and linguistic clues, as generalizations of the familiar physical properties of distance, time, mass, charge, and their derivates.

With these "consciousness atoms" thus defined, their combination into "consciousness molecules" may also be undertaken. This bonding process, which is classically inexplicable even in the physical regime, is a particularly illuminating format for representation of the operator/machine anomalies described earlier, and for broader comprehension of many other consciousness-related phenomena as well, including biological phenomena. In the physical regime, when the wave patterns of the valence electrons of two atoms come into close interaction, they cannot be distinguished in any pragmatic sense, and this loss of identity or information, when properly acknowledged in the quantum mechanical formalism, leads to an "exchange energy" which is the basis of the molecular bond. The strength of this bond depends on the spins of the two interacting electrons, as well as on the pattern of overlap of the two electronic wave functions within the composite potential well established by the two atomic nuclei and the electrons themselves.

Our metaphor would thus predict that an individual consciousness immersed in a given environmental situation would establish a set of characteristic experience eigenfunctions. A second individual, exposed to the same situation, would develop a different set of experiences. However, if these two consciousnesses were strongly interacting, their experiential wave functions would become resonantly intertwined, resulting in a new pattern of standing waves in their common environment, such as those demonstrated in the co-operator experiments described earlier. These "molecular" experiences may be quite

different from the simple sum of their "atomic" behaviors, and if we insist on comparing them with such, they will appear anomalous. In their own properly constituted "molecular" context, however, they are quite normal.

Even our individual operator/machine effects may be addressed in this fashion if we are willing to regard the machine as a form of "consciousness" in its own right. Thus, a bonded operator/machine system should not be expected to conform to the isolated operator and isolated machine behaviors, but to establish its own characteristic behavior. Viewed as an influence of one system (the operator) upon another (the REG), the empirical results are inexplicable within the laws that govern the behavior of isolated systems. However, viewed as a process of wave-mechanical resonance within two components of a single interactive system, they are behaving quite appropriately.

This concept of resonance as a mechanism for introducing order into random physical processes may also be a viable model for comprehending various other "anomalous" processes, such as human creativity, whether artistic, intellectual, or biological. The key lies in the mechanics of the Indistinguishability Principle, where the surrender of the distinction between the identities of two interacting subsystems translates into an increment in the structural integrity of the bonded system. Thus, when the perceived boundary between consciousness and its environment is eliminated or reduced via subjective identification of the "I" with the "Not I", the resultant bonded system may marginally alter both the physical structure of the environment and the experience of the consciousness in a cumulatively consequential way. If this resonance entails a volitional or intentional component, be it conscious or unconscious, the eigenfunctions of the bonded system will reflect that intention in a manner unique to the particular molecule. Our experimental results suggest that while the scales of these effects are minuscule and impossible to identify on a trial-by-trial basis, nevertheless they can manifest in significant probabilistic trends accumulated over extremely large bodies of experience.

From all of this emerges the intriguing possibility that what we denote as "chance" behavior, in any context, rather than deriving from some ultimately predictable, fully

general, mechanistic behavior of a deterministic physical world, is actually some immense subsumption of a broader distribution of potentialities reflective of all possible resonances and intentions of consciousness with respect to the system or process in question. Sir Arthur Eddington proposed the possibility in only slightly different terms:

> It seems that we must attribute to the mind power not only to decide the behavior of atoms individually but to affect systematically large groups - in fact to tamper with the odds on atomic behaviour. ... Unless it belies its name, probability can be modified in ways in which ordinary physical entities would not admit of. There can be no unique probability attached to any event or behaviour; we can only speak of 'probability in the light of certain given information,' and the probability alters according to the extent of the information"[21].

Or, in the words of Schiller's Wallenstein:

> There is no such thing as chance, and what we regard as blind circumstance actually stems from the deepest source of all"[22].

Acknowledgements

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NONLOCALITY IN COMPLEX SYSTEMS: A WAY OUT OF ISOLATION?

Walter von Lucadou

Abstract

Many researchers, beginning with N. Bohr, have speculated that quantum theory might also provide a conceptual basis for the understanding of living systems. P. Jordan was the first physicist who tried to apply quantum theory to psychological problems. However, the question of whether macroscopic quantum mechanical systems really exist cannot be decided by physics alone.

At least for sufficiently complex systems, good arguments exist for assuming an underlying quantum mechanical structure. The demonstration of "nonlocal correlations" within such systems would be especially a sufficient criterion for this assumption. In contrast to other "quantum-like" features, nonlocal correlations cannot be comprehended by classical models.

A recent meta-analysis of psychokinesis (PK) experiments yields strong support for the hypothesis that observers may be able to interact in an anomalous direct way with physical random processes that had been carefully separated from them. The PK-effect could be interpreted as a nonlocal correlation, but if certain conditions are met, the PK-effect could also be identified as a signal emitted by the observer that overcomes the shielding and changes the random process.

From present data, it is not possible to decide whether the PK effect includes a signal or merely a nonlocal correlation. Theoretically the Model of Pragmatic Information (MPI) predicts that PK is only a nonlocal correlation but not a signal. A thought experiment demonstrates that the signal hypothesis leads to experimental contradictions, at least in certain situations. The MPI does predict specific limitations for the PK effect, which implies restrictions on possible applications and on the replicability of PK experiments. Each attempt to use the PK effect as a real signal transfer would make it

vanish. However, this does not imply that replications are not possible at all. Additional experimental requirements (triple-blindness) have to be fulfilled. Two practical examples demonstrate how this can be done in real experiments.

Introduction

That quantum theory could be relevant to biology and psychology was considered by its founders including N. Bohr, E. Schrödinger W. Pauli, and P. Jordan. The latter especially argued that quantum mechanics would be the last possibility to reconcile the personal experience of "free will" with the physical world view. In classical physics the whole universe works like a tremendously complicated yet fully deterministic "clockwork" that does not allow "free will". P. Jordan (1947) assumed that the quantum mechanical indeterminism of processes inside the human brain can be amplified in such a way that the unpredictable reactions of a person could occur that must be interpreted as manifestations of free will. Moreover, he assumed that the process of suppression as described by Freud's model of psychodynamics shows similarities to the concept of complementarity in quantum theory.

However, these ideas never played an important role in either biology or psychology. Some biologists even argued that for principal reasons quantum effects cannot show up in biology (Bünning, 1943). As we adopt a pragmatic point of view, we first have to ask whether macroscopic quantum mechanical systems can really exist.

Can Macroscopic Quantum Mechanical Systems Exist?

It is often said that quantum mechanical effects only occur in the microscopic domain where single elementary particles are involved. However, this is not true in general. Several macroscopic phenomena such as superconductivity or superfluidity exist which can be understood only on the conceptual basis of quantum theory and which must be considered as macroscopic quantum effects (Ristik, 1981). These systems are macroscopic as they include a macroscopic number of particles. Other systems such as the EPR experiments (Paty, 1977) involve single particle conditions, but the relevant distances between the two spin measurement devices are in the macroscopic range.

However, all of these macroscopic quantum effects can only be detected under highly artificial conditions, which do not exist in everyday life situations. These systems are completely isolated from their environment (Clough, 1988), or involve highly coherent conditions or very low temperatures (Kawamoto, 1987), or extreme measurement resolutions. Usually it is argued that the correspondence principle describes the limitations of the classical description: if the action E*dt is of the order of magnitude of h, or the distances of the order of magnitude of the wavelength, and if the quantum numbers, n, are small enough, the correct description of the system is given by quantum theory. If these conditions are not fulfilled, the classical theory seems to be a good approximation. However, under highly artificial conditions, as mentioned, these criteria cannot be applied blindly. The postcollision interaction is an example where interference patterns can be detected even with very high quantum numbers, if the resolution of the measurement is high enough (Morgenstern, et al., 1977).

Still, quantum effects may not underlie "genuine" macroscopic systems involving long distances, many particles, not isolated from their environment, at high temperatures, and transmitting large amounts of action. In these "natural" systems there is no experimental possibility in physics to measure the difference between the quantum mechanical and the classical. From a positivist viewpoint, the assumption of an underlying "real" quantum mechanical structure of "natural" classical systems is therefore an additional assumption not justified by experiments (May and Spottiswoode, 1988). The so-called "Copenhagen interpretation" takes this into account by its distinction of microphysical objects and macrophysical measurement devices.

Epistemologically this situation might be unsatisfactory, but the assumption that quantum effects play a role in biological and psychological systems involves much more difficult questions (e.g., the reductionism problem) than the correct interpretation of quantum physics. Nevertheless, there are several good phenomenological arguments why highly complex systems at least may have some similarities to quantum physical systems (Fahrenberg, 1979; Kornwachs, 1987; Lucadou, 1989b; Kornwachs and Lucadou, 1985; 1989; Lucadou and Kornwachs, 1980):

1. The axioms of quantum theory do not contain information about physics itself but merely about how measured data are linked with the theory, and how the states of a system develop in time.

2. There exists a formal similarity between the Schrödinger equation describing stationary quantum mechanical systems and the eigenequations describing self-referential complex systems.

3. Any measurement of a sufficient complex system causes perturbations. For example, any questionnaire exerts an influence on the assessment of a subject.

4. The results of different measurements, A and B, depend on their temporal order: $(AB - BA) \neq 0$.

5. Some features of macroscopic complex systems seem to be governed by uncertainty relations (e.g., autonomy versus reliability of a system).

6. Some features of macroscopic complex systems exhibit stepwise rather than continuous changes, resembling quantum leaps.

7. Macroscopic complex systems can show chaotic behavior that cannot operationally be distinguished from the stochastic behavior of a quantum mechanical system.

8. In some macroscopic (complex) systems, "anomalous" correlations between psychological conditions (or variables) of a human observer and variables of an independent physical process have been observed in spite of careful shielding against any known physical signal transfer which could have produced the correlation. This anomalous effect is called a PK effect. Where the correlation includes temporal displacement, any classical (local) model fails to describe the PK effect (Jahn, 1981; Schmidt, 1987). Thus, it seems plausible that these correlations are nonlocal in nature like the EPR correlation.

Conditions 1. through 7. cannot be regarded as sufficient to assume that complex (psychological) systems are "nonclassical", because a suitable classical model can describe the effect. However, the situation resembles that of atomic and molecular physics before the invention of quantum theory: the spectra of specific atoms or molecules could be calculated with an enormous degree of precision on the basis of classical models. However, the parameters of the corresponding equations had to be determined individually, *post hoc*; and no "explanation" for these specific values could be given. Similarly, in psychology very distinct classical models can be found for learning curves of individuals, which, however, do not allow a generalization of the adapted special system parameters (Geert, 1989). In contrast, if condition 8. could be experimentally demonstrated, this would be a necessary and sufficient condition for a nonclassical structure. The existence of "genuine" nonlocal correlations is not compatible with any classical model. This is the kernel of Bell's well known theorem (Bell, 1966).

Finally, it should be said that the Model of Pragmatic Information (MPI) (Lucadou, 1987a; 1989a) suggests that such an assumed "quantum theoretical structure" of complex systems depends on the degree of complexity of the system. This assumption seems to be corroborated by the fact that such quantum-like features can be found in psychological systems but not in biological systems.

To find out if an empirical basis exists for condition 8 the essential question is whether the PK effect found experimentally may be interpreted as an "influence" of an observer on a physical process or merely as a nonlocal correlation.

Signals and Correlations

The term "correlation" is more general than the term "signal". Each signal transfer produces a correlation, but a correlation can exist without signal transfer. An example is the alleged correlation between the decrease of the stork population and the birthrate in Sweden. In this case, a common factor such as environmental conditions may be responsible

for the correlation. For nonlocal correlations in quantum physics, the common factor for the correlation is the "superposition principle". It can be distinguished from any classical factor because it includes instantaneous change over large distances. This "collapse of the wavefunction" has been the subject of many discussions among physicists who argue that any change in a physical entity cannot proceed faster than the speed of light. However, this requirement of the special theory of relativity holds only for signals. Furthermore, at least in physics, a nonlocal correlation cannot be used to transmit signals.

In the EPR experiment, the deviation from the classical correlation function indicates the presence of a nonlocal correlation (Aspect, et al., 1982). However, this deviation cannot be detected without normal (local) signal transfer. The outcomes of each of the two spin measurements are completely isotropic distributions from which the nonlocal correlation function has to be extracted or filtered out by a coincidence measurement. Thus, by pure physical means it is not possible to use an EPR experiment as a "faster-than-light-telegraph".

More generally, the notion of signal includes two additional requirements: (1) Any signal must enable the "receiver" to choose one out of at least two equal probable alternatives and (2) the alternatives must be specified in advance. A nonlocal correlation violates at least one of these requirements. For instance, in the EPR experiment a spin measurement at one side of the apparatus does not permit prediction of the outcome of a spin measurement at the other side of the system, because the state of a single particle cannot be specified before the first measurement has been done. This means that the measurement of the spin in a given direction is equally probable for all directions. Thus, at least the second requirement is not satisfied because the alternatives for the direction of the spin cannot be specified before the first measurement nor the second. Only if the two spin measurements are compared with each other, the (nonlocal) correlation can be detected. Such a comparison of two measurements, however, requires a normal signal transfer.

Some theorists (Costa de Beauregard, 1987) assume that the PK effect might be used to bias the observed isotropic spin distribution of the first measurement in a predictable way. As a result, the nonlocal correlation should lead to an instantaneous bias of the spin

distribution on the remote side of the apparatus. See Figure 1. If this is possible, a nonlocal correlation could be used as an instantaneous signal transfer or a "superluminal telegraph".

This paper argues that this is not possible. The PK effect itself must be considered as a nonlocal correlation within a highly complex system including the human brain and a physically (but not informationally) separated physical process.

Therefore, it is important to know whether the experimental data support the traditional assumption that PK is a signal superimposed on a physical process, or whether they support the assumption of the MPI, which describes PK as a nonlocal correlation between psychological conditions and physical random fluctuations.

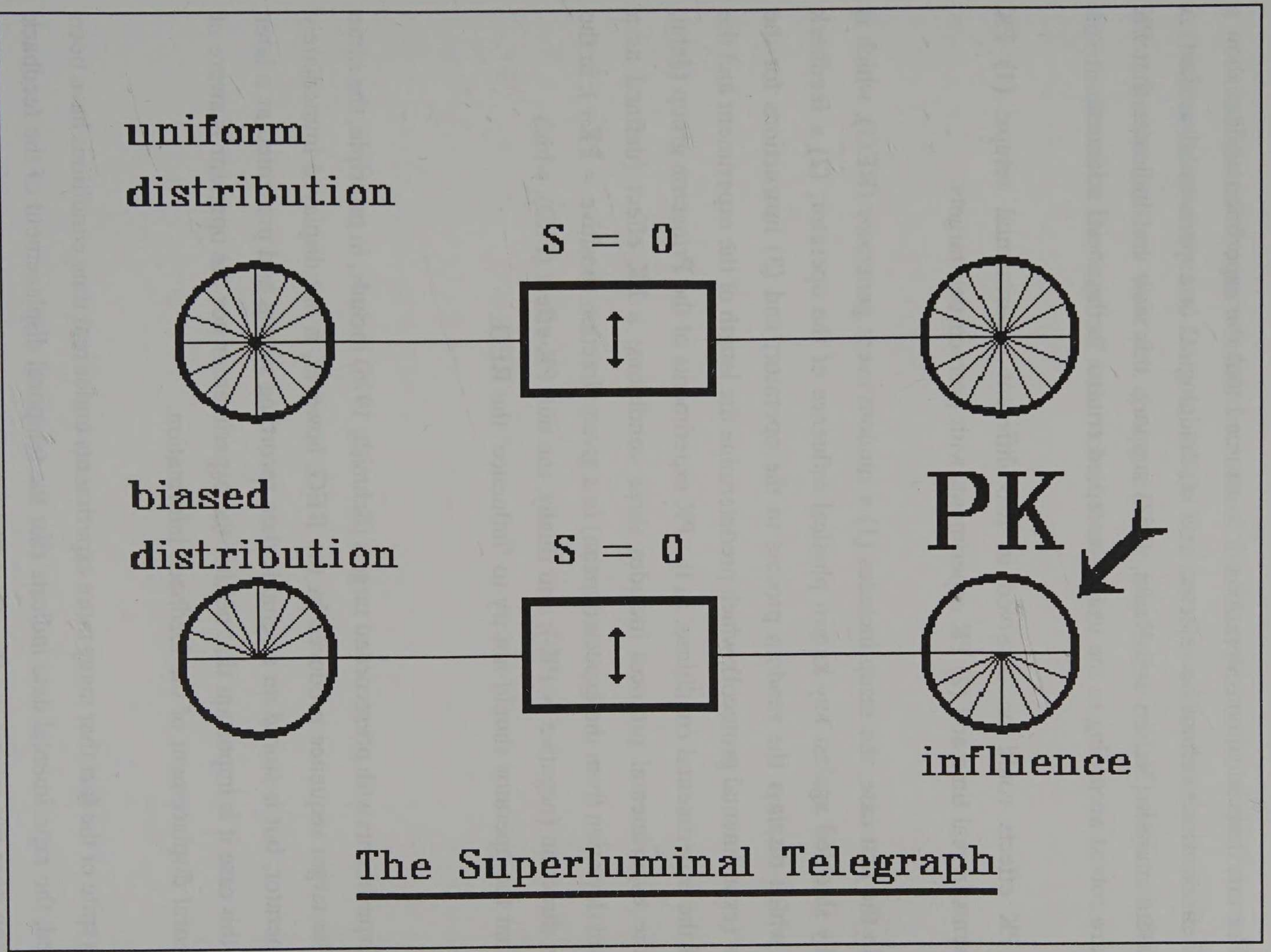

Figure 1. If PK is a signal, it could be used to bias the (uniform) distribution of a spin measurement at one part of an EPR experiment. In this case the remote spin distribution must also show a biased distribution. As a result, it would be possible to build a "superluminal telegraph" that could transfer signals faster than light.

Anomalous Human Observer Effects

For our theoretical considerations, it is assumed that the experimental data show a real PK-effect, which cannot be rejected as a methodological or experimental artifact. A recent meta-analysis (Nelson and Radin, 1988) supports this view and indicates that PK effects are robust according to the usually accepted criteria in the social sciences.

PK effects could be observed in two different experimental setups: (1) PK experiments in real time and (2) PK experiments with prerecorded targets.

In the first case, the setup includes (1) a random event generator (REG), which is physically shielded against any known physical influence of the operator; (2) a feedback system, which displays the random process to the operator; and (3) instructions for the operator (experimental protocol), which predetermine the length of the experiment and the order of the experimental conditions. In the PK experiments of the Princeton group (Jahn, 1981), the experimental protocol includes three conditions: a PK effect (defined as a significant deviation from the expected mean) in a given direction (positive = PK+); in the opposite direction (negative = PK-); and finally, the null PK-effect (PK0), which means that the operator should not try to "influence" the REG.

Experiments with prerecorded targets (Schmidt, 1976) include, in principle, the same setup. The target sequence produced by the REG, however, is not displayed immediately to the operator, but is stored on a reliable data recording system and presented at a later time. In this case it is important that neither the experimenter nor the operator is aware of the temporal displacement of the feedback information.

In spite of the fact that many more experiments under real time conditions have been performed, the experimental data indicate that the temporal displacement of the feedback information does not inhibit the PK effect (Schmidt, 1987).

Experimental Criteria for Signals

In Figure 2 the accumulated results of the PK experiments of the Princeton group are presented (Nelson and Dobyns, 1988). The cumulative distribution shows a clear PK effect in the desired direction, giving a clear impression of an additional PK signal superimposed on the "normal" behavior of the REG.

Figure 2. Cumulative deviation of means of PK experiments including three conditions, HI = PK+, LO = PK-, and BL = PK0, from a meta-analysis by Nelson and Dobyns, 1988.

However, from these data alone it cannot be decided whether the criteria for a PK signal are fulfilled.

In Figure 3, the experimental situation is described in a schematic and very general way. The sequence R represents the random sequence produced by the REG. In general, not all events of this sequence are really used in PK experiments. For instance, it may be that the REG is always in operation, during the pauses as well, but the results are not recorded, or the device needs a "warming up" phase. The sequence E specifies the actual experimental phase. Normally only these sequences are recorded. The experimental sequence, E, contains in general different experimental conditions such as PK+, PK-, or PK0. As these conditions have to be specified in advance, we call the corresponding sequence the filter sequence, F. If one combines the filter sequence, F, with the random sequence, R, and the experimental sequence, E, one gets the matching sequence, M.
M represents the cumulative PK effect (PK+ plus PK-) because it counts each random event of R as a "hit" if an experiment is performed according to E, and if it is in agreement with the desired direction of the filter sequence, F. In our example, for the PK0 condition each deviation from the mean value of the corresponding sub-sequence is counted as a "miss" because such deviations do not match the instructions, but one could also just "copy" the corresponding random sequence, R. In the case that the experimental sequence, E, indicates that no experiment is performed (E = 0), the matching sequence, M, must be "filled" with an independent unbiased random sequence (control sequence) instead of the original random sequence, R. This procedure takes the possibility of undetected relaxation processes into account which might be produced by a PK effect in R. Normally a PK experiment is thought to exhibit a PK effect if the matching sequence, M, shows significantly more "hits" than the expected mean value of n/2, at least in the experimental sub-sequences (of joint length n, with E = 1).

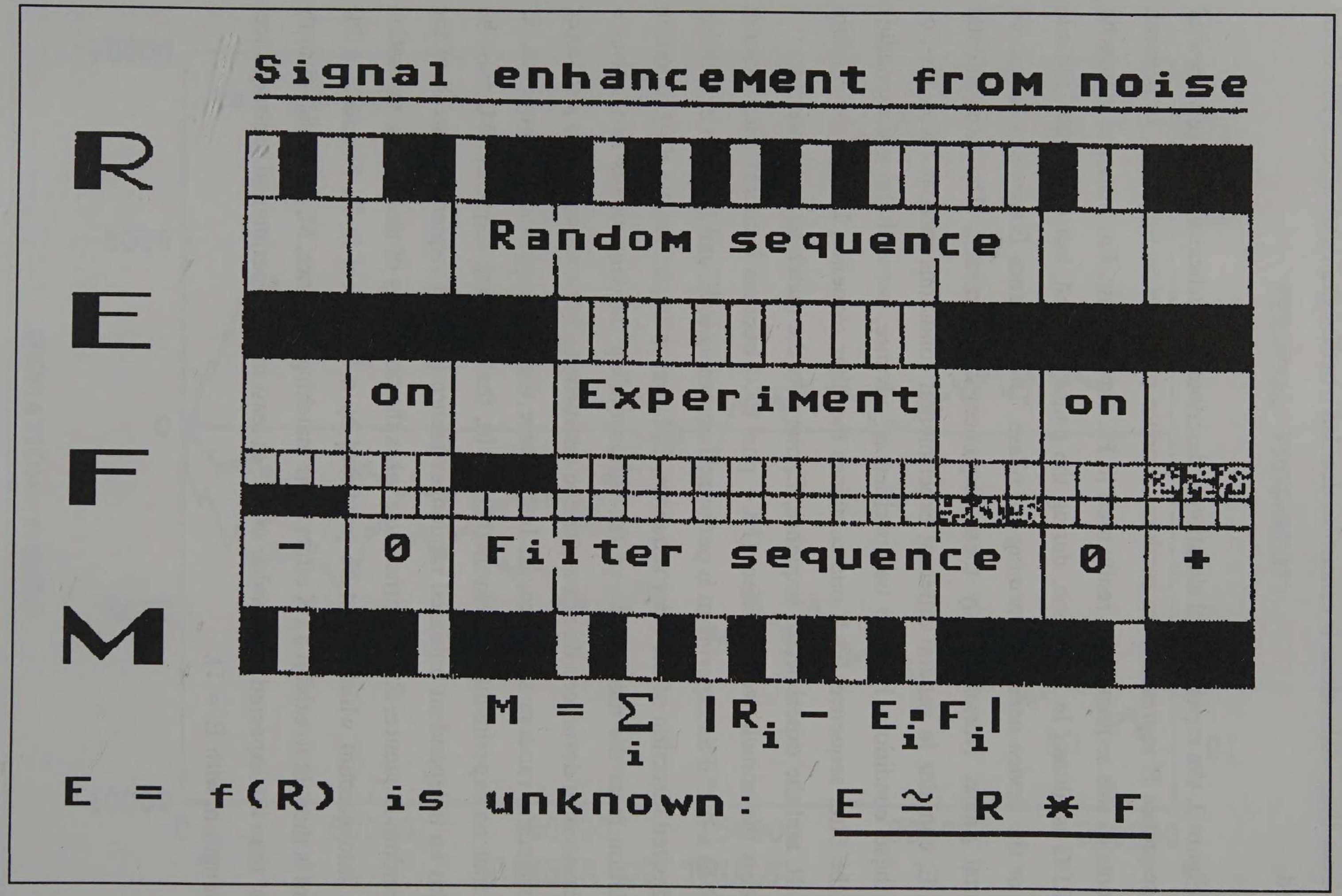

Figure 3. Sequences of events in an idealized PK experiment. R is the random sequence produced by the REG; E describes the subsequences of R that are used for the experiment. The filter sequence, F, contains information about the direction of the PK task, i.e., PK+, PK-, PK0. The matching sequence M describes the "hits" of the PK task during the experiment E in relation to the instruction F. If PK is a signal, it must be possible to reconstruct E by means of R and F.

The question of whether PK is a signal or only a (nonlocal) correlation cannot be decided on the basis of the matching sequence, M, alone. However, from the requirements for signals, there are two minimal experimental criteria for a PK signal. The PK effect is a signal if and only if: (1) there exists a method which allows to reconstruct the experimental sequence, E, from the random sequence, R, and the filter sequence, F, (for instance, the cross-correlation function R * F would be such a method); and (2) if the filter sequence, F, can be specified before the experiment is performed.

The first criterion is just a more precise formulation of the requirement that the alleged PK signal must be detectable from the random process. Without knowing the matching sequence, M, an independent judge should be able to decide whether a PK experiment was carried out on a given sub-sequence of R leading to a distinct disturbance of the random process, or whether the random process was not disturbed by a PK influence of an operator. Obviously the correlation function (R * M) would allow identification of the sequence, E, but M already contains E. Perhaps, this explains the impression of a PK influence as shown in Figure 2. The second criterion sounds trivial, but it is not fulfilled in the EPR experiment. The given experimental criterion for a PK signal does not explicitly describe the method used to reconstruct E. All methods to date do not fulfill the criteria.

Unfortunately, only a few studies explicitly deal with this problem. Most "parapsychologists" see PK as a signal because they could not conceive of an alternative model. The first study to test the signal hypothesis explicitly (Lucadou, 1984; 1987b; c; Lucadou, Lay and Kunzmann, 1987) used a correlation technique to find PK signals. The experiment showed meaningful correlations between psychological variables of the subjects and their scoring rate. However, no indication for a PK signal (called a tracer) could be found by two different correlation methods.

Another completely independent investigation along these lines was the data analysis that led to the so-called IDS-model (May, 1984; May, et al., 1985). The data of nearly all successful PK experiments then available were tested in relation to classes of different types of influence models. None showed agreement with the experimental data. These models

may be too specific in relation to the general concept of signals. Nonetheless, completely independent studies with independent sets of data and quite different methods support the same conclusion: "PK cannot be considered as an influence".

Several studies seem to contradict this statement at first glance, but it is difficult to decide from the experimental reports if the conditions were really fulfilled. Consider the analysis of D. Radin (1988), who started with the assumption that different operators produce different signatures of the PK effect during an experimental session, which can be repeatedly observed in subsequent sessions similar to the decline and U curves first described by Rhine. Radin used a neural network approach to "recognize" these signatures in a given set of PK data from different operators. Finally, the "trained" neuronal network was used to identify the corresponding operator from an independent set of PK data. From our point of view, the signature serves as a filter, F, which is used to reconstruct the experimental sequence, E, of a specific operator from the experimental random sequence, R (PK data). Because this method was successful, the first criterion for a signal is met. The second criterion, however, is not because the signature (the filter, F) was not available before the experiment was performed. In his analysis, Radin used a split-half technique on a homogeneous set of previously collected data. Thus, the correlation between the experimental data, R, and the corresponding operator, E, was only found *post hoc*. The situation resembles the EPR case, although it is more complicated.

Predictions of the Model of Pragmatic Information (MPI)

MPI (Lucadou, 1987a; 1989a) is not a reductionistic model. It assumes that sufficiently complex systems show a structure isomorphic to that described by quantum theory. This means that features of quantum theory can also be found in observables not definable within basic physics. For most psychological concepts it is not clear how they could be expressed in physical terms without first solving the problem of reductionism (Lucadou and Kornwachs, 1983b). Nevertheless, it is assumed that such "high-level observables" can be treated formally like quantum mechanical observables. To find these observables a

categorical analysis of the complex system is required, as well as distinguishing sets of complementary observables (Lucadou, 1974). Another possibility is to find analogous structures in physics and in complex systems (e.g., in psychology) using the physical concepts as metaphors. This method was used by R. Jahn and B. Dunne (1986; 1987).

By contrast to pure quantum physics, in complex systems it is often possible to decompose the system into subsystems. For instance, a spin measurement on an electron cannot be decomposed into "smaller" parts, but the measurement of the extraversion of a group can be decomposed to the extraversion of the individual group members. In such cases, it seems that the perturbation produced in the system by a measurement could be prevented. This could be rationale for assuming that complex systems can be described by classical models. However, this is an illusion, as the decomposition of a system into subsystems is just another type of measurement, which also exerts a perturbation on the system (Lucadou and Kornwachs, 1983b). This becomes clearer if we consider the problem of nonlocal correlations in complex systems.

In macroscopic (complex) systems, nonlocal correlations cannot easily be predicted by a theoretical consideration like Bell's theorem, because until now the model is not explicit enough in relation both to the classical and to the non-classical formulation. Even in pure quantum physics, only very specific and highly artificial systems exhibit a difference between the classical and the quantum mechanical predictions. However, nonlocal correlations may be found experimentally. The experimental criteria for a nonlocal correlation are: (1) the measurement of a correlation between two observables (variables) of the system, (2) which cannot be produced by a signal transfer between these two observables, and (3) which cannot be produced by a signal transfer from a third variable that influences both observables (partial correlation). The MPI assumes that the PK effect is such a nonlocal correlation between psychological and physical observables in the (organizationally closed) system, consisting of a subject observing a physically shielded random process, instructed to "influence" it mentally. Obviously the shielding is no sufficient condition to prevent a signal transfer, because there could be an unknown "mental force" able to surmount the shielding, as is assumed within the Rhinean paradigm. Rhine's concept

of PK includes basically four implicit assumptions that are questioned by the MPI: (1) PK is an influence, i.e., a signal; (2) PK can be accumulated statistically; (3) PK is not explicitly dependent on time; and (4) PK can be separated from its meaning. However, this question cannot be completely solved on the basis of present empirical data.

However, if we accept the "goal-orientedness" and the "independence from temporal distances" of the PK effect as it is suggested by experiments with prerecorded random targets (Schmidt, 1987), we can discuss a "gedanken experiment" (thought experiment) to clarify the assumption of the MPI.

In our gedanken experiment, we design a "PK-canceller", a special sort of random event generator (REG) that is either able to cancel automatically any PK effect of a gifted PK-subject (without transferring any signal to her/him), or to produce contradictory results concerning the normal functioning of the REG. It is important to note that the PK canceller works only if the PK-effect is assumed to be a signal transmitted (backwards in time) from the subject to the REG.

Now, we will try to demonstrate how the assumption that the PK effect involves a signal transfer must either lead to a paradox or violate the "goal orientedness" and "complexity independence" of the PK effect. Otherwise it fails to satisfy the requirements for signals.

The PK canceller is a normal REG with a subsequent data memory as it is used in experiments with prerecorded targets. Furthermore, the PK-canceller contains a preinspecting device called "preinspector" (e.g., a computer), which is automatically able to test and manipulate the content of the memory. As the experimental condition of a PK experiment must be specified in advance, we can assume without loss of generality that each sub-sequence of R used as a target under the experimental sequence, E, is followed by a "control sequence" not displayed to the subject. The control sequence should have double the length of the experimental one. Furthermore, we can assume that we have specified in

advance a sufficiently effective filter, F, to find the PK signal in R. The preinspector uses this filter, F, to find out whether a stored experimental sequence (sub-sequence of R) contains a PK effect. If he detects such an experimental sequence, he exchanges it immediately with the first half of the subsequent control sequence. As a result we obtain three sub-sequences of R which can be formalized as a triple sequence (re, rc1, rc2).
(If the pre-inspector finds a PK-signal rx = 1 ; otherwise rx = 0). Under the null hypothesis, i.e., no PK effect, the PK-canceller cannot be distinguished from a normal REG because the preinspector cannot filter out any sequence. Thus, it produces just a normal random sequence, (re, rc1, rc2) = (0, 0, 0). Here it is important to note that this only holds for real signals that can effectively be distinguished from random fluctuations. If random fluctuations would be filtered out, this may result in a nonrandom sequence.

If we assume that a gifted subject is able to produce a PK-effect on prerecorded targets, the preinspector can detect them before they will be presented to the subject and exchange them with the control sequences. In this situation four possible cases can be discussed: (1) (0, 1, 0) in which the original control sequences do not contain a PK signal; (2) (0, 1, 1) in which the first part that has been exchanged and which is presented to the subject does not contain a PK-signal, yet the second part of the original control sequence does; (3)(1, 1, 0) in which the first part that has been exchanged contains a signal, but the second part of the control sequence does not; and finally (4) (1, 1, 1) in which all three parts contain a signal.

In the first two cases, the subject will be unsuccessful using a REG which cannot be distinguished by any means from a normal REG. This is in contrast to the assumption of the goal-orientedness and complexity independence. The subject would not understand why she/he is unsuccessful. Moreover, in the first case (0, 1, 0), there is the contradiction that part of the unobserved sequences (in which the preinspector found a PK signal) shows a malfunction of the REG for which no reason can be given, because the second control sequence shows that it is working correctly. In the second case (0, 1, 1), one could interpret the result as an inversion effect: the sequence presented to the subject does not contain a PK signal, whereas in absence of the subject a PK signal is found. In this case one could

argue that the first condition for a signal transfer is given, as alternatives can be distinguished. However, the second condition is not fulfilled because the alternatives specified beforehand are inverted; the "wrong" information is transmitted. In the third case (1, 1, 0,), the subject would be successful, but we would also encounter the problem of the contradicting control sequences. Finally, in the fourth case (1, 1, 1), we would no longer have the two alternatives to decide upon. Once again, the second condition for a signal is violated. One would simply say that the REG is malfunctioning.

In all cases either a contradiction is produced, or the requirements for signal transfer are not fulfilled, the latter contradicting our initial assumption. Thus, we can conclude from our gedanken experiment that either PK is not a signal, or it is not goal-oriented, at least for PK effects on prerecorded targets.

The only way to prevent paradoxical situations in our gedanken experiment is to assume that the PK effect must disappear in such situations where it is used as a signal. As we have already discussed, no paradoxes or problems occur under the null hypothesis. Thus, the fifth case (0, 0, 0) is at least one possibility that does not lead to a paradox. However, it is not the only one. As a result of our gedanken experiment, we can specify the assumptions of the MPI in the following way. Each attempt to use the PK effect as a real signal will make it vanish. In this context it is important to state that from this pragmatic viewpoint the knowledge and application of a filter, F, is in fact a measurement which changes (and disturbs) the system.

The so-called "negative-result measurement" in quantum physics (Renninger, 1960) is a good statement for this illustration. In physics even single particles can produce interference patterns on a screen if they pass through a double-slit apparatus (Tonomura, et al., 1989) as shown in Figure 4. It is one of the "mysteries" of quantum physics that the particles appear as indivisible particles on the screen and can never be detected as a wave. Thus, it seems justified to ask through which of the two slits a particle passes. However, if a detector is behind one of the two slits, the interference pattern disappears in those cases as well where no particle is observed in the detector. It seems as if the single particle passesing through the slit without a detector "knows" that a detector is waiting behind the other slit. The disappearance of the interference pattern can be conceived as a breakdown of a nonlocal correlation inside the double-slit system caused by a "negative-result measurement". This example illustrates that even the "potentiality" of a measurement can cancel a nonlocal correlation. In our gedanken experiment the introduction of the filter, F, is a potential measurement even when no PK signal is detected.

This negative-result measurement allows a natural explanation for the so-called "elusiveness" of PK. As J. Houtkooper (1983) pointed out, "Straight replication has been a good recipe for significant results to change sign!" Normally, the knowledge of the results of a previous PK experiment includes a filter, F, which could be potentially used in the replication study to transfer a PK signal. As a result of our gedanken experiment, we would expect either no PK effect in the replication experiment (case (0, 0, 0)), which would traditionally be interpreted as an inter-experimenter decline effect, or at least a reversal of the effect (case (0, 1, 1), which is normally regarded as a "displacement-effect".

The assumption that PK is "only" a nonlocal correlation has indeed important consequences and includes many limitations concerning a practical application of the PK effect (Lucadou and Kornwachs, 1983a).

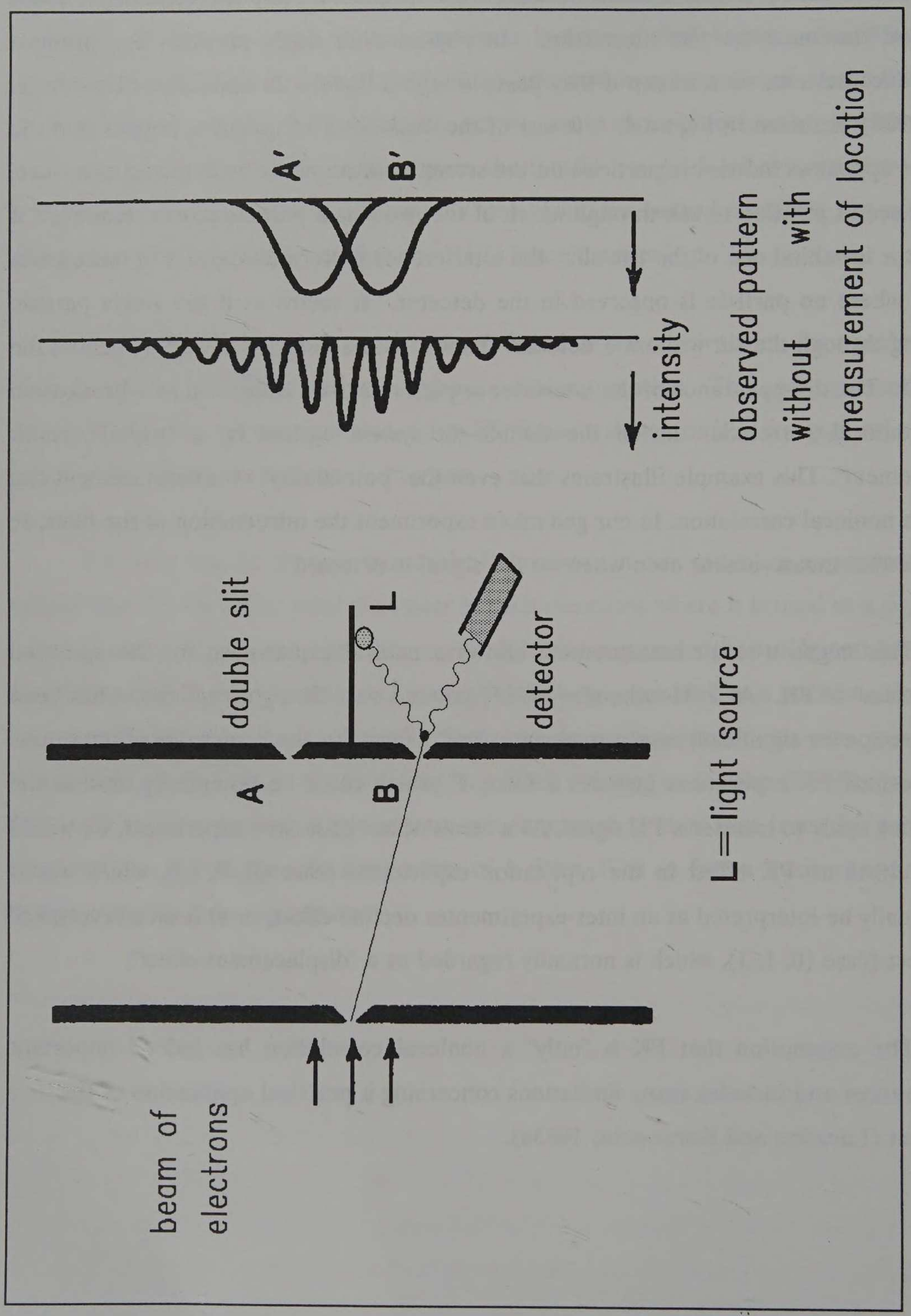

Figure 4. Double slit experiment. If electrons pass through two slits, they produce an interference pattern on a photographic plate. The interference pattern disappears if a measurement is made to trace the path of the electrons.

A Way Out of Isolation

It is understandable that most parapsychologists are not pleased with such a model, because it is inconsistent with the traditional idea of PK as a "mental force". Furthermore, it seems to be self-immunizing in relation to the argument of skeptics who criticize the lack of repeatability in PK experiments. Thus, I was not surprised when an anonymous referee of my paper about the MPI (Lucadou 1987a) wrote, "The theory itself has profound nihilistic implications relative to serious, systematic research. It contains a message that the parapsychological community does not need to hear."

However, I think that there is no reason to be so pessimistic about the MPI because it does not imply that a replication of a PK experiment is not possible in general. We simply have to guarantee that the experimenter cannot act as a preinspector as in our gedanken experiment.

To elucidate this further, let us assume that an experimenter has found in a previous PK experiment that extraverts score higher than introverts. Let us further assume that this "signature" is strong enough to serve as a filter, F, which enables us to identify the experimental sequence, E, of single subjects and to detect whether an extravert or introvert is operating. In a replication experiment, the experimenter could use this knowledge to transmit a signal via the PK correlation simply by preselecting the subjects as introverts and extroverts, and coding a signal by exchanging them as operators in a given order. From the MPI, we would then expect that either the subjects would not be successful in producing a PK effect, or the "signature" would change in an unpredictable way. From the concept of negative-result measurement, we can further conclude that the experimenter does not even need to carry out a coding of a signal to cause a breakdown of the nonlocal correlation. The simple potentiality that he could do it is sufficient. However, this should not be misunderstood to mean that the pure knowledge of the relationship between extraversion and scoring rate would collapse the nonlocal correlation. This would be too subjective a view. In a similar way the concept of the observer is often mistaken in quantum physics if it is assumed that unobserved physical processes have no reality. Therefore, the MPI implies

that only operationally or pragmatically realized potentialities represent a negative-result measurement. For instance, if the experimenter in our example had no possibility of preselecting the subjects into groups of extraverts and introverts, this would actually imply that he could not exploit his knowledge of the previous experiment to use the PK effect as a signal transfer. In this case, a replication of the previous experiment should be possible. Of course, it is necessary to specify what is meant by "no possibility". To have such a possibility, a measurement has to be made. If the measurement of the extraversion score is made on a individual basis before the PK experiment, this implies that a selection of individual subjects has occurred.

The distinction between measurement of a composed and of a decomposed system, e.g., of the extraversion of a group and that of the individual group members is that these two measurements are operationally different in principle. However, in practice we encounter a problem, because normally the extraversion measurement of a group implies that of the individual group members. We can solve the problem by introducing a "triple blind" condition. Under the usual double blind conditions, both the experimenter and the subjects are not allowed to know the rationale of the experiment. Under triple blind conditions, the measurement method, e.g., the extraversion measurement, must be kept blind as well until the final measurement of the nonlocal PK correlation has been completed. This means that the (extraversion) measurement must be "opaque" for both the experimenter and the subjects and is not allowed to be evaluated before the PK experiment is done. Otherwise the situation is similar to the gedanken experiment, where a preinspector could use the evaluation of the measurement as a filter to separate extraverts and introverts, for example. As most personality questionnaires are more or less transparent to an experienced experimenter, she or he should at least never read the raw data before the final evaluation, and should try to use different questionnaires in a replication experiment.

Under these experimental conditions, an "intervention paradox" cannot be produced anymore. Therefore, from the MPI one would expect that a direct replication of the previously observed nonlocal correlation between extraversion and the PK effect should be possible. As the described method can be applied easily in real experiments, there is no

longer any reason to assume that the MPI would lead to the vicious circle of a model which merely describes its own deficiencies. Furthermore, it is possible to test these predictions experimentally by comparing replication studies that take into account the recommendations of the MPI and the usual "strict" replications.

Another possibility for a "way out of isolation" of nonlocal correlations is the use of immediate feedback to select random fluctuations in (real time) PK experiments. If the PK effect is only a random fluctuation, but not a signal, the arguments used in our gedanken experiment to deduce paradoxes cannot be applied anymore. In this case, an actual deviation from chance expectation might correlate with a given psychological condition, e.g., the instruction for PK+, PK-, and PK0, in a replicable way, provided that the PK effect is only a random fluctuation.

At first glance, the concept of a replicable random fluctuation seems to be a contradiction per se. However, a random fluctuation is not a signal because it cannot be distinguished from the background noise by any filter, and therefore the two conditions for signals are not fulfilled. This means that the frequency of a fluctuation depends on its amplitude according to the chance distribution of the random process. In this case, the IDS-model is in agreement with the MPI. Both assume that the PK effect is not "allowed" to violate the normal chance distribution. This includes that the amplitude of a PK effect in a given direction (H) depends on the run length (n), where $H(n) = c/(n)$ (Lucadou, 1987a). It is more or less equivalent to say that the subject is able to "select appropriate chance fluctuations" intuitively as suggested by the IDS model, or to speak of an "establishment of a nonlocal correlation" between chance fluctuations and psychological conditions of an observer. To avoid chance fluctuations becoming signals, they are not allowed to occur too often or regularly. Therefore a decline effect is to be expected if the PK task would "force" the system to produce fluctuations only in a given direction (e.g., PK+ only). If, on the other hand, the PK task allows alternating possibilities between PK+, PK-, and PK0, a "forbidden" deviation from the overall distribution can be avoided more easily. This might be the reason why the replicability of the Jahn and Dunne experiments seems to be larger than that of the traditional PK experiments. In contrast to most other PK

experiments, they used a three-step protocol from the beginning with short intervals of PK+, PK-, and PK0, instead of long series of PK+, and long "control runs", PK0. The fact that the overall distribution results of the Jahn and Dunne experiments (including PK+, PK-, and PK0) fits a normal distribution perfectly under the null hypothesis can therefore be regarded as direct support of our assumptions.

The advantage of the MPI in comparison to the IDS model is a conceptual one. The IDS assumes that in a PK experiment the operator is "intuitively" able to select fluctuations. The notion of intuition, however, reintroduces the notion of a signal that is "transmitted" from the random source to the operator and that enables him or her to select appropriate outcomes. If we assume that the operator has a built-in filter to recognize these signals, we run into the same problems as in our gedanken experiment. If we assume that there is no such signal, the model does not explain anything because it does not reveal where the origin of the "intuitions" comes from. At this point, the MPI is much more explicit. The nonlocal correlation between the physical process (chance fluctuations) and the psychological conditions (or variables) mirrors the organizational closure of these two initially isolated subsystems. It is produced by the pragmatic information given to the operator, which contains two aspects: the instruction and the intention to "influence" the physical process, and the feedback information about the "success" of the operator. Thus, the observer and the observed can become a unity even though they are physically separated.

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MEDITATION AND MIND/MATTER INTERFACE

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Abstract

In many cultures, meditation has been traditionally regarded as a means of enhancing psychic abilities. The recent upsurge of public interest in meditation and its secularization in Western societies have provided an impetus to study it scientifically. Already extensive literature has accumulated. Unfortunately, with the exception of a few critical reviews, much of it is flawed, however, by conceptual confusions, lack of methodological rigor, and exaggerated claims. Nevertheless there is reason to suppose that the data as well as theory in this area may provide a heuristic model for understanding the mind/matter interface.

Much discussion on meditation suffers from confusion arising from (1) the failure to distinguish between meditation as a state and as a technique; (2) lack of adequate criteria or uniform procedures to reliably identify it; and (3) the simplistic notion that sitting quietly cross-legged and chanting a *mantra* is qualitatively the same as advanced practice of the rigorous disciplines of classical meditative traditions. Methodologically, many experimental studies of meditation either do not employ controlled conditions, or they use the same subject as the control. Furthermore, they have failed to control for individual differences in personality, attitudes, expectations, training, and the length and quality of meditation practice. These problems severely limit the conclusiveness of the research.

There does not appear to be any unique physiological state characterizing meditation. Instead, the observed physiological effects appear to be a manifestation of the meditator's volitional and cognitive control of brain activity. Low arousal and other biologically beneficial states considered to be effects of meditation are more likely to be the preconditions for avoiding distractions to meditation.

Experimental studies of meditation have confirmed hypotheses that subjects obtain higher extrasensory perception (ESP) scores after meditation than before. A literature review of studies relating psychic abilities with meditation similarly suggests a positive relationship. Although these studies are not free from methodological flaws, they add further credence to the belief that meditation may indeed facilitate intentional and direct interaction with the environment.

Attention is apparently a key factor in understanding meditation and the mind/matter interface. Ordinarily attention either fluctuates randomly or is determined by environmental conditions and individual dispositions. Thus, much of cognitive behavior can be understood and explained by deterministic models. However, if consciousness is regarded as an independent principle, there would then be reason to believe in volitional freedom and intentionality. Meditation may be a process of promoting voluntary attention. Singular attentional focus in concentrative forms of meditation controls the random fluctuations and renders attention impervious to environmental pressures. In passive meditation, the meditator learns to nonreactively attend to incoming thoughts for prolonged periods of time, thus promoting voluntary attention and intentionality.

Enhancing intentionality may have the effect of bringing about mind/matter interactions in ways that are not explicable in terms of current scientific constructs which ignore or deny a nondeterministic role of mental functions. Consequently, if anomalous effects could be facilitated by enhancing voluntary attention and intentionality as in meditation, we might come closer to understanding the mind/matter interface.

What is Meditation?

In the Western world, during the past twenty years, there has been a considerable amount of popular and scientific interest in the study and practice of meditation. Literally hundreds of thousands of people have become meditators, and scores of research reports have been published. It appears that meditation was a response to the psychedelic "challenge" of the sixties (Carrington, 1977). Experience with mind-altering drugs led to a heightened interest in altered states of consciousness. Meditation produces an agreeable state without any chemical stimulation. Age-old claims of yogins (people who have achieved proficiency in yoga) and other adept meditators, having produced extraordinary phenomena, became more credible as laboratory evidence indicated that autonomic functions could be controlled by means of suitable feedback and reward systems (Barber, et al., 1972). Again, the successful promotion of Transcendental Meditation (TM) as a simple and easily practiced standardized technique for stress reduction has greatly contributed to both the popularity of meditation as a technique and the widespread interest in studying it scientifically.

This eruption of interest has not been without its share of problems. The concept of meditation became somewhat nebulous, resulting in a variety of ambiguities in its usage. Research on meditation suffered much on this account, which led one researcher to complain that "ninety-seven percent of meditation research is not worth the paper it is printed on" (Smith, J. C., personal communication).

There is confusion as to whether meditation is a state or technique. Meditation as popularized is a practicing technique, but as a subject of research it is equated with a state. The necessity to distinguish between the state and the technique led some writers to coin such phrases as "meditative experience" (Goleman, 1978), "meditative mood" (Carrington, 1977), or "relaxation response" (Benson, 1975). To compound this confusion, meditation technique is not clearly limited to one practice or to one set of practices. Occasionally any practice believed to produce a particular state has been regarded as meditation (Smith, 1986). At other times engaging in a certain practice is automatically equated with being in

a meditative state (Wallace, 1970a). Thus, there is a failure to clearly define meditation either as a technique or a state. If meditation is a state, we need precise criteria for identifying it; if it is a technique, it should be clearly described.

This confusion may have its roots in the classical writings associated with different systems of meditation in which there was no particular need for making the distinction. In the Buddhistic practices as described by Buddhaghosha (1923) in *Visuddhimagga*, *jhana* (Sanskrit, *dhyana*) is a state. In fact, eight *jhana* states are distinguished. By the time one reaches the fourth stage of *jhana*, there is the cessation of all limiting conditions that bind our minds and limit our mental functions. The last four stages are efforts to seek out or realize answers to ultimate philosophical questions and experience reality with greater clarity. In Raja Yoga as described in Patanjali's *Yoga Sutras*, meditation (*dhyana*) is a technique which in combination with *dharana* (concentration) and *samadhi* produces a state called *samyama*, comparable to Buddhistic *jhana*. The counterparts to *dharana* and *dhyana* of yoga are *upacara* and *appana* in Buddhistic psychology. *Upacara* is concentration that is unsteady, whereas *appana* is steady concentration leading to a state of absorption.

Most meditation research has been done with subjects practicing Raja Yoga, Transcendental Meditation, or Zen, or adaptations by researchers such as Benson (1975) and Carrington (1977). The roots of the various techniques under study may be traced to Hindu and Buddhistic practices. The authoritative sources of these traditions are the aphorisms of Patanjali, the many commentaries on the *Yoga Sutras*, and the elaborate descriptions in Buddhaghosha's *Visuddhimagga*. They are discussed in detail herein.

Yoga Meditation as a Technique

Patanjali, who lived in the second century B.C., is not the founder of yoga; but, as Dasgupta (1922) points out, he collected the different yoga practices, systematized diverse ideas on the subject, and "grafted them on Samkhya metaphysics" (p. 229). Vyasa, of fourth century A.D., wrote a commentary on *Yoga Sutras*; and Vacaspati and Vijnana Bhiksu wrote

extensive commentaries on Vyasa's commentary. Together these works constitute the original and primary sources of the Raja Yoga tradition.

Briefly, the goal of yoga is to control the natural tendency of the mind to wander. The method used to obtain a certain attentional focus is called *ekagrata*. When mental wanderings are controlled, one reaches a state of stillness and absorption called *samadhi*. In *samadhi*, our awareness is unaffected by the normal psychological processes and therefore becomes pure, unconstrained, and unbiased.

The term for mind is *citta* in yoga. Citta is described as incessantly undergoing fluctuating changes like the flame of an oil lamp, called *citta vrittis*. The vrittis are limitless in number, but are classified into three categories. The first comprises false perceptions, errors, illusions, and hallucinatory experiences in dreams and waking states. The second includes all normal experiences of a non-yogin. In the third category are the paranormal experiences achieved through the practice of yoga. The *citta* functions at five levels, resulting in five modalities of consciousness. According to Vyasa, they are: (1) *ksipta* (unstable), (2) *mudha* (obscure), (3) *viksipta* (stable-unstable), (4) *ekagra* (single-pointed), and (5) *niruddha* (fully controlled).

The purpose of Patanjali's yoga is to attain the *niruddha* state where the psychic fluctuations are completely under control. This can be achieved through certain psychophysical exercises that include meditation and concentration.

The *citta* fluctuates not only by sensory stimulations, but also by subliminal forces called *vasanas*. The *vasanas* are dispositional latencies. Having their own dynamism, they constantly strive for expression in consciousness and precipitative *vrittis.* Much of human experience is determined by these latent tendencies. Unless they are revealed, controlled, and eradicated, the *citta* cannot be restrained from its habitual fluctuating tendency. Yoga practice therefore aims, not only to shut out the external inputs provided by sensory stimulation, but also to "burn" the subliminal latencies so that the *niruddha* state is attained.

The *citta* is neither a canvas that takes on impressions, nor a passive plastic state that takes on various forms. Rather, as Dasgupta (1930) writes:

> There is also the reserve power in it called the *sakti*, by virtue of which it can reflect and react back upon itself and change the passivity of its transformations into active states associated with will and effort. Thus, man's thoughts and actions are pure psychological determinations. But there in the *citta* is the reserve force by which it can act upon itself and determine itself. This force gets its full play in the strong effort required in meditation by which a particular state is sought to be kept in a steady condition as a check against the natural flowing tendency (pp. 286-87).

Yoga is a psychophysiological method involving eight steps to control the fluctuations of the psyche. The first two are *yama* and *niyama* which include certain moral rules such as truthfulness, non-stealing, continence, cleanliness, and contentment. The next two, *asana* and *pranayama*, are physical exercises that involve several physical postures and breath control. The fifth stage, *pratyahara*, is simple introspection designed to understand the workings of the psyche. The last three, *dharana* (concentration), *dhyana* (meditation), and *samadhi* (the state of mental stillness), are the most important ones in attaining mental discipline. The first five are preparatory, and the last three are the essential stages of yoga.

The need for ethical and physiological practices in yoga is not difficult to understand. Desires and sensory indulgence encourage further involvement in the sensory processes resulting in continuous mental fluctuations that are precisely what yoga seeks to control. The physical exercises are also designed to control internal processes, reduce the sensory input, and ensure physical health.

The *pratyahara* or introspective stage is important. It seems to focus on certain internal monitoring processes, a type of biofeedback, and may be the connecting link between the physiological and the psychological realms. The yogic practitioner is able to regulate the body by introspection to suit the requirements of his or her mental states. This enables the yogin to isolate certain experiences and produce them at will.

The object of all these exercises is to enable one to concentrate. Concentration or *dharana* produces a state in which the natural wandering of our thoughts, the fluctuations of the psyche, are brought under control. In a state of concentration, the psyche attends to one thing, and the activity of the mind is intensified in a single direction. In a state of concentration, the focus of attention is narrowed. However, this focus is expanded when one moves from concentration to meditation or *dhyana*. Meditation helps to concentrate longer, to fix attention on any object for a length of time. When this is achieved, the psyche progresses to a standstill state in which the mind is steady and becomes one with the object of concentration. The triple effort of *dharana-dhyana-samadhi* is called *samyama*. According to the *Yoga Sutras*, one could achieve supernormal powers by doing *samyama* on a variety of things.

Buddhistic Meditation as a State

The original source of Buddhistic psychology is the *Abhidamma Pitaka*. Especially important is its first book, *Dhamma-Sangani*, which is a compendium of states of consciousness. It is generally agreed that *Dhamma-Sangani* was compiled toward the end of the fourth century B.C. Buddhaghosha of the fifth century A.D. wrote a commentary on it entitled *Atthasalini*. Buddhaghosha's *Visuddhimagga* is the most important source book for understanding Buddhistic meditation. It includes a very detailed and insightful account of the surroundings and attitudes needed for meditation as well as a comprehensive description of the specific ways of training and focussing attention to attain the most profound and subtle meditative states.

The goal of meditation is transcendence, *nibbana* (Pali) or *nirvana* (Sanskrit). *Nibbana* is a state of perfect equanimity. It is a state in which one has objectless awareness which is neither perception nor its opposite. Buddhism has worked out elaborate procedures to enable one to achieve such a state of transcendence. The eight-fold practices of the Theravada tradition, for example, involve: (1) scrupulous observance of moral precepts (*silas*), (2) practice of meditation (*samadhi*), and (3) realization or understanding

(*panna*). These disciplinary rules are found in great detail in the *Vinaya Pitaka*. The general direction of all these precepts is to overcome the basic obsessions, namely, greed, hatred and delusions, and to control the tendencies of attachment, aversion, wrong thoughts, and ego.

Panna or understanding is also given great prominence in Buddhism. A person who dispels ignorance through understanding may become an *arahant*. Apparently it is believed that some may attain transcendence by understanding alone, as prescribed in various states of *jhana*. Such a person is called *panna-vimutto*, whereas a person who achieves transcendence through successive states of meditation is called *ceto-vimutto*. As Buddhism allows the possibility of achieving transcendence through insight and understanding (*panna*), the path of understanding is sometimes interpreted as another form of meditation. Thus, a distinction is often made between concentrative meditation and insight meditation. While it is entirely correct to say that there are two paths for achieving transcendence, that of *jhana* and *panna*, only the former may be legitimately called meditation. The confusion is probably due to the fact that they are not mutually exclusive.

Visuddhimagga gives minute details of the processes involved in attaining the various states of meditation from the lowest to the highest. Five types of variables have been identified. They are (1) the hindrances to achieving a state of meditation, (2) the object of meditation, (3) the teacher, (4) the meditator, and (5) the process of meditation.

All meditation should have an object on which one could fix attention while he or she is in a state of meditation. Theoretically, there can be any number of objects for achieving meditative states. However, tradition speaks of only forty of these.

The need for choosing a competent teacher is highly emphasized in Buddhist practices. The *guru* is the guide who leads the meditator to a state of right concentration through a difficult terrain full of obstacles. The *guru* or teacher should have mastered the fourth and fifth *jhanas* and become an *arahant*.

The teacher, after understanding the disciple's basic disposition and character, recommends suitable objects for meditative practice. For example, for behavior characterized by lust, the ten *asubhas* that involve a corpse as an object of meditation are recommended; for *dosa*, or hatred, one of the four *brahmaviharas* is recommended. Thus, the choice of an appropriate object for meditative practice has a very prominent place in the Buddhistic meditative system.

The preparation for meditation involves certain preliminary practices and two kinds of exercises before one enters a *jhana* (meditation) state. Eight successive states of meditation are distinguished. The preliminaries include offering invocations to the Buddha, *Dhamma* (moral law) and *Sangha* (the order of monks following the Buddha), prayers for happiness of all beings, confession of one's guilt, and faith in the teachings of the Buddha. Sitting cross-legged and erect, the disciple performs a series of exercises. The first one is *upacara*, which has three steps. In the first step, the meditator fixes his attention on the object of his meditation. In the second, the meditator is able to form a vivid and distinct mental image of the object. In the third state, the meditator attempts to make the mental image clearer and brighter than the object itself, but devoid of such characteristics as color, form, and size. In the state of *upacara*, the meditator's mind still wanders, having not yet reached a state of steady concentration.

The next step from *upacara* is *appana*. In this state, the meditator is able to fix his attention on an object for a long period, and his concentration becomes strong and steady. In order to attain this state, the meditator should sever the connection between his subliminal consciousness (*bhavanga citta*) and the object in order to reflect on the mental image of the object without activating the *bhavanga*. When he is able to do this for some duration, he enters the first stage of meditation (*jhana*).

At this point the meditator should continue to direct his mind to the object and engage in a steady concentration of the mind. The first four stages of meditation are attained by practicing concentration on a suitable object to induce *upacara* and *appana*. Thus, the attentional focus and the single-pointedness of the mind are present in all four of

these *jhana* states. In addition, there are four higher stages which are achieved by meditating on the four *arupas*, namely, unlimited space, unlimited consciousness, nothingness, and a condition of neither perception nor nonperception.

Contemporary Interpretations

Meditation techniques as employed in various classical and contemporary religious traditions have been described by several contemporary writers. Daniel Goleman (1978) surveyed fourteen different techniques and argued that all of them employ essentially one or two methods described in *Visuddhimagga*. These are concentration (focusing attention on one object) and mindfulness (focusing attention on bare sense impressions), and they involve redeployment or, as he termed it, "retraining" of attention. As Goleman (1978) writes: "The need for the meditator to retrain his attention, whether through concentration or mindfulness, is the single invariant ingredient in the recipe for altering consciousness of every meditation system" (p. 111).

Describing meditation as "the pursuit of a certain state of mind . . . a mental process rather than a mental content," Naranjo points out that its practices "generally involve an effort to stop this merry-go-round of mental or other activity and to set our attention upon a single object, sensation, utterance, issue, mental state, or activity" (Naranjo & Ornstein, 1971, p. 10). Naranjo distinguishes three kinds of meditative practices. His classification is based on the object of meditation rather than on any intrinsic differences in the meditative process itself. In concentration meditation, the meditator focusses on "externally given symbolic objects . . . attempting to interiorize an externally given form." In absorptive meditation, the object of focus is any of the "spontaneously arising contents of the mind." The third form, neither "outer-directed" nor "inner-directed," involves an effort "to attain a stillness of the mind's conceptualizing activity, a withdrawal from external perceptions and internal experience alike" (p. 18). Naranjo is merely paraphrasing the final three steps of Raja Yoga practice, *dharana, dhyana*, and *samadhi*. They are not different inasmuch as one

practice may lead to the other. Successful meditation may involve a combination of the three practices, as presumed to be the case in Raja Yoga when one practices *samyama.*

On the psychology of consciousness, Ornstein refers to two general varieties of meditation: "those exercises which involve restriction of awareness . . . and those which involve a deliberate attempt to 'open up' awareness of the external environment" (Naranjo & Ornstein, 1971, p. 144). An essential element in many meditative practices is the actual "restriction of awareness" to a single, unchanging stimulus. Ornstein finds the object of meditation much less important than maintaining it "as the single focus of awareness over a long period of time" (p. 161). In concentrative meditation, the focus on an unchanging stimulus causes a diminished awareness of the external environment, leading to a "blank out" that permits expanded awareness of faint signals that otherwise would go unrecognized. An analogy is that of the dark night when the stars are visible.

Taking a totally secular view of meditation, psychologist Jonathan Smith (1986) sees it "not so much as a technique but as a set of skills" (p. 4). According to Smith, the essence of meditation is to learn how to (1) avoid physical tension and be physically calm; (2) overcome distraction and be able to focus attention on a task for a period of time; and (3) give up over-control and let yourself be "fully and restfully involved in what you are doing." Smith apparently brings an eclectic approach to a clinical application of meditation by combining it with other techniques of relaxation. However, it is not difficult to see that avoiding tension and distraction are considered to be essential preliminaries for successful meditation. Meditation proper, however, is limited to the attentional part, whether it is achieved via concentration on an object, external or internal, or passive and effortless awareness of spontaneous mentation.

Some Meditative Techniques Used in Research

Transcendental Meditation

Maharishi Mahesh Yogi's transcendental meditation (TM) is probably the single most extensively researched meditative technique (Orme-Johnson & Farrow, 1977). This is because: (1) Mahesh Yogi, himself a student of science, is not averse to subjecting his technique to scientific scrutiny, and therefore his organization has encouraged and even supported such research; (2) the large number of TM practitioners available for research is an attraction for many researchers; (3) the technique itself is simple and easy to practice; and (4) more importantly, as it has been uniformly taught by those trained in the TM organization, it appears to be a standardized technique.

Basic to TM is the premise that in addition to the known states of wakefulness, sleep, and dreaming, there is a transcendental state of consciousness which is blissful (Mahesh Yogi, 1963a, 1963b). It is a state that is physiologically necessary, like sleep and dreaming, to relieve stress and rejuvenate our whole system. Meditation is a means of reaching the transcendental state.

It is claimed that Mahesh Yogi's system is different from others, especially the classical ones, in two crucial respects. First, there is no need for elaborate preparation for practicing TM because virtuous life is a consequence of the experience of transcendental consciousness rather than a prerequisite for attaining it. Secondly, the transcendental state is blissful, and the natural tendency of the mind is not to wander aimlessly, but to move in the direction of experiencing bliss. Therefore, the movement toward the transcendental state can be quite effortless and natural. Meditation, then, need not involve special effort to hold our attention steadfast. It happens easily if we allow ourselves to experience it.

In TM, each initiate is given a Sanskrit mantra by the teacher, and meditation consists in repeating this *mantra* mentally. In the words of its founder, one turns "attention inward towards the subtler levels of a thought until the mind transcends the experience of the

subtlest state of the thought and arrives at the source of the thought." Meditation is described as the process of developing systematic contact with the source of thought, pure awareness. TM meditators are told to avoid any mental effort to concentrate on the *mantra*, and to gently bring their attention back to the *mantra* when it wanders. The teacher apparently decides which of the various *mantras* is the most appropriate for a given individual. The *mantra* itself remains a secret, and the practitioner is asked not to reveal it to anyone.

The initiation into TM involves a series of two orientation lectures in which the benefits of meditation are explained, and positive expectations are built up. Then the would-be meditator is instructed on how to passively attend to the *mantra* while covertly repeating it. Follow-up meetings clear up questions the novice meditator may experience. The meditator is advised to practice twice daily sitting comfortably in a quiet environment for about twenty minutes with the eyes closed. It is estimated that over a million people were initiated into TM in the USA alone (Orme-Johnson & Farrow, 1977).

Benson's Technique

Benson was among the first, along with Wallace, to carry out some well-known research on TM which is cited as evidence that its practice can help lower the metabolic rate (Wallace, Benson & Wilson, 1971; Wallace & Benson, 1972). Benson later developed his own technique of meditation which, he claimed, produces similar effects but is noncultish (Beary & Benson, 1974). The "relaxation response," as he called it, is a low-arousal hypometabolic state which can be produced by a variety of techniques. Physiologically, it is described as an integrated hypothalamic response with parasympathetic dominance and decreased sympathetic activity (Benson, Beary, & Carol, 1974). The relaxation response may be obtained without any *mantra* or *puja* rituals associated with TM. In Benson's method, the meditator, after some muscular relaxation exercises, sits in a quiet environment and passively concentrates on breathing, counting "one" each time he or she exhales. When distracting thoughts come up, the meditator attempts to ignore them and count "one,"

coordinating with outer breath. Benson's contention that all meditation techniques produce a common pattern of physiological changes is questioned by Schwartz, Davidson, and Goleman (1978), who maintain that more specific patterns of physiological responses may be superimposed upon the relaxation response by the particular meditative technique employed.

Carrington's CSM

Patricia Carrington felt that there were several disadvantages in using TM for research. Firstly, as TM is associated with a quasi-religious movement with strong support groups and high expectations built into its practice, it is difficult to assess accurately the extent to which the observed effect is contributed solely by meditation, not by other factors. Secondly, TM followers claim that the *mantra* is very important for meditation, but the *mantra* itself is kept secret. This makes it very difficult to study TM scientifically and assess the role of the *mantra*. Thirdly, in order to obtain the cooperation of the TM organization, the research proposals must first be submitted to them for approval. They seldom grant permission for comparing TM with any other technique, which makes it difficult to carry out comparative studies of different meditation techniques. For these reasons, Carrington (1977) devised her own type of *mantra* meditation, Clinically Standardized Meditation (CSM), that could be used in clinical practice and research.

CSM is quite similar to TM without the latter's expectations and mystery surrounding the *mantra*. In CSM, the choice of the *mantra* is left to the individual, who chooses one among the sixteen *mantras* in Sanskrit that Carrington collected. It is even possible for the meditator to concoct his own *mantra* by following some simple rules.

Similar to TM, the instructions for CSM dwell on the effortlessness of meditation. The meditator is asked to choose a *mantra* and first say it aloud with the eyes open. Repeating it more and more softly, one then drifts gradually, with the eyes now closed, into

a state where one simply listens to the *mantra* repeated internally. The meditator, sitting peacefully, thinks the *mantra* without saying it. Carrington writes:

> That is all there is to meditating, hearing the mantra in your mind, allowing it to change any way it wants--to get louder or softer--to disappear or return--to stretch out or speed up. . . . Meditation is like drifting on a stream in a boat without oars--because you need no oars--you are not going anywhere (1977, pp. 79-80).

Meditation as Deployment of Attention

Meditation, in classical terms, is a pursuit of transcendence from the constraints of the human condition. It is a quest for perfection, a quest to experience reality in and of itself, unblemished by the sensory modalities. As we travel on this path to perfection, we find ourselves on new frontiers of unfolding human potentials that hitherto have lain dormant and hidden from us. It is hardly a concern of the traditional meditator to lower anxiety or control blood pressure. In fact, such concerns are considered preparations for meditation.

In the traditional yoga system, for example, cultivation of certain attitudes, habits, and the practice of physical and breathing exercises precede meditation. They are preliminary steps that enable one to practice meditation more efficiently. If the purpose of yoga is to gain control over one's mind through meditation, all distractions that hinder such concentration and attentional focus must be overcome. It seems, therefore, that the goals of contemporary meditative systems to help achieve psychosomatic well-being seem to be somewhat misplaced.

There are many important differences between classical and contemporary approaches to meditation: (1) Classically, meditation is a rigorous discipline practiced for many years before one considers himself to be proficient; (2) teaching meditation in traditional systems requires close supervision, personalized attention, and constant guidance; (3) meditation is preceded by several preparatory steps that are considered necessary; and (4) good health and well-being are not effects but necessary conditions for practicing

meditation. Despite these differences there is an underlying theme behind most meditation practices.

The commonality among all systems of meditation has to do with attention, as most reviewers of the variety of religious practices seem to agree (Goleman; 1978, Naranjo & Ornstein, 1971). Attention is the essence of yoga, the control of normal mental functions (*chitta vrittis*). In his commentary on the *Yoga Sutras*, Vacaspati Misra defines attention as the focusing of the mind on one object to the exclusion of others. According to Buddhaghosha, attention narrows the focus of consciousness and makes the object of attention distinct.

As Davidson and Goleman (1977) suggest, meditation appears to be one of the oldest techniques for self-regulation of attention. Both forms of meditation, concentrative and passive, involve manipulation of attention. Although the object of attentional focus may differ, attentional deployment is at the core of all meditative practices.

Meditation is not a psychic development technique as is often assumed. Sustained focused attention would lead to a state of absorption and expanded awareness that transcend the limitations imposed by the normal psychobiological processes, an awareness that gives unbiased knowledge. In order to attain a sustained attentional focus, it is necessary to avoid distractions. In addition, other benefits such as psychological and biological well-being may accrue, but they are not a direct result of meditation. Despite the fact that meditative practices can help us gain volitional control of autonomic processes or achieve psychic abilities, they should not be regarded as the essence of meditation. Classical systems warn us against pursuing those ends because they become hurdles on the path to perfection.

Studies of Meditative States

There are already a number of excellent reviews of the psychophysiology of meditation (J. M. Davidson, 1976; Schuman, 1980; and Holmes, 1984). Therefore, this paper will only point out what seem to be some of the salient findings. Much of scientific research on meditation has assumed that it is a state. As Schuman (1980) notes, "based on research involving practitioners of Yoga, Zen, or Transcendental Meditation (TM), meditation has been considered a unique psychophysiological state, associated with a distinct configuration of autonomic and electrocortical changes" (p. 333). Studies on meditation have tested three major hypotheses: that the practice of meditation produces a unique state, that it lowers arousal, and that it is conducive to the manifestation of psychic abilities. The status of these claims will be discussed.

Wallace (1970b) concluded his study of 27 TM meditators with the assertion that "transcendental meditation produces a fourth major state of consciousness which is physiologically and biochemically unique" (p. 107). Wallace reported significant decreases in oxygen consumption, carbon dioxide elimination, cardiac output, heart rate, and respiration rate during meditation as compared to pre- and post-meditative periods in the same subjects. Significant increases in skin resistance, changes in certain EEG frequencies, and marked decrease in arterial lactate were also noted during meditation.

The findings of Wallace were considered to be the first major scientific confirmation of some of the claims made for TM and to support the contention of Mahesh Yogi that there exists a transcendental state, identifiable by measurable physiological changes, a state easily accessible to those practicing a simple technique of meditation. Wallace's findings have become the basis of further research.

Earlier there were several sporadic efforts to identify physiological correlates of meditative practices. Perhaps the first attempt was made in 1935 by the French cardiologist Therese Brosse (1946). Das and Gastaut (1955) tested seven practicing yogins and observed an increase of EEG alpha frequency by 1 - 3 Hz with a decrease in amplitude, and beta

wave activity appearing in the range of 15 - 30 Hz, which appeared to correlate with subjectively experienced "mystical" states. This observation was largely ignored until another Frenchman, J. P. Banquet (1973), using a more sophisticated EEG analysis, found in four of his TM subjects a stable and continuous beta activity at 20 Hz against a persistent background of alpha and theta activity as they approached deeper states of meditation.

A series of studies were also carried out on Indian yogins and Zen practitioners. Bagchi and Wenger (1957) did not find any changes in the alpha activity of 14 Indian yogins between the meditation and rest periods. However, they did find decreased respiratory rate and increased skin resistance that indicated a state of deep relaxation of the autonomic nervous system without drowsiness or sleep (Wenger & Bagchi, 1961). Anand, Chhina, and Singh (1961) reported that their meditating Indian yogins who produced persistent alpha activity did not show any alpha blocking to external stimuli. Working with Zen meditators in Japan, Kasamatsu and Hirai (1966) also observed an increase of alpha activity during meditation. But their subjects, unlike those tested by Anand, et al., showed EEG patterns that resemble the alpha blocking response of the waking state when external stimuli were applied to them. However, they showed no evidence of the habituation to recurring stimuli we find in normal subjects.

The remarkable difference in the findings of Anand, et al., and Kasamatsu and Hirai may result from the difference between the two meditative practices of their subjects. Yogic meditation is a concentration type of meditation, whereas in Zen meditation one allows the free flow of all sensory inputs, to which one passively attends. In other words, the concentrative meditative practices lead to decreased reactivity to external stimuli, whereas "mindfulness" or insight meditation helps to maintain alertness at an unusual level (Johnson, 1970; Mills & Campbell, 1974). If this interpretation is correct, one could regard the two types of meditation, Zen and Raja Yoga, as physiologically distinct.

However, this interpretation is problematic on several grounds. In an early review of the physiology of meditation, Davidson (1976) pointed out that the alpha blocking responses of the Zen meditators in the study by Kasamatsu and Hirai (1966) are essentially

uninterpretable. The Zen masters meditated with their eyes open and the control subjects were tested with their eyes closed. Consequently, the EEG measurements of the latter cannot be regarded as true controls. In addition, there were too few subjects in these studies--three subjects in the Zen study, and four in the study by Anand, et al.(1961). Until replications with refined methodologies are made, it would seem premature to conclude that a case has been made for differential reactivity to external stimuli by Zen and yogic meditators. The study of Banquet (1973), which is sometimes cited as a confirmation of the finding of Anand, et al., regarding the failure to elicit alpha blocking in meditators, was carried out with TM practitioners. However, TM is more like Zen than the concentrative meditation of *Raja yogins* tested by Anand. In an attempt to replicate the findings of Anand, et al., and Kasamatsu and Hirai, Becker and Shapiro (1981) tested thirty experienced Zen, yoga, and TM meditators, along with twenty college student controls. They found that EEG alpha blocking and skin conductivity response both showed clear habituation in all groups without any significant difference between them. Schuman (1980) concludes:

> Even assuming the basic effects to be replicable, it does not follow that changes in the alpha-blocking response are necessarily due to the meditative ASC achieved through mindfulness and concentration practices. Differences in cognitive set during meditation might account for differences in alpha blocking apart from the induction of an ASC (p. 360).

There is, however, a general tendency for meditating subjects to produce greater alpha activity, whatever the form of meditation (Anand, Chhina & Singh, 1961; Akishige, 1968; Kasamatsu and Hirai, 1966; Banquet, 1973; Glueck & Stroebel, 1975). Also, Banquet (1973) as well as Kasamatsu & Hirai (1966), found theta activity, especially among the advanced practitioners. Another interesting finding is the intrahemispheric coherence of EEG during meditation (Banquet, 1973; Rogers, 1976; Orme-Johnson, 1977). Orme-Johnson characterized such a coherence as, "the EEG signature of the transcendental state."

Is Meditation a Unique Physiological State?

The presence of slow-wave EEG activity, reduced oxygen consumption and carbon dioxide elimination, reduced heart rate, and increase of skin resistance during meditation were claimed by Wallace as indicating a unique physiological state of profound relaxation, a wakeful hypometabolic state. However, many of the same autonomic-metabolic changes are found also during sleep and drowsiness. In fact, in a study by Pagano, et al., (1976), the EEG records of five male subjects who had been practicing meditation for over 2.5 years were obtained when they were meditating (TM) and when they were taking a nap while sitting. Analyses of the data showed that, "(1) during TM, meditators spent 39.2% in stage W (wakefulness), 19.2% of time in Stage 1 EEG sleep activity, 23.0% of time in Stage 2, and 16.8% in Stages 3 and 4; (2) there were no significant differences between meditation and nap sessions in the amount of time spent in sleep stages 2, 3, or 4" (Pagano, & Warrenburg, 1983, p. 156).

This study raises questions about the physiological uniqueness of the meditative state. In fact, the experiments of Wallace were criticized on the grounds that he did not have nonmeditating control subjects. Some of the results Wallace found in his original study, such as a large 16% decrement in $V0_2$ during meditation, appear to be exaggerated because the baseline values of his subjects in the resting period were 9% above the expected base value. Davidson (1976) pointed out that:

> (a) TM represents a state of profound physiological rest, greater than that attainable with sleep of much longer duration; and (b) the specific changes in consciousness and the unique (and, in my opinion, unquestionable) benefits of meditation are somehow linked to the physiological changes discussed above still seem to lack a solid basis in experimental fact (p. 354).

Davidson's assessment has been supported by later reviews as well. On the basis of the results of their own experiments and a review made by others, Pagano and Warrenburg (1983) concluded:

> We regret to report that our search for a unique or dramatic effect directly attributable to meditation thus far has not been successful. . . . Our experience has been that when good

scientific methodology has been used, the claims made have been extravagant and premature (p. 203).

Meditation and Arousal

In an important review of experimental literature on meditation and somatic arousal reduction, Holmes (1984) concluded that across experiments or measures there is no evidence that meditating subjects show lower levels of arousal than resting subjects, and "the most consistent finding was that there were not reliable differences between meditating and resting subjects" (p. 5). Holmes pointed out that the studies fall into three groups: (1) case studies, (2) experiments in which the subjects served as their own controls, and (3) experiments with independent control groups. Case studies, inasmuch as they lack controls, cannot serve as empirical tests of a hypothesis. Experiments in which the same subject served as his or her own control at best provide equivocal evidence. Much of the evidence in support of the hypothesis that meditation lowers somatic arousal comes from experiments with the subjects serving as their own controls. Such evidence, however, is not sufficient to prove that meditation lowers arousal more effectively than simple resting, because the subject expectations may be critical. Meditators generally believe in the efficacy of meditation over resting, and this may be sufficient to cause the observed differences. Holmes pointed out that none of the experiments in which proper controls were provided gave evidence that meditation reduces somatic arousal significantly better than resting. He argued that:

> not one experiment provided consistent evidence that meditating subjects were less aroused than resting subjects. . . . Indeed, there does not even appear to be one bad experiment offering consistent evidence that meditation reduces arousal more than sleep (p. 6).

Meditation and Psi

The belief that the practice of yoga and meditation enhances one's psychic abilities is a very old one; however, scientific investigation of this is only recent. A review of the experimental studies as well as their implications may be found in Rao (1991).

Schmeidler (1970), who was the first to attempt a systematic study of meditation and psi, found her subjects scoring high on an ESP task following a brief instruction in meditation and breathing. The subjects in this study first did an ESP run by attempting to identify the concealed symbols printed on cards. Then they listened to a swami's lecture on meditation, performed the prescribed breathing exercises, and made a second ESP run. The results of this study showed that while the performance in the first run was close to chance expectation, the scores in the second run were significantly more than chance, suggesting that meditation may have been responsible.

Osis and Bokert (1971) carried out three correlational studies and found meditation and ESP to be related in a complex manner. The meditative practices of the subjects in this study varied; they were encouraged to use their own preferred techniques that included Zen and Raja Yoga methods, self-hypnosis, and depth imagery concentration. The ESP tests employed were both forced-choice and free-response tasks. The forced-choice test was a version of Burgmans's checkerboard test, which the subject attempted to identify one of the 48 squares on a checker board that the agent hidden from the subject was trying to transmit telepathically. The free-response test involved guessing pictorial slides. Questionnaires designed to measure changes in the state of consciousness were administered before and after each session. The ESP tests themselves were given after a period of meditation.

A factor analysis of the questionnaire material revealed three stable factors. Of these, that of "self-transcendence and openness to experience" was found to be associated significantly with ESP scores. The investigators concluded that the meager correlations between meditative experiences and ESP might be due to the subjects' experiencing the ESP

tests as interruptions to their meditation, thus causing "task rivalry" and possibly a preferential effect.

In a PK study by Matas and Pantas (1971), subjects who had experience with some form of meditation meditated for 15 minutes before they attempted to influence by PK a random event generator. The results of the meditators were found to be significantly better than those of control subjects who performed identical tasks without meditating. In three series of experiments, Schmidt and Pantas (1971) found that a single subject performed significantly over chance on a PK task after practicing Zen meditation for 20 minutes prior to the test.

At Andhra University, Rao, et al., (1978), carried out a series of forced-choice and free-response ESP tests to see whether subjects would obtain higher ESP scores after meditation than before. The same subjects were tested in pre- and post-meditation sessions, thus, acting as their own controls. Fifty nine subjects who were practicing a nonstandardized form of meditation at Anandashram in Pondichery participated in this study. The results showed that subjects obtained significantly better ESP scores in tests immediately preceding meditation than in tests carried out before the subjects meditated. Interestingly, the subjects obtained significantly fewer hits in premeditation sessions than would be expected by chance.

While the results of the above studies do suggest a positive ESP score for meditating subjects, it is difficult to argue that these experiments support the hypothesis that meditation enhances one's psychic ability. Like the studies of meditation in other areas, ESP-meditation studies suffer from a lack of appropriate controls.

Conclusion

Contemporary meditation research, as we have seen, is characterized by some insightful reviews, a few good experiments, but a great many marginal studies and many exaggerated claims. Part of the problem may be due to the personal convictions of some

of the researchers and the jealous commitment of some of the organizations supporting them. The major issues, however, are conceptual and methodological, and not ideological. Secularization of meditation has been a healthy development even if at times it has taken a wrong direction for lack of conceptual clarity. Scientific research is basically empirical. Therefore, methodological questions are of primary concern. Yet conceptual issues cannot be ignored for a meaningful understanding of the phenomena.

As we have seen, there are many methodological questions that severely limit the generalizability and interpretation of results of most experimental studies in this area. The experiments with subjects acting as their own controls do not provide unequivocal results. There should be adequate safeguards against the contamination by subject expectations. That the subjects in the premeditation task by Rao, et al., (1978) obtained fewer ESP hits than expected by chance clearly suggests the role of expectation.

Much of meditation research suffers from failure to control for the amount of training and experience subjects have had in practicing meditation. Not only is the length of time subjects have practiced meditation important, but the intensity and quality of meditative practice are extremely relevant. As D. H. Shapiro (1983) aptly noted, traditional practices of meditation are long-term, involving arduous discipline. Typically the Western meditators tested in our laboratories were relatively new to meditation and with relatively little experience, and the techniques employed seem to have been little different from relaxation exercises. For research purposes, the distinction between short- and long-term meditation can not be ignored. In instant meditations like TM, which, it is said, can be learned in just a few sessions by almost anyone, we cannot be certain of the effective manipulation of the independent variable. For example, if the results show no difference between meditation and resting conditions, this may be due to the subjects' failure to get into the presumed meditative state. The inability to objectively measure the depth of meditation, as in hypnosis, for example, is a serious constraint on meditation research. The claim that meditation can be taught to almost anyone in just a few sessions and that its effects manifest themselves almost instantly is unsubstantiated and contrary to the classical conception. Unfortunately, many of the experimental studies of meditation have been based on this

questionable assumption. Large individual differences among meditators, their background, personality, and training have been mostly ignored.

There are also serious methodological questions in the selection of subjects (Holmes, 1984). In any investigation of long-term meditators, we may be dealing with certain types of persons who may be different in important respects from those who do not choose to learn meditation or are unable or unwilling to practice after learning. Some kind of self-selection may be involved with the subjects who participate in meditation experiments.

There may also be statistical problems in comparing the data of meditating and nonmeditating subjects, unless we control for the initial difference between them. Regrettably this was not done in most studies of meditation. Even small baseline differences can produce pronounced effects with physiological measures (Holmes, 1984).

It is not surprising that no consistently significant differences between meditation and relaxation procedures were found. It is obvious to anyone familiar with classical meditative practices that there is a world of difference between them. Sitting quietly and getting oneself into a passive and relaxing mood may not be expected to produce effects very much different from other methods of relaxation. The crucial point in meditation, as we have seen, is the deployment of attention that distinguishes it from simple relaxation exercises. Unfortunately, few studies have attempted to investigate the role of attention in meditation, even though many researchers recognized its central place in meditation.

An exception here is the work of Pagano and associates (Pagano & Frumkin, 1977; Frumkin & Pagano, 1979; Pagano & Warrenburg, 1983). Following the speculation of Ornstein (1972) that meditation may bring about an attentional change resulting in a shift in the relative hemispheric dominance of the brain from analytical and verbal to more intuitive and holistic, Pagano and Frumkin (1977) designed a series of studies to test whether right-hemispheric (RH) function of the brain would dominate among those practicing meditation. They tested three groups of subjects: (1) long-term TM meditators, (2) novice TM meditators, and (3) nonmeditators. The first two experiments in which the

tonal memory scores of the groups were obtained showed results "consistent with the hypothesis that the relatively long-term practice of TM produces a shift in information-processing strategy toward greater involvement of the right hemisphere" (Pagano & Warrenburg, 1983, p. 177). Follow-up experiments confirmed the finding that long-term meditators score significantly better on the tonal memory test. It was also found that the nonmeditating group obtained better scores on cued verbal memory, considered to be a left-hemispheric (LH) dominant task, than the two meditation groups. In five other tasks relating to hemispheric dominance, no significant differences between the groups were found.

Further analyses of the results in terms of drop-outs and those who continue the practice of meditation as well as EEG asymmetry data led Pagano and Warrenburg (1983) to conclude:

> our original hypothesis that meditation globally facilitates RH- and impairs LH-dominant information processing was not supported. Rather, our performance differences are most likely due to characteristic traits of meditators prior to learning meditation (p. 190).

This finding lends support to the preparatory stages that have been uniformly emphasized by classical meditation systems.

Whether or not meditation involves any shift in hemispheric dominance, attention undoubtedly is central to meditation. The important work of Broadbent (1958) and that of Hernandez-Peon (1964) on the physiological correlates of attention notwithstanding, the nature of the attentional process still remains far from being understood. This is essential for systematically exploring meditation in the laboratory. If attention is the process of regulating inputs into our awareness, intentionality signifies voluntary attention. Intentional use of attention, such as intense attentional focusing on an object so as to be absorbed in it, may bring about radical alterations of awareness itself.

However, attention, albeit manipulated, is not the end point. Attention should lead to absorption. In yoga *dhyana* is a practice beyond *dharana* (concentration). The distinction

between *dharana* and *dhyana*, and in Buddhistic terms, between *appana* and *upacara*, should not be overlooked. The need for developing appropriate criteria for identifying and measuring the meditation "depth" cannot be overemphasized either.

If meditation is a process that involves manipulation of attention, a variety of techniques may be used and diverse state effects or even trait effects may be obtained. It may therefore be futile to look for a unique psychophysiological characterization of meditation. Instead, we should be looking at attentional phenomena. It is likely that meditative practice enables selective deployment of attention to arouse or depress specific cortical areas. I tend to agree with Schuman (1980) that cognitive variables may be more important than physiological correlates of meditation in determining the meditative experiences. As she points out,

> the available evidence supports the notion of specificity in cortical activation and suggests that EEG correlates in meditation may, in fact, be explicable in terms of specific cognitive behaviors, that is, in terms of the content rather than the context of meditation (p. 361).

Discovering physiological correlates of meditation, if they exist, is not sufficient to understand the meditation process. The urgent need now is to define adequately the phenomenology of meditation, rather than attempt to discover its neurophysiological roots. This can only be done by carefully studying the subjective experiences of highly proficient meditators, not by questioning the "instant" meditators or recording their physiological measures.

I also believe that attention is a key factor in understanding the mind/matter interface. Ordinarily attention either fluctuates randomly or is determined by environmental conditions and subject's dispositions. The subject's conditions that influence attention are themselves products of environmental or genetic determinants. For this reason, much of cognitive behavior can be understood and explained by deterministic models. However, if we construe consciousness as primary and autonomous, there should be nondeterministic

aspects to human volition and intentionality. Meditation, it would seem, is a process of promoting such voluntary attention.

One-pointed attentional focus in concentrative forms of meditation controls the random fluctuations of attention and renders attention impervious to environmental pressures and subjective bias. Even doing the so-called passive meditation, one learns to nonreactively attend to incoming signals for prolonged periods of time, which serves the same purpose of promoting voluntary attention or pure volition. In other words, meditation brings about cessation of thought-evoking habitual brain activity which normally has the effect of masking pure volition.

Enhancing pure volitional activity may effectively bring the mind/matter or the consciousness/environment interface into action and in ways that are not explicable in terms of current scientific constructs, which deny or ignore a nondeterministic role of mental functions such as free will. Consequently, if anomalous effects on the relation between mind and matter could be facilitated by manipulating volition and attention through meditation, new insights on the mind/matter interface might be gained. Thus, there is the importance of studying meditation in relation to paranormal phenomena.

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MULTIPLE PERSONALITY DISORDER: A WINDOW INTO THE ORGANIZATION OF CONSCIOUSNESS

Frank W. Putnam

Abstract

Dissociative disorders are psychiatric disorders characterized by the entry of an individual into an altered state of consciousness coupled with a marked alteration in the individual's sense of identity. Multiple personality disorder (MPD) is an extreme form of dissociative disorder manifested by the existence of separate personality states each with its own unique memories, behavior patterns, and social relationships. These alter personality states appear to represent discrete bounded units of consciousness that can be studied under laboratory conditions. Biological studies of alter personalities indicate that they have unique and consistent physiologies, exhibit specific information processing capacities, and behave as nonlinear transform functions for sensory stimuli. Studies of the psychophysiology of the switching between alter personality states permits exploration of transition dynamics as the individual moves from one discrete state of consciousness to another. The phenomena observed in MPD appear generalizable to other discrete states of consciousness and fit surprisingly well with data from studies on behavioral states in newborn infants.

Many of the important advances in science and medicine have revolved around specific disorders that disrupt normal functions, thereby providing a window into a process that otherwise would remain invisible in its normal operation. Multiple personality disorder (MPD) appears to provide such a perspective on the organization of consciousness and behavior. MPD is a condition in which the individual is organized as a collection of semi-autonomous selves, with individualized senses of identity (APA, 1987; Putnam, 1989). This condition has been reported in Western medicine for over 200 years and is probably the basis of possession states and shamanistic transformation found in most world cultures (Carlson, 1981; Coons, Milstein, and Bowman, 1990; Martinez-Taboas, 1989; Putnam, 1986; Putnam, 1989; Steinberg, 1990). Considered a psychiatric disorder in Western society, MPD is highly associated with histories of early childhood trauma, especially child abuse (Putnam, 1989). Clinically, MPD is widely regarded as an adaptive response to overwhelming trauma that becomes maladaptive when it persists outside of the trauma context or is easily evoked by minor stressors (Ludwig, 1983; Putnam, 1989).

The psychological process underlying MPD is known as dissociation. Dissociation is manifest as an interruption in the normal association of information so that thoughts, feelings, emotions, and memories are not associated or integrated with other pertinent information as they would normally or logically be (Putnam, 1991a). Dissociation occurs along a continuum of severity in terms of frequency, duration, and depth of dissociative experiences. Everyone dissociates; minor examples include daydreaming and highway hypnosis. In pathological forms, dissociation produces a set of psychiatric syndromes, the dissociative disorders, characterized by disruptions in memory and identity. In its most extreme form, MPD, the individual is composed of a series of alter personalities, who differ in cognitive age, self-perceived gender, moral values, fund of knowledge, and an array of physiological capacities and sensitivities.

Recent research with MPD patients, in which the alter personalities are studied separately and then compared with each other and with normal control subjects simulating alter personalities, has demonstrated that the alter personalties of MPD subjects often have unique physiological properties that can not be duplicated by the controls. Physiological

differences include: differences in brain electrical activity (Coons, Milstein, and Marley, 1982; Flor-Henry, Tomer, Kumpula, Koles, and Yeudall, 1990; Hughes, Kuhlman, Fichtner, and Gruenfeld, 1990; Putnam, 1984; Putnam, 1986), autonomic nervous system activity (Coons, 1988; Putnam, Zahn, and Post, 1990), differential visual function (Miller, 1989; Miller, Blackburn, Shcoles, White, and Mamalis, 1991), dominant handedness (Putnam, Guroff, Silberman, Barban, and Post, 1986), and differential allergic and medication responsivity (Putnam et al., 1986). Clinically, examples of differential psychophysiology in MPD have been reported since the early nineteenth century (Alvarado, 1989; Putnam, 1986).

In addition, studies of learning and memory demonstrate that the alter personalities of MPD subjects are capable of superior performance in compartmentalizing highly similar information (Silberman, Putnam, Weingartner, Braun, and Post, 1985). However, MPD patients also display some unusual problems with retrieval of information across alter personalities. For example, if personality A learns how to solve a problem, often that solution is not available to personality B (Nissen, Ross, Willingham, Mackenzie, and Schacter, 1988; Putnam, 1991b; Schacter, Kihlstrom, Kihlstrom, and Berren, 1989). This barrier to information transfer is particularly apparent for types of memory referred to as "implicit" memory, which involve knowledge and information generally outside of conscious awareness, but which, nonetheless can be shown to powerfully influence behavior.

The results of such studies of the differential physiology and memory retrieval capacities of different alter personalities are best understood as examples of state-dependent phenomena. The alter personalities appear to be discrete states of consciousness that serve as markers for encoding of memory and for the activation of alter personality-specific physiological responses. Other examples of state-dependent memory and psychophysiology are known and include: (1) the behavioral states associated with manic-depressive disorder (mania, depression, and euthymia); (2) catatonic reactions, in which the individual goes in and out of catatonic states characterized by dramatic and often rapid changes in motor activity and reactivity to the environment; (3) panic attacks; and (4) altered states of consciousness induced by psychedelic drugs, meditation, or extreme stress, pain, or fatigue.

State-dependent physiology and behavior are also well described in normal infants and appear to be the primary basis of early human behavioral organization (Wolff, 1987).

MPD provides many advantages for the study of the role of discrete states of consciousness in human behavior. Unlike the other conditions listed here, MPD allows the researcher to easily elicit and verify specific discrete states of consciousness, i.e., the named alter personalities. These personalities can be reliably brought out again and again for measures of consistency over time. Several alter personalities can be examined in a single session, whereas in manic-depressive illness, for example, researchers often must wait weeks to months to compare the depressed state with the manic state. The distinctness of the alter personalities greatly aids the researcher in identifying and classifying the states.

In addition to being able to collect repeated measurements on sets of behavioral states, researchers can study the transition process between states directly. This process, known as switching, involves the transition from one alter personality state to another. This can often be induced on demand and usually occurs within seconds to a few minutes (Putnam, 1988; Putnam, 1991b). At times it may involve passage through transient, unstable, intermediate states. Switches in MPD patients appear to resemble closely the transitions between behavioral states seen in normal infants, suggesting to some that the early childhood trauma experienced by the vast majority of these cases has somehow interfered with the developmental maturation of their capacity to modulate the behavioral state. Switching may provide a powerful point of clinical leverage because much of the practice of psychiatry involves attempting to get an individual out of some dysphoric or dysfunctional state of consciousness such as depression.

Future research in this area should concentrate on a number of salient issues. The first is the ability of the alter personality states to exist and function simultaneously, often in a foreground/background configuration; that is, one personality state may be in executive control of the individual's behavior, while another is monitoring the situation and making comments about the situation (experienced as voices within the individual's head). At times the background state may directly or indirectly influence the foreground state's behavior, a

phenomenon known as a "passive influence experience". A common example of passive influence is possession, in which the individual feels as if he or she is struggling with another entity for control of his or her behavior. This suggests the capacity for simultaneous existence of multiple autonomous states of consciousness within an individual.

Secondly, the psychophysiological differences exhibited by the alter personality states represent an extraordinary opportunity to probe the mind/body connections inherent in specific states of consciousness. A number of potential mechanisms have been identified that could produce such changes. Unfortunately, adequate resources have not been available to undertake the systematic study of this problem. Understanding how an individual with MPD is able to alter dramatically his or her bodily physiology by changing personality state may open the door to more focused and fruitful exploration of the power of the mind for health and healing.

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MODERN MEDICINE AND THE RELATIONSHIP BETWEEN MIND AND MATTER

Larry Dossey

I can see no other escape from this dilemma . . . than that some of us should venture to embark on a synthesis of facts and theories, albeit with second-hand and incomplete knowledge of some of them--and at the risk of making fools of ourselves.[1]

--Erwin Schrödinger

But if you stop clinging to coincidence and try explaining this trumpery affair, you might shatter one kind of world.[2]

--J.B. Priestley

Abstract

The historical legacy of the healing arts affirms the importance of "higher" factors in health and illness--thoughts, emotions, attitudes, perceived meanings. Against this backdrop, which spans thousands of years, the dismissal of the potency of consciousness by modern medical science seems a distinct historical aberration.

This position in medical science is ironic because of an increasing body of scientific knowledge in all major disease categories affirming the power of consciousness to change the material state of the body. The importance of these data is generally dismissed by effectively defining consciousness out of existence--i.e., by equating it with the workings of the brain, by regarding it as an epiphenomenon of physical activities in the body, by considering it as an emergent property of matter, etc. This approach to consciousness effectively annuls the impact of the "consciousness studies" in various clinical settings. As long as this attitude toward consciousness is dominant, it is difficult to imagine how more and similar studies might engender a different belief about the pivotal role of consciousness in health and illness.

Studies of a different kind, however, are emerging; studies which seem to demonstrate that consciousness can do what the brain cannot do. These studies, thus, cannot be dismissed by a physicalistic reduction of consciousness. They demonstrate

a decidedly nonlocal character of consciousness showing that it is unconfined to specific points in space (brains, bodies) or time (the present moment). These studies are exceptionally relevant clinically because they suggest that consciousness can bring about remarkable changes in the course of human illness and can make the difference between life and death. This genre of effects has been demonstrated not only in medical settings such as coronary care units where human bodies are involved, but also in controlled experiments involving simple biological systems such as germinating seeds and yeast cultures. These studies are particularly troublesome philosophically because they suggest that consciousness can engage in action-at-a-distance.

The nonlocal qualities of consciousness contain implications that are decidedly spiritual because they suggest an aspect of the psyche that is omnipresent and unbounded by time--features that have traditionally been attributed in the West to God. They also lead to the idea of an unbounded, universal, single mind--an idea developed in some detail by the physicist Erwin Schrödinger and, most recently, by the physicist Henry Margenau.

Introduction

In modern medicine, the concepts of consciousness and mind have fallen on hard times. When mind and consciousness are spoken of in medicine today, they are usually equated with the workings of the brain, or described in terms of artificial intelligence and information processing. As an example, in an admirable recent book, Howard Gardner's *The Mind's New Science: A History of the Cognitive Revolution*[3], the word "consciousness" is not even listed in the index. "Mind", which is included, commands eighteen references. Fourteen of these, however, refer to "mind and computers"; and the final, prophetic directive for "mind" is "see also brain." This example is not unique. A few years ago a new textbook of neurology was published in which the word "mind" did not even appear. When the authors were asked how they could write a textbook about the workings of the brain and the nervous system without speaking of the mind, they replied that they found it completely unnecessary to introduce the concept. Thus a strange silence has fallen over the lecture halls of almost all our medical schools on these issues, which go almost completely unexamined.

The reasons for this are not obscure. Today almost all physicians are taught that the human mind is not primary or fundamental but derivative, a function of physiological processes in the brain and body. This view has been succinctly summarized by astronomer Carl Sagan: "[The brain's] workings--what we sometimes call mind--are a consequence of its anatomy and physiology, and nothing more."[4]

The influence of this materialistic approach to the mind in medicine is simply enormous. There are no strong contending points of view. People outside medicine may not believe this. Many seem to think that medicine is on the verge of a radically new view in which the mind is accepted as a causal factor in shaping events in the physical body. This is suggested by the appearance within the last decade by entirely new disciplines such as psychoneuroimmunology. However, implicit in all these new developments is the same rigid, materialistic concept of the mind that was there all along. When "mind" or "psyche" are referred to, as in psychoneuroimmunology, it is really the activities of the brain that are

the key concepts. Scratch the surface of the new "breakthrough" areas, and the materialistic view of the mind remains.

That is why it seems futile to recite even landmark studies pointing to the potency of the mind in the world of medicine, in spite of the fact that thousands of such studies exist, encompassing all major disease categories. But virtually all of them are variations on a theme--and that theme has not changed. It continues to reflect the view that the mind is nothing more than the workings of the brain.

Thus it may be that there is little to be gained by focusing on mind-body research of the usual sort, i.e., studies that focus solely on the physiological changes within individuals that result from a change in certain psychological variables. There is a flood of data of this sort already, as mentioned. Some of these studies are indeed remarkable. Examples include the ability of persons with high cholesterol levels to lower them up to one-third by regularly assuming a silent, meditative state;[5] the generation of life-threatening cardiac arrhythmias by noxious psychological states;[6] the ability of certain persons to mentally influence the activity of certain immune cells within the body;[7] and the ability to intervene mentally in severe, disfiguring congenital disease.[8] Remarkable as these studies may be, recitation of them becomes tiresome; they simply have not been convincing in reorienting our basic ideas in medicine about the relationship between mind and matter. For, again, in all these sorts of cases it is generally assumed that any apparent effects of the mind can be completely explained by the activities of the brain. Thus, strictly speaking, these are not "mind-body" studies at all but "brain-body" studies--exercises in materialistic science.

A New Kind Of Experiment

What could conceivably break this impasse? One possibility is a qualitatively new kind of experiment--one that demonstrates that the mind can do things the brain cannot do, an experiment whose results cannot be explained by regarding the mind as "brain in disguise". Such an experiment would conform to the vision of one of the greatest physicians

who ever lived, the Arabian Avicenna (980-1037 A.D.), who said: "The imagination of man can act not only on his own body but even others and very distant bodies. It can fascinate and modify them; make them ill, or restore them to health."[9]

What might such an experiment look like? As an example, in July 1988, a paper appeared in the *Southern Medical Journal* with momentous implications about the nature of the mind and its relation with the material world.[10] The study originated from the coronary care unit of San Francisco General Hospital, the major teaching hospital of the University of California Medical School at San Francisco, and was conducted by a faculty member and staff cardiologist, Randolph Byrd. It incorporated the features of good clinical experiments: it was a randomized, double-blind, prospective study of a large number of patients (approximately 400). As persons were admitted to the coronary care unit for reasons of an actual heart attack or the suspicion of one, they were assigned to one of two groups. One group, composed of about 200 people, received state-of-the-art medical care. The other group, also consisting of approximately 200 people, received comparable medical care, but with a difference: they were prayed for. Their names and a brief description of their status were given to various Protestant and Catholic prayer groups across the United States. The prayer groups were not told how, or how often, to pray. Neither the doctors, nurses, nor patients knew who was being prayed for; this meant that the health care team could not give preferential care to one group over the other, nor could the prayed-for patients try harder in some way to get well, confusing the results of the study.

The outcome was striking. The prayed-for group differed from the non-prayed-for group in several ways. For one, none of the prayed-for group required endotracheal intubation (in which an artificial airway is inserted in the throat and attached to a mechanical ventilator), while twelve in the non-prayed-for group required such. Secondly, the prayed-for group was three times less likely to develop pulmonary edema, a condition in which the lungs fill with fluid as a consequence of the failure of the heart to pump properly (six compared to eighteen patients). The prayed-for patients were five times less likely to require antibiotics (three compared to sixteen patients). Also, fewer of the prayed-for patients died, but this was not statistically significant.

What is the significance of this study? Before any firm generalizations can be made, it must first be replicated by other medical scientists. However, for the moment let us assume, for the sake of discussion, that this rigorously designed study will hold up. What might it indicate? Most importantly--and I say this with great hesitation, fully realizing the prohibition against such a possibility in medical science--this study suggests that the mind can intervene in rather spectacular ways in the course of distant happenings, and, moreover, that the degree of spatial separation of the intervening mind from the object may be irrelevant. Dr. Byrd did not discover that prayer groups close to the hospital were more effective than those far away. This suggests that no conventional "energy" was involved in the mind's intervention. Because the strength of energetic signals decreases according to the inverse square law, those prayer groups down the street from the hospital should have had an advantage over distant groups if prayer involved the transfer of energy of some sort.

This study goes beyond the usual type of mind-body experiment in medicine because it suggests that there is something the mind can do that cannot be explained by the workings of the brain. It suggests that a mental, non-energetic, action-at-a-distance is at work, and that this effect is far from trivial and may have life-or-death consequences.

The Spindrift Experiments

There are some other little-known experiments that bear on the question of the mind's ability to affect the state of biological systems. These studies have been quietly conducted for more than a decade by a unique organization called Spindrift located in Salem, Oregon. ("Spindrift" comes from an old Scottish word describing sea spray driven by wind and waves.) The questions addressed by the Spindrift researchers are fundamental. Is "distant healing" real? Is there an effect that can be measured? Is the effect reproducible?

One of the simplest ways of answering these questions is to test the interaction of a "healer" or prayer-practitioner with simple biological systems such as sprouting seeds. If the healer prays for one batch of germinating seeds and not another, is there a difference in the rate of germination?

In one test, rye seeds were divided into two groups of equal number. They were placed in a shallow container filled with vermiculite, a light, soil-like substance commonly used by gardeners. A string was placed down the middle of the container, dividing the seeds into sides A and B. The seeds on one side were prayed for and the others were not. After the seeds had grown, the slender rye shoots were counted. Results from several "runs" indicated that there were significantly more rye shoots in the "treated" (prayed-for) side than in the control side.

But in "real life" one prays for unhealthy persons as well as for healthy ones. So, the researchers asked, what if the rye seeds being prayed for were unhealthy instead of healthy? Would the prayer continue to work? To test this question, they stressed the rye seeds by adding salt water to the seed container, keeping the rest of the experiment the same. The salt water diffused upward through the vermiculite, eventually reaching the seeds. The results of prayer were now even more striking. The ratio of the treated to control shoots increased sharply, suggesting that prayer worked even better when the organism was under stress.

The "stress" was subsequently increased in the experiments by increasing the concentration of the salt solution. With each added increment of salt up to a certain limit, the effect of prayer increased, suggesting that prayer works better when physical conditions are "worse". (There is a strong parallel in clinical medicine with the finding that placebo pain medication, a "sugar pill" that has no known biological effect, works better to alleviate severe pain than mild pain.)

Then the researchers changed systems. When soy beans were used instead of rye seeds, and when temperature and humidity were used as the stressors instead of salt water, the results were the same: prayer worked best with increasing stress on the organism.

The experimenters then asked another question: does it matter how much one prays? If an individual prays ten minutes versus twenty minutes, will the effect be the same? A simple test of this question involved four containers, this time using soy beans. One container was marked "control" and was not prayed for. The other three were marked X, Y, and Z. In each run of the experiment, the X and Y containers were prayed for as a unit, and the Y and Z containers were also prayed for as a unit. This meant that the Y container was prayed for twice as much as the X and Z containers. Germination measurements indicated that the soy beans in the Y container did twice as well as the X and Z containers, suggesting that the measurable growth effect was proportional to the amount of prayer, twice as much prayer yielding twice the effect.

Because the Spindrift experiments involve a control and a prayed-for group, a logical question seemed to be, how does the prayer "know" which seeds to help? In search of an answer, experiments were conducted in which the person praying was kept uninformed about the nature of the seeds he was praying for. Results showed a drastic reduction in the effect of prayer. The researchers thus concluded, "In order for . . . prayers to have any effect, we need to know who or what we are praying for."

Are some healers better than others? The answer proved to be "yes." In seed germination experiments like those mentioned above, as well as in tests with yeast in which the amount of carbon dioxide produced by the yeast culture was measured, it proved to be the more experienced practitioner or healer who produced the more powerful outcomes.

One of the more remarkable conclusions of these experiments is that there is no loss of effect as the number of parts involved increases. In tests with seeds, the results were comparable no matter whether the total number of seeds was large or small. Thus after many years of research, the Spindrift researchers have formulated what they call "the law

of the conceptual whole". As long as the practitioner can hold in his or her mind an overall concept of the system involved, the effect of prayer is constant over all components.

One of the most interesting conclusions of the Spindrift researchers is the distinction between "directed" and "nondirected" prayer. Directed prayer occurs when the practitioner has a specific goal, image, or outcome in mind. He or she is directing the system, attempting to steer it in a precise direction. In healing, he or she may be praying for the cancer to be cured or the pain to go away; in the seed germination experiments as described above, he or she is praying for a more rapid germination rate. Nondirected prayer, by contrast, uses none of these strategies. It involves an open-ended approach in which no specific outcome is held in the imagination. The Spindrift tests are unequivocal. Although the experiments show that both methods work, the nondirected technique appears quantitatively much more effective, frequently yielding results that were twice as great or more when compared to the directed approach. The researchers thus conclude that the emotional and personality characteristics be excluded from the thoughts of anyone praying, and that they be replaced by a "pure and holy qualitative consciousness of whoever or whatever the patient may be." It is this method which they refer to as true "spiritual" healing. Methods relying on directed prayer, in contrast, are referred to by them as "psychic" healing, "faith" healing, "mental" healing, or the placebo effect.

Today there is much enthusiasm for the use of various sorts of imagery, visualization, meditation, and prayer techniques in healing. There are even studies suggesting that certain skilled persons can "tell the body what to do", steering certain physiological processes in a particular direction. However, what if one is not a physiologist and does not know what the "right" direction is? Should he or she pray for an increase or decrease of blood flow to a specific organ, or for an increased or decreased activity of a particular type of immune cell? These questions can be bewildering to nonspecialists and specialists alike. The Spindrift experiments are consoling on this point. They suggest it isn't necessary to know which way the physiological processes ought to go. One need only to pray for "the norm," asking only for "what's best", what may be considered as the "Thy will be done" or the "let it be" approach.

The effect of this attitude was demonstrated in several tests in which the condition of the prayed-for seeds varied from dry to over-soaked. When prayed for as a group in a nondirected way, the oversoaked seeds lost water and decreased their weight early in the germination process, and the under-soaked seeds gained water and increased their weight. Each group achieved the norm that was best for it.

The Spindrift researchers are aware of the scientific heresy implied by their findings. "Scientifically," they state, "it is a shocking thing to think of [a] 'force' as intelligent, loving, kind, good, and aware of needs. But each test prayer . . . moved the seeds toward their norms. When prayer was for seeds in different conditions--the same prayer at the same time--[the outcome] was always in the direction that was best for the individual need of the individual beans."[11,12] These experiments are simple and elegant. They ask basic questions, are quantifiable, and they appear to be reproducible.

The Spindrift experiments and the study of cardiologist Randolph Byrd cannot be explained by any known mechanisms involving the brain. They are qualitatively different from the usual mind-body studies because they seem to require some kind of action at a distance for their explanation--an effect of a mind, if you will, that is beyond the brain and the body.

Is Mind Nonlocal?

If these studies are valid, we are led to the conclusion that the mind cannot be localized to the brain or body, and indeed, may not be in a place at all. Such a mind would be nonlocal with respect to space. Nonlocality is still a strange concept to physicians and bioscientists who continue to believe in an objective world in which everything must occupy some point-position in space and time. However, this is not so in modern physics. In order to emphasize this point briefly, I wish to cite the comments of physicist Nick Herbert, whose book, *Quantum Reality,* received critical praise from the physics community.[13] In discussing

developments bearing on the concept of nonlocality, the theorem of physicist John S. Bell and the several experimental tests of it, Herbert says,

> Bell does not merely suggest or hint that reality is nonlocal, he actually proves it, invoking the clarity and power of mathematical reasoning. . . . Despite physicists' traditional rejection of nonlocal interaction, despite the fact that all known forces are incontestably local, despite Einstein's prohibition against superluminal [faster than light] connections, . . . Bell maintains that the world is filled with innumerable nonlocal influences. Furthermore, these unmediated connections are present not only in rare and exotic circumstances, but underlie all the events of everyday life. Nonlocal connections are ubiquitous because reality itself is nonlocal.[14]

> [Whatever model of reality we decide upon in physics,] it must be nonlocal. . . . No local reality can explain the type of world we live in. . . . although the world's phenomena seem strictly local, the reality beneath this phenomenal surface must be superluminal. The world's deep reality is maintained by an invisible quantum connection whose ubiquitous influence is unmediated, unmitigated, and immediate.[15] . . . When quantum theory joins the ranks of phlogiston, caloric, and the luminiferous ether in the physics junkyard, Bell's theorem will still be valid. Because it's based on facts, . . . it is independent of whether quantum theory is correct or not.[16]

The experiments described suggest a spatial nonlocality of the mind, i.e., a mind that is not solely in a place, such as the brain or body. However, recent evidence also suggests a temporal nonlocality in which the mind is not confined to the present moment, but can range freely between past, present, and future. I refer to the remote sensing experiments done by many investigators including Jahn, Dunne, and others.[17,18] Nonlocality in both space and time is a central feature of their experiments.

Physicist Herbert notes that the nonlocal description of the world particularly irks physicists whose taste in realities is strictly local. The same can be said about the medical and biological experiments we have discussed so far, as they are a potent irritant to many physicians and bioscientists. Many consider it a frank betrayal of biological science to propose that the mind may not be localizable.

Other Points of View

One may ask, whose science is being betrayed by these findings? The fact is, there has never been a unanimity of opinion on the relationship between mind and matter, even among the most eminent scientists. It is important to recognize this, for if we realize the diversity of opinion that has always existed on these matters, it may seem less heretical to speak of the mind-body relationship in novel ways.

Many eminent scientists who have thought deeply about the nature of the physical world have been convinced that mind and consciousness could never be explained in terms of matter. Three examples of Nobel laureates underscore this point. Niels Bohr, whose name is virtually synonymous with modern physics, wrote: "We can admittedly find nothing in physics or chemistry that has even a remote bearing on consciousness."[19] His contemporary, Werner Heisenberg, who elaborated the principle of uncertainty in quantum physics, said as much: "There can be no doubt that 'consciousness' does not occur in physics and chemistry, and I cannot see how it could possibly result from quantum mechanics."[20] And physicist Eugene Wigner has stated:

> It seems inconsistent . . . to explain the state of mind of the observer . . . in terms of concepts, such as positions of atoms, which have to be explained, then, in terms of the content of consciousness. It may well be . . . that present-day physics represents . . . a limiting case--valid for inanimate objects. It will have to be replaced by new laws, based on new concepts, if organisms with consciousness are to be described. . . . [I]t is true that we have at present not even the vaguest idea how to connect the physio-chemical processes with the state of the mind.[21]

Mind and Emergence

A central concept in modern biology that conflicts violently with the idea of a nonlocal mind is that of "emergence." According to this view, mind and consciousness "emerged" at a particular stage in evolution when the brain reached a sufficient level of biological complexity. This concept decisively anchors the mind to the brain as a property

derived from matter. Accordingly, the mind like the brain must be local. While there is admittedly no alternative proof of the origin of mind, alternative views do abound. The viewpoint of eminent scientists may prove to be liberating in considering the mind-matter relation. One of the most prominent philosophers of science in this century, Sir Karl Popper, has this to say about the idea of emergence:

> From an evolutionary point of view, I regard the self-conscious mind as an emergent product of the brain. . . . Now I want to emphasize how little is said by saying that the mind is an emergent product of the brain. It has practically no explanatory value, and it hardly amounts to more than putting a question mark in a certain place in human evolution.[22]

George Wald, Nobel laureate in biology, goes further. He states: "Mind, rather than emerging as a late outgrowth in the evolution of life, has existed always. . . , the source and condition of physical reality."[21] A Nobel laureate in neurophysiology, Sir John Eccles, who has collaborated with Popper, wrote the following on the concept of emergence:

> Regardless of the complexity of electrical, chemical, or biological machinery, there is no statement in the 'natural laws' that there is an emergence of this strange . . . entity, consciousness or mind. This is not to affirm that consciousness does not emerge in the evolutionary process, but merely to state that its emergence is not reconcilable with the natural laws as at present understood. . . . [S]uch laws do not allow any statement that consciousness emerges at a specified level of complexity of systems, which is gratuitously assumed . . . .[24]

Alternative Approaches

What alternative approach could be offered to that of "emergent materialism" in defining the mind-matter relation? Some believe that, since the "anomalous" scientific findings seem to be increasing in number at a rapid rate, in due time the paradigm will tilt of its own weight, and new views of the mind-matter relation will be at hand. However, some of us want more than this. In spite of the fact that the paradigm will change as it always eventually does, we are impatient creatures and want to be active participants in creating change.

How can this be achieved? It is clear that the scientific evidence for the mind's potency in medicine is burgeoning already. This evidence is so weighty that the second-class status attributed to the mind can only be explained, I feel, on sociological, psychological, and philosophical grounds. If the extant evidence is to be taken seriously, a new mind-body philosophy is needed. A first task for such a philosophy will be to circumvent the Cartesian split that prohibits a nonmaterial mind acting on a material body. As one approach, one might simply point to the historical arbitrariness of the prohibition itself. This has been done by John Beloff of the University of Edinburgh, who states,

> . . . Descartes and his followers simply [took] over a principle of scholastic philosophy according to which an effect must be of the same nature as its cause. But there is no reason in logic why this must be so. There is nothing contradictory in supposing that an immaterial entity, if that is what the mind is, could produce physical effects. . . . The idea still being purveyed by so many modern philosophers, that there is something absurd or incoherent about [this]. . . is without foundation. [It is] quite right to insist that mind and matter must have 'something in common' but that something is, precisely, the power to influence one another; nothing more than that is required.[25]

Secondly, one may observe that respected philosophers are currently in the process of constructing maps of reality that fully permit the action of mind on matter. An outstanding example is David Ray Griffin, Professor of Philosophy of Religion at the School of Theology at Claremont College, Executive Director of the Center for Process Studies, and founding president of the Center for a Postmodern World in Santa Barbara, California. Employing the philosophy of Alfred North Whitehead to buttress his model, Griffin has constructed a majestic "postmodern world view" that differs radically from the contemporary scientific world view. It features a "new animism" in which mind and consciousness dwell hierarchically in all levels of nature, with no exceptions. This hierarchical feature is a key to Griffin's model and leads to "a new panentheism," as he calls it, rather than to primitive pantheism. Because all levels of nature basically share mind and consciousness, albeit of differing degrees, these different levels, including mind and brain, are not ontologically different. Therefore, the classical dualistic prohibition is overcome. This allows for the possibility of a genuinely nondualistic interactionism that is entirely salutary to the interaction of mind and body.[26]

Spiritual Implications

Maybe a fella ain't got a soul of his own, but on'y a piece of a big soul--the one big soul that belongs to ever'body.

--John Steinbeck, *The Grapes of Wrath*

Much more is at stake in the debate over the mind-matter relation than "being accurate" in some narrow scientific sense. At heart, this is a spiritual issue, as many today recognize. Consider the implications of a decidedly nonlocal mind--a mind, as we suggested earlier, that is not confined to specific points in space and time. This would imply that the mind would be omnipresent in space and infinite in time, thus eternal and immortal. Such a mind would be inherently unbounded--and if unbounded, then ultimately unitary or one. We are led by these considerations, then, to an ancient idea of the Universal Mind or the One Mind of which each individual mind is a part.

Descriptions of the mind as nonlocal, universal, and unbounded are legion and belong to all cultures and eras. A typical description of mind as nonlocal and indescribable in terms of space and time comes from the Zen master Huang Po:

> **This Mind, from the beginningless beginning, is unborn and indestructible, not green nor yellow, without form nor appearance. It does not belong to the categories of neither existence nor nonexistence and cannot be defined new or old. It is neither long nor short, big nor small, for it transcends all measurement, expression, survey, and approach.**[27]

But the implied qualities of a nonlocal, unbounded mind, with omnipresence and infinitude in space and time, are qualities reserved in the West to describe God. Thus, it is no surprise that this idea has traditionally been regarded as blasphemous and heretical, and many who espoused it have paid with their lives. But many of the world's great religions find the concept of shared qualities between God and humanity, an inner divinity, to be quite natural. For the most part, these are the Oriental religions. In the Hindu tradition, for example, the goal of spiritual development is to awaken or become enlightened to this ever-present fact. The belief in one's inner divinity is epitomized in the Hindu saying, "Tat tvam asi!" (Thou art that).

But it is a mistake to regard the vision of inner divinity as being confined to the East, for it also has been present for millennia in the West. Thus we find St. Augustine expressing this fifteen-hundred years ago in these words:

> I, Lord, went wandering like a strayed sheep, seeking Thee with anxious reasoning without, whilst Thou wast within me. I went round the streets and squares of the city seeking thee; and I found thee not, because in vain I sought without for him who was within myself.

One of the Germany's greatest mystics, Meister Eckhart, stated similar ideas in the fourteenth century on the nonlocal nature of God and the sharing of these qualities by humanity:

> If a soul is to see God it must look at nothing in time; for while the soul is occupied with time or place or any image of the kind, it cannot recognize God.[28] . . . When a man goes out of himself to find or fetch God, he is wrong. I do not find God outside myself nor conceive him excepting as my own and in me.[29]

One of the most dramatic examples of the call to "spiritual nonlocality" can be found in the *Corpus Hermeticum*, a body of Western writings dating back at least two thousand years. In it we find these remarkable words in which the spiritual seeker is urged in various ways to burst the limitations of locality, of space and time:

> Unless you make yourself equal to God, you cannot understand God: for the like is not intelligible save to the like. Make yourself grow to a greatness beyond measure, by a bound free yourself from the body; raise yourself above all time, become Eternity; then you will understand God. Believe that nothing is impossible for you, think yourself immortal and capable of understanding all, all arts, all sciences, the nature of every living being. Mount higher than the highest height; descend lower than the lowest depth. Draw into yourself all sensations of everything created, fire and water, dry and moist, imagining that you are everywhere, on earth, in the sea, in the sky, that you are not yet born, in the maternal womb, adolescent, old, dead, beyond death. If you embrace in your thought all things at once, times, places, substances, qualities, quantities, you may understand God.[30]

The idea of an unbounded, Universal Mind that includes all individual minds has recently been elaborated in great detail by two eminent modern physicists, Erwin Schrödinger, whose wave equations underlie quantum mechanics, and Henry Margenau, emeritus professor of physics at Yale University's Sloan Laboratory, who has made

fundamental contributions to modern physics for half a century. Schrödinger was fully aware that a mind nonlocal in space and time implied a Universal Mind, and he put the matter unequivocally: "Mind by its very nature is a *singulare tantum*. I should say: the over-all number of minds is just one."[31]

Schrödinger's views are contained in his books, *My View of the World*; *What is Life?;* and *Mind and Matter*.[32] Margenau's model is in his book, *The Miracle of Existence*.[33] Space does not permit an elaboration of the ideas of Schrödinger and Margenau on the Universal Mind; for this the reader is referred elsewhere.[34]

It may seem that it is mainly stubborn, orthodox scientists and physicians who are obstructing the path toward new views of the mind, but I think it is not the case. Enormous resistance has also come from the religious community. Many theologians seem to have a great investment in keeping the mind local and finite. In our own day the idea of a nonlocal, unbounded mind has been condemned by theological scholars as "misplaced conceit" and "cheap grace." However, this vision does not easily die and reappears today fortified by the implications of actual laboratory studies, as we have seen.

If the idea that the mind is not in a particular place in space or point in time is taken seriously, the spiritual implications would ironically seem to move us in an immense, historical circle to almost two-thousand years ago when the following observation was made in the West by the mythical Hermes Trismegistus: "There is nothing more divine than mind, . . . nothing more apt to unite men to gods, and gods to men."[35]

Conclusions

One of the great explorers of frontier science in the last century was Thomas H. Huxley. Huxley was Darwin's ablest defender when his new theory was under intense attack. In 1892, in his *Essays Upon Some Controverted Questions*, Huxley stated,

> I understand the main tenet of materialism to be that there is nothing in the universe but matter and force; and that all the phenomena of nature are explicable by deduction from the properties assignable to these two primitive factors. . . . It seems to me pretty plain that there is a third thing in the universe, to wit, consciousness, which . . . I cannot see to be matter or force, or any conceivable modification of either.[36]

Although we remain puzzled along with Huxley about the exact nature of mind and its relation to matter, we sense today that our bewilderment is perhaps beginning to clear. If we are to be true to the scientific tradition Huxley championed, our goal must be always to move forward through the "anomalies" and not side-step them. Only then can we be sure of honoring all of science, not just part of it.

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VOLITIONAL EFFECTS ON A BACTERIAL SYSTEM

Beverly Rubik

Abstract

The effects of volition accompanied by 'laying on of hands' of Olga Worrall and other self-proclaimed healers on normal, chemically inhibited, or nutritionally starved cultures of *Salmonella typhimurium* were measured in a series of controlled experiments. The participants treated the bacteria by placing their hands near but not touching microscope slides or racks of test tubes containing liquid bacterial cultures with the intention to heal them. Bacterial culture growth was measured at various time intervals by light scattering using a double beam spectrophotometer. Motility was quantitated by photographing the bacteria under dark-field microscopy illuminated by a strobe lamp, such that tracks of swimming bacteria could be counted from the microphotographs. Naive participants who similarly placed their hands near the cultures for identical time periods but without intention to heal were used as controls in addition to untreated control cultures.

The results with Worrall are summarized as follows. (1) Various levels of enhancement of the growth of treated cultures over controls were observed on those cultures to which growth inhibitors chloramphenicol or tetracycline were added. The magnitude of the effects observed depended on the concentration of antibiotic used, and ranged from small to moderate. In general, a greater volitional effect was observed for low concentrations of growth inhibitors which did not completely inhibit growth. (2) No effect on culture growth over controls was apparent under optimal laboratory culture conditions of logarithmic growth phase in minimal media. (3) Bacterial motility in Worrall-treated cultures was observed to be enhanced over controls for bacteria completely paralyzed with phenol. (4) No growth was observed for a met(-) mutant starved for methionine in either test or control cultures.

In a few experiments with Worrall, no volitional effects were observed over controls. Nonetheless, the results obtained were generally consistent with her intention to heal or protect the bacteria from harsh environmental conditions. At the same time, Worrall was occasionally able to remotely ascertain the conditions of the various cultures

as well as predict results of particular test tube aliquots which she spontaneously voiced throughout the experiments, although this was not part of the experimental design.

Three other participants reputed to have healing abilities were also tested using the same protocol for measuring culture growth. Two of these manifested similar small enhancements of bacterial growth consistent with their intentions. However, the results for one of the participants was insignificant compared to controls.

The experimental results of volitional effects on bacterial cultures generally show small effects on bacterial growth and motility consistent with participant volition. One may speculate that a signal emitted from the participants in the form of a specific low-level non-thermal electromagnetic field associated with a 'healing' state of consciousness stimulates bacterial vitality.

This experimental design is exemplary in being a simple, relatively inexpensive, quantitative measure of volitional effects on a well-characterized biological system. Nonetheless, there are shortcomings to such experiments which neglect the inner states of the participants and the experimenters. A more balanced and complete approach to the effects of volition would address both the inner states as well as measurable physical interactions. Recommendations for a new paradigm for the human sciences are offered.

Introduction

Persons with reported healing abilities have apparently existed in every culture, and ours is no exception. There have been laboratory examinations by others of purported abilities to remotely affect biological systems, for example, on wound healing in mice[1], plant growth[2], and enzyme activity[3]. Whereas those studies involved effects on complex phenomena in multi-cellular organisms or on enzymes, non-living components of cells, this work examines the subtle interactions of humans with the bacterium, *Salmonella typhimurium* (ST). This bacterium is closely related to the ubiquitous *Escherichia coli* which inhabits the human gut. More physiology and biochemistry is known about them than any other organism. The motility (swimming behavior) and growth rate of ST cultures as affected by so-called "healers" were measured in comparison to control cultures.

The purpose of this work is: (1) to see whether volitional life-enhancing effects could be observed on a simple, classical biological system; (2) to investigate the possibility of measurable bioeffects of 'laying on of hands'; (3) if volitional mind-body participant effects are found, to work toward elucidating their *modus operandi* on a well characterized organism; and (4) if positive effects are observed, to see whether this methodology yields phenomena that could be replicated over time.

The experimental design involves a number of considerations. It is very important to take into consideration the attitude and belief system of the participant because the psychological conditions can possible enhance or inhibit any positive experimental results. The participant that was studied first and most extensively over a four-year period is the late Olga Worrall. She had worked as a spiritual faith healer in Baltimore and was internationally known for her purported healing abilities. In the early stages of the experimental design, she expressed interest and enthusiasm in the possibility of treating a biological target, as she had already demonstrated volitional interactions with physical targets.

The biological system should be well-characterized. That is, there should be a compilation of data from controlled experiments without the participant present to provide an adequate baseline. As I had already completed four years of experimental research involving the motility behavior and growth rate of ST prior to my studies on volitional effects, it was an ideal system for me to use. It is relatively simple to prepare identical control and test samples, and the results on control cultures are replicable over years.

It should be possible for the participant to receive immediate feedback as to the state of her intervention in the system. If possible, the experimenter should be able to observe the effects of this feedback on the participant and the system. The motility of ST can be directly observed by using a double-ocular microscope so that both participant and experimenter can readily observe motility changes in real time. However, the growth rate experiments do not lend themselves to immediate feedback.

The system should have a rapidly varying parameter that is well characterized, in which one can measure change or rate of change. Motility changes and culture growth rate represent rapidly changing parameters in ST that are easily measured.

It should be possible to make a permanent record of both the test and control measurements. The motility measurements can be permanently recorded using dark-field microphotography at the same time that a sample is observed. The growth rates of liquid cultures can be recorded as absorbance over time using a recording spectrophotometer.

A variety of tests to study volitional effects should be available to stimulate the participants and prevent boredom. Moreover, as the nature of specific participant effects are unknown or may vary, a variety of tests is needed to best capture a participant-associated phenomenon, if any. In the case of ST, which is a weak pathogen in humans, a variety of tests was especially important, as it was unclear exactly how participants might react to it. Some might try to produce detrimental effects on the bacteria, whereas others might try to produce life-enhancing effects. Furthermore, by using specific chemical inhibitors and various mutants in the various test designs, the specificity, if any, of any volitional effects on the bacteria might be observed. For example, a participant's ability to reduce the effect of one particular chemical inhibitor would provide a clue as to a specific mechanism for that participant's effect. The tests using a met(-) auxotroph, a mutant requiring methionine (an animo acid) for growth, starved for methionine was designed to show whether participants might affect the bacteria by increasing the background mutation rate.

It is typical in biology or medical research to choose a simple cell or animal model to study a new phenomena, and bacterial systems are among those traditionally used. They have been selected for their relative inexpensiveness and ability to yield rapid results that are easily replicated over time and by others. Because this system is relatively simple and already well-characterized, it maximizes the potential toward understanding the nature of

volitional effects, if any, on life processes. Furthermore, such an understanding may lead to predictions as to the nature of the interactions that may be observed on more complex systems such as volitional healing effects in animals or humans.

The experimental results with Worrall as participant have already been reported elsewhere[4,5].

Experimental Methods

A wild type strain of *Salmonella typhimurium* (ST1) was grown in Vogel-Bonner citrate medium, an aqueous mixture of buffered salts to which 1% glycerol was added as a carbon source. This is a minimal medium favored by ST that supports growth of flagella (organelles for motility). Bacteria were grown to mid-logarithmic growth phase (active growth), resuspended in fresh media, and used directly for experimentation. The details of working with this bacterial system are described in the literature[6]. Olga Worrall as participant performed what she described as "healings" for up to two minutes in which she held her hands with the palms facing near to (up to 2") but not touching the closed containers of liquid bacterial cultures with an expressed intention to heal them. From changes in her face and tone of voice during these treatment intervals, she appeared to be in an altered, trance-like state.

In the first type of experimental test, volitional effects on the growth of chemically-inhibited cultures were measured. The participant treated plastic-stoppered glass or plastic test tubes containing 15 milliliters (ml) of liquid cultures of ST171, another strain of *Salmonella typhimurium*, the population density being 3×10^8 bacteria per ml, to which was added various doses of the bacterial antibiotics, chloramphenicol or tetracycline, immediately prior to the treatment. These antibiotics inhibit protein synthesis in bacteria and thereby stop culture growth to some degree, depending upon their concentration. Control cultures prepared in exactly the same way were removed from the room prior to treatment of the test cultures. Naive participants also served as additional controls. Samples were run at least in triplicate.

The second type of experimental test involved treatment of normal cultures to see if any growth enhancement would occur. The participant treated test tubes containing 15 ml of medium either with ST1 in early logarithmic growth phase or freshly inoculated with

ST1. Control cultures prepared in exactly the same way were removed from the room prior to treatment of the test cultures, to prevent any possible 'field effects' associated with participant treatment. A naive participant who had no prior experience was also used as an additional control. Samples were run at least in triplicate.

In the third type of experimental test, volitional effects on bacterial motility were determined. The biological target was in the form of three microliters of bacterial culture on a glass microscope slide under a glass coverslip. Prior to preparation of the slide, phenol was added to the bacterial suspension to a final concentration of 50 millimolar (mM). This high concentration of phenol is sufficient to paralyze ST1 in all control cultures by destroying the energy source for motility. I had previously used 50 mM phenol in over four years of experimentation on ST1 with the result of completely immobilizing the bacteria. Both participant-treated and -untreated control samples were run in triplicate. Treatment by a naive participant served as an additional control. Control cultures prepared in exactly the same way were removed from the room prior to treatment of the test cultures, to prevent any possible 'field effects' associated with participant treatment. The slides were observed under a dark-field microscope at 600X magnification both by experimenter and participant and at the same time photographed using a one-second time exposure to a 5 Hz xenon stroboscopic lamp. Motility was calculated from the microphotographs showing sequential patterns of rod-like tracks characteristic of motile bacteria, easily distinguishable from the fixed or blurred rod-like images characteristic of immotile bacteria. Tracks were counted and motility expressed as a percentage of total bacteria present. From a series of such photographs, the percentage of motile bacteria at specific times up to 15 minutes after treatment was calculated and compared to controls.

In the fourth type of experimental test, the participant treated test tubes containing 15 ml of minimal medium lacking methionine in which 3×10^8 met(-) bacteria per ml were suspended. This is a mutant strain of ST that requires methionine in order to grow. Furthermore, this particular mutant was previously characterized as being a "nonsense" mutant, i.e., having a point mutational defect in a single base pair in its DNA. Not only is it one of the simplest mutations, but a further single mutation induced at that point in the DNA would cause it to revert to normal, whereby it could grow normally without methionine. The aim of this test was to see if the participant could effectively cause point mutations above and beyond the normal background mutation rate of about 1 spontaneous mutation in 10^6 bacteria per generation time. Control cultures prepared in exactly the

same way were removed from the room prior to treatment of the test cultures. Samples were run in triplicate.

In the experimental tests involving culture samples in test tubes, aliquots of bacterial cultures were taken from the tubes using standard sterile technique and placed in 1 ml glass cuvettes in order to measure the density of bacteria optically by means of a standard technique. The absorbance at 620 nanometers in a spectrophotometer was determined for each bacterial sample using the growth medium as a blank. The absorbance measurement or optical density, related to the light scattered from the bacterial cells, was previously experimentally correlated with bacterial cell density.

Most of the experiments were performed in an electromagnetically shielded 30°C constant temperature room, in which cultures were aerated by mechanical rotation at 20 rpm, conditions optimum for the motility of the strains used. Double-blinded or at least blinded conditions were utilized in all experiments.

Results

Table 1 gives a summary of the results of three experimental studies conducted with Worrall as participant. The results shown are calculated differences from controls averaged for at least triplicate samples. Particular time points were selected in each case to show the maximum differences from the controls. In all cases, naive participant controls did not differ significantly from other controls, and the data is not shown. Thus, Worrall-treated samples are compared directly to untreated controls.

The data for the growth studies compiled in the table are expressed as the percent difference of Worrall-treated samples over controls, calculated from the numbers of bacteria at equivalent numbers of bacterial generation times. The bacterial generation time was determined to be about 1 hour under normal growth conditions by measuring the time in which normal cultures (without antibiotics present) double in opacity, as optical density is proportional to cell number.

Table I

Summary of Results from 1979, 1980, and 1981 Studies
with O. Worrall as Participant

Bacterial Culture Conditions	Generation time, hrs.	Per Cent Average Difference of Healer-Treated over Controls*
Normal, 1981	24	+23%
Normal, 1979	16	0%
Growth Inhibition Using Antibiotics 1 microgram/ml tetracycline, 1981	23	+121%
10 microgram/ml tetracycline, 1980	21	+28%
10 microgram/ml chloramphenicol, 1981	22	+70%
100 microgram/ml chloramphenicol, 1979	16	+22%
100 microgram/ml chloramphenicol, 1980	21	+24%
Methionine Auxotroph Starved for Methionine, 1980	23	0%
Motility Inhibitor Present, 1979 50 mM phenol	-	+7%

* % difference is defined as (T-C)/C x 100%, where T = average number of bacteria in healer-treated samples, and C = average number of bacteria in control samples.

Effects of Worrall Treatment Upon Bacteria in the Presence of Antibiotic Growth Inhibitors

Although the two antibiotics, chloramphenicol and tetracycline, differ in their mode of action in stopping bacterial protein synthesis, the experiments in which they were used yielded quite similar results, in that the Worrall treatment apparently did not discriminate between them. Also similar was the apparent dose-response trend for each particular antibiotic. That is, for smaller concentrations of either antibiotic, the healer treatment enhanced bacterial growth more than it did on larger concentrations of the same antibiotic. As a dose-response effect is one criterion for a definitive result in biomedical research, this is an important result. It appears that the bacteria respond more positively to the Worrall treatment when they are less thwarted by chemical inhibitors.

In each of the three studies performed in different years, it was also found that the time course of the effects of Worrall's treatment on bacterial growth rate was relatively constant. Thus, for each Worrall-treated bacterial sample, the features of the viability curve (numbers of bacterial survivors over time) are similar for both antibiotics at comparable doses. This indicates that there is some measure of constancy and reproducibility in these experiments.

The application of 10 micrograms/ml tetracycline completely inhibits bacterial growth after about four hours in the absence of participant intervention. Treatment by Worrall apparently inhibited the effect of tetracycline, producing a maximum difference from controls of 121% more bacteria surviving in the presence of 1 microgram/ml tetracycline at 23 generation times. The viability curves is shown in Figure 1. The maximum difference observed in the Worrall-treated cultures with 10 micrograms/ml tetracycline was 28% more bacteria at 21 generations. These figures show significant differences between control and participant-treated cultures, as the random error in the control samples is only 2%. Although the random error in the treated samples ranged from 2 to 20%, the treated samples were always observed to possess more viability than the controls. These data demonstrate a dose response trend.

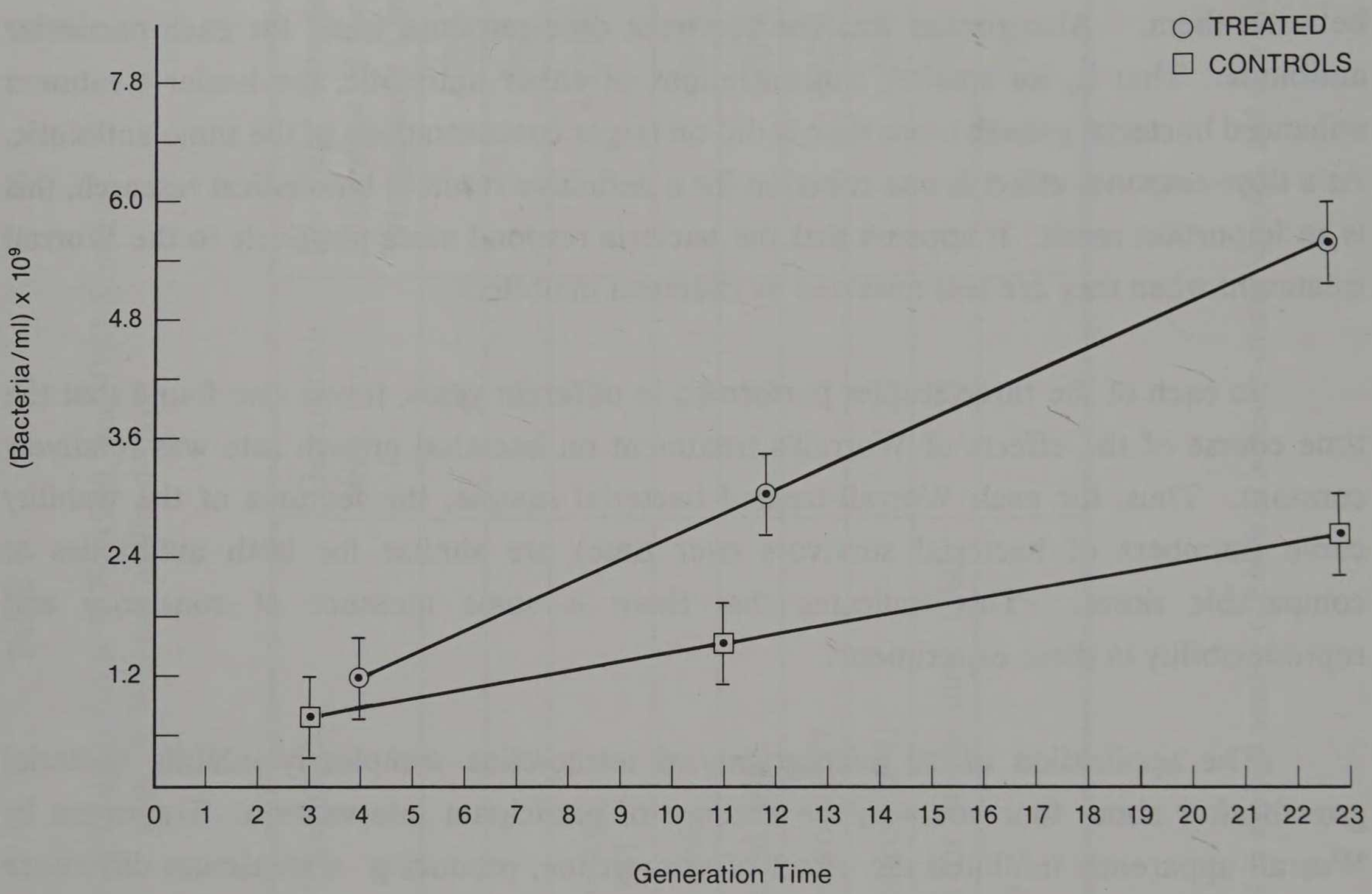

Fig. 1. Viability curve for bacteria in the presence of 1 microgram/ml tetracycline (1981).

The application of 100 micrograms/ml chloramphenicol completely inhibits growth of ST after about four hours in the absence of participant intervention. Worrall's treatment inhibited the effect of this particular dose of chloramphenicol to the effect of 22 to 24% more bacteria surviving over controls, and in the case of 10 micrograms/ml of the drug, an enhanced growth rate of 70% over controls. These data also show a dose-response trend. As the results from the naive participant controls are the same as untreated controls, one cannot account for the Worrall effect by a warming of the bacteria by human hands.

In the 1979 and 1980 studies, very similar results were obtained for the growth enhancement of participant-treated cultures containing 100 micrograms/ml chloramphenicol. The 1979 experiments yielded a 22% enhancement of treated over controls, and the 1980 experiments yielded a 24% enhancement. This indicates some degree of replicability of this approach. Note that in Figure 2 where standard deviations are not displayed, they are equal to or smaller than the circles or squares around the data points.

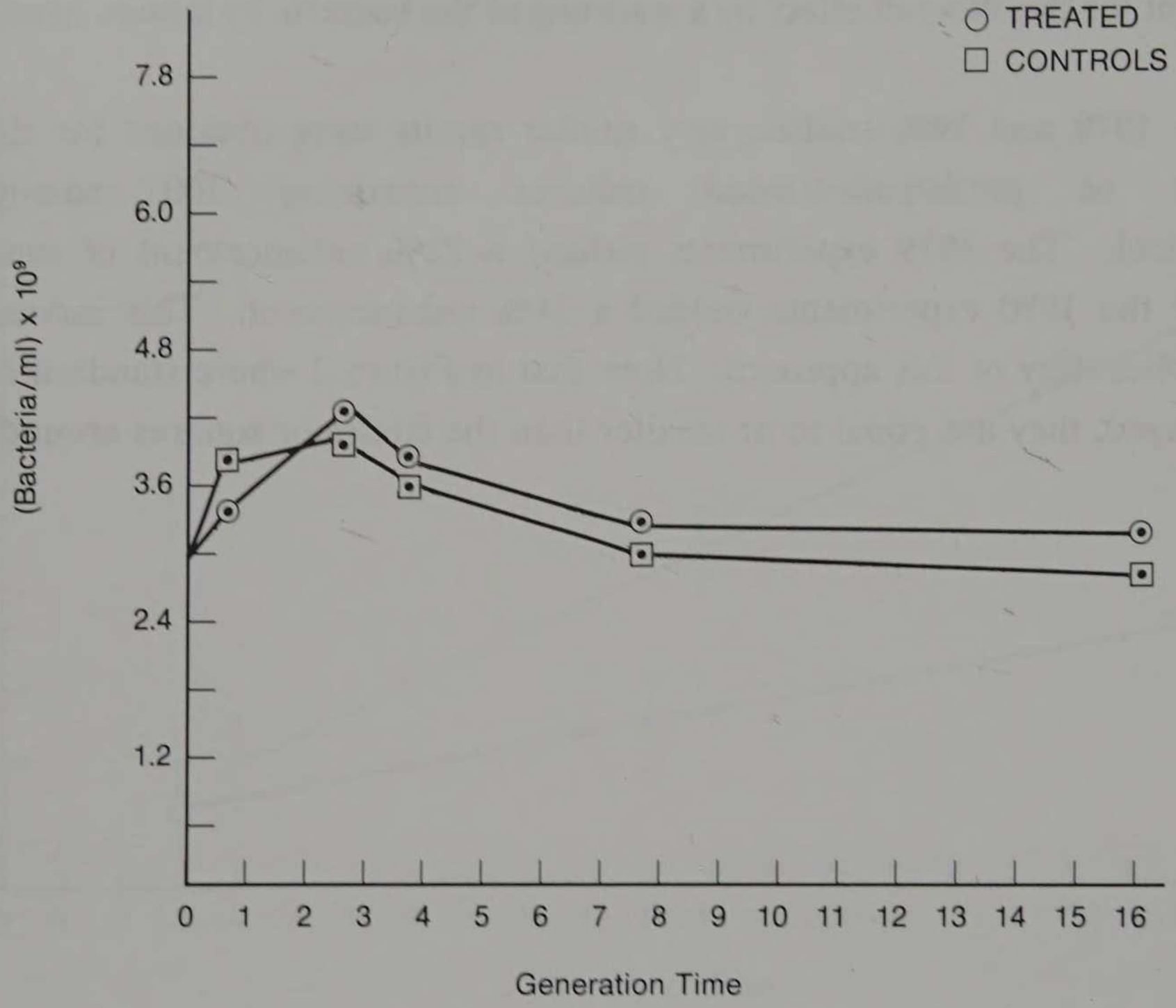

Fig. 2. Viability curve for bacteria in the presence of 1000 micrograms/ml chloramphenicol (1979).

Effects of Worrall Treatment upon Normal Bacterial Cultures without Inhibitors

Two sets of experiments were done to examine Worrall's interaction with the growth of normal bacterial cultures. The 1979 experiments yielded no difference in growth between control and treated samples when the organisms were treated early in their growth phase, the so-called lag phase. In 1981, participant treatment was performed while the bacteria were in mid-logarithmic growth phase (actively growing), and led to a 23% increase in numbers of bacteria over controls. One major difference between these two experiments is the culture conditions. In lag phase, conditions are optimal for growth with no accumulation of bacterial wastes. However, in logarithmic phase, the culture medium may be less than optimum, since bacterial wastes have accumulated. Thus, the difference in the results obtained between these two different experiments may be significant, indicating the possibility of an optimum state of health for the bacteria beyond which healer intervention has little or no effect.

Effects of Worrall Treatment upon Bacterial Cultures Treated with a Motility Inhibitor

Application of 50 mM phenol completely paralyzes the bacteria within 1 to 2 minutes. Worrall's treatment inhibited this effect on ST1, such that on the average up to 7% of the bacteria continued to swim after 12 minutes exposure to phenol compared to the control groups which were completely paralyzed in all cases. This is highly significant, for motility had never been observed in over four years of biophysical experiments using ST1 in 50 mM phenol.

Effects of Worrall Treatment upon Met(-) Auxotrophic Strains Starved for Methionine

No effects of Worrall treatment above controls were observed in this case. That is to say, no culture growth occurred for the mutant bacteria starved for methionine and requiring methionine for growth, either in controls or Worrall-treated cultures. This result is consistent with the apparent inability of the Worrall treatment to increase the spontaneous mutation rate of ST.

Additional Observations in Experiments with Olga Worrall as Participant

On two occasions, Worrall spontaneously produced information during the experiments which subsequently or cotemporaneously proved to be true. Upon placing her hands near the met(-) bacterial auxotrophs which were methionine-starved and unable to grow, she exclaimed that these were like "starving children". Since all of the bacterial samples appeared identical as opalescent liquid suspensions, there were no cues to suggest this. On other occasions, she put her hands near a test tube labelled #20, and said that it was anomalous and that she felt much "energy" associated with it. Data gathered subsequently on the growth of sample 20 indeed proved that it was an anomaly, showing growth several times faster than all other samples. Such unplanned occurrences, however, have no place in the scientific literature, but nonetheless appear to be significant demonstrations of psi.

Volitional Effects of Others Performing 'Laying on of Hands' on Bacterial Growth

Three other participants who are purported healers have been studied to date. Only two of these were able to produce positive volitional effects on the growth of the bacterial cultures in the presence of the same antibiotic inhibitors under the same conditions of the experimental design (data unpublished). The results suggest similar trends of a dose-response effect. However, rapid-onset effects within 10 minutes in growth stimulation were observed in the case of one participant who also predicted this type of effect. As with Olga Worrall, no participant effects were observed on the met(-) auxotroph starved for methionine.

These findings also offer considerable support for the results obtained with Worrall. They suggest that the phenomena observed are not merely isolated anomalies, but that a distinctive pattern of results may be obtained using this experimental protocol with purported healers as participants.

Conclusions

Results indicate that volitional participant treatment associated with 'laying on of hands' produces typically small but significant bacterial culture growth and motility increases over controls in the presence of a variety of chemical inhibitors, without any apparent specificity. These results suggest the hypothesis of a generalized effect of healer intervention upon bacterial cultures.

There is the possibility that specific signals that are low-level non-thermal electromagnetic (EM) fields may be associated with volitional 'laying on of hands'; for example, specific EM frequencies that produce enhanced vitality of the bacteria. For example, in bioelectromagnetics, specific resonant frequencies of extremely low-level microwaves have been shown to stimulate *in vitro* growth of yeast[7]. Because naive participants did not produce any net effects above untreated controls, such specific frequencies, if they are present, would be physiological correlates to specific states of consciousness, i.e., healing states, and not associated with ordinary states of consciousness. This is consistent with the fact that human nervous system activity, as shown by electroencephalography or magnetoencephalography, consists of extremely low frequency activity whose patterns are known to change with altered states of consciousness. However, particular patterns of extremely low frequency fields have not yet been reported in association with 'laying on of hands' treatments. Moreover, such experiments to measure low-level extremely low frequency EM fields are difficult to do, requiring special conditions and equipment.

On the other hand, studies with Worrall done by other experimenters demonstrated long distance effects on organisms, suggesting that local electromagnetic fields associated with particular states of the body-mind may not be involved in these types of healer treatments. Alternatively, it is possible that more than one type of *modus operandi* may be involved in participant effects on biological systems, i.e., for local and nonlocal.

The studies described here examine the effects of a purported psychic healer, the late Olga Worrall, on a rapidly growing, motile bacteria with controls, direct feedback to the participant, and a permanent recording system. It is important to consider the attitude of the participant, which may be critical to the experimental outcome. Prior to the experiment, Worrall was informed that ST is a weak pathogen for humans, capable of causing dysentery. Their motility behavior was shown to her through a microscope. She

was asked whether her intention would be to heal or harm the bacteria. Upon seeing the swimming bacteria under the microscope, she responded with, "cute little critters". She also said that she would enhance their motility and growth because her healing abilities could not be used to the detriment of any organism. The feedback which Worrall received during the motility experiments was positive in terms of her having an effect on the motility. This enhanced her already positive attitude toward performing the experiment and toward the bacteria as well. Most of the experimental results obtained here are consistent with Worrall's stated intentions and expressed attitudes.

This bacterial system appears to be a most suitable one within which to study intention to heal or volitional effects under controlled laboratory conditions on a well-characterized organism. Like most experiments on microbial systems, these are relatively inexpensive, technically simple, and involve basic parameters associated with the living state--growth and motility. Furthermore, others may attempt to replicate them by using the same bacterial strains and laboratory conditions.

Discussion

Reflecting several years later on these experimental studies raised several issues about the approach used here as well as in psi research, research on paranormal abilities, more generally. For example, the fact that Worrall was able to remotely ascertain information about the status of the bacterial targets, despite the double-blinded conditions of the experiment, was significant and meaningful, even if unquantifiable. Since it was not anticipated or controlled for in the experiments, it is not considered to be reportable scientific evidence. It suggests that further experiments be set up to measure these apparent psi abilities by an appropriate methodology. However, psi may manifest more readily under conditions of natural spontaneity than focussed attention. Can psi research really ever meet this level of spontaneity?

There were also uncontrollable differences in the psychological atmosphere from one experiment to another, which on occasion appeared to correlate with Worrall's performance in the laboratory. But contemporary science largely ignores the psychological aspects of both experimenters and participants, assuming that its validity depends only on operations for gathering evidence. In general, psi research results suggest that the psychological conditions prior to and during the experiment are of critical importance.

This is not surprising, since such research is intimately involved with particular states of consciousness and intention. But how can we adequately control for subjective aspects we cannot measure, such as states of consciousness? Can the subtle realms of mind be contained by experimental boundary conditions? What about psychological effects of others present or not who have vested interests in the experimental outcome? Are we deluding ourselves when we close the laboratory door in a psi research experiment, in believing that we are isolating ourselves from other influences? What about the possible effects of other nonlocal influences on psi, such as geomagnetic field variations and other natural cycles?

Humans may be regarded as dynamical dissipative biological structures, ever changing. Of all aspects of life, consciousness may be the most fleeting, since we cannot easily control our own rambling thoughts or inner states. For psi research, this makes the scientific validating criteria of reproducibility and replicability difficult, if not impossible. However, since the living state is dynamic, not static, in the limit these criteria may need to be reexamined for the life sciences in general.

It appears that quantitative data gathering and statistics dominate contemporary psi research. Although it may seem easy enough to put psi participants through numerous trials to generate a large amount of data, it may be statistically significant, but humanly insignificant. Boredom, fatigue, alienation, or mistrust may affect the participant, destroy the psychological rapport, and yield a lower psi score. It is well known that any psi effect is effectly lost upon numerous subsequent trials, just as habituation results with any repetitious human activity. In my research with Worrall, by the third study she expressed her reluctance to repeat what she had already done twice before, and some of the data reflected this. Novelty was clearly important in maintaining her interest and ability.

These questions lead to the deeper issue of developing a more appropriate paradigm for psi research. One possible framework is general systems theory. The experimental human system may be considered to be composed of all the researchers and participants, with psi a property of the whole system. In addition, psi events from a system's view may be regarded as dynamical spontaneous features of the cosmos at large, analogous to Mach's Principle in physics in which things are related to the system of all other bodies in the cosmos. Rather than putting all the emphasis on the participant, acknowledgement of a holistic ideology may be an important step forward for psi research both philosophically and methodologically. The specific location and time of the

experiment, people present, and other subtle factors including geo-cosmic rhythms may be important considerations toward optimizing the experimental outcome.

Although conventional science requires replicability by any scientist, this may be an extreme requirement for psi research considered from a systems view. All scientists are not equivalent in psi research because each has a unique presence that would create a distinctly different experimental experience for the participant. If the psi-challenging magician, James Randi, had repeated the experimental protocol with Olga Worrall, it is conceivable that he would not obtain the same results. None of us are impartial observers. We have interests, even passion, in proving or disproving our hypotheses. In one sociological study on scientific falsifiability[8], hypotheses were assigned to groups of scientists and clergymen that were entirely false, although they did not know it. They were asked to perform a simple experimental test of their hypotheses to see whether they would conclude that the hypotheses were indeed false. The results indicated denial, as most of the scientists refused to admit that their hypotheses were false. However, the clergymen more frequently reported that theirs were false! Nonetheless, there is a myth in the scientific community, an undercurrent of expectation, that scientists function as intelligent extensions of machines. Given the complexity of conscious and unconscious factors, are we deluding ourselves in considering that we could even attempt impartiality in any experiment?

From examining the literature on research methodology in psychology, one of the most notable omissions is any indication of how the psychological researcher is supposed to think. A search uncovered only one paper that indicated that the role of intention on the part of researchers is a significant component of the process and outcome of research in psychology[9]. If the consciousness of the experimenter is important, what is the appropriate state and relationship to the participant in psi research? Will a scientist who believes strongly in psi affect the outcome of the experiment? From a holistic systems viewpoint, new properties emerge at new levels of order, i.e., the new whole comprised of persons and target systems together in a psi research experiment. Just as powerful effects of collective or coherent phenomena are observed at molecular and cellular levels, one might expect strong synergistic effects of collective, focussed attention associated with the mind-body of a coherent group of people. These could be explored experimentally.

Human systems are interactive, mutually causal systems[10]. There are different ways of interacting with participants under study. One way is to render them naive and uninformed about the experiment. Another is a more cooperative inquiry between

researchers and participants, allowing both to contribute directly to hypothesis formation and experimental design. The latter was utilized in the studies with Worrall as participant. This interaction may be more appropriate for psi research and may enhance the results obtained. Analogous situations in education and business show that people perform better when interactive or participatory management is employed.

The main reason that I stopped doing research in this area was that I felt that the real challenge for psi research was not to refine a method for reproducibly measuring and documenting psi, but to develop a new paradigm that is appropriate. In my opinion, the conventional paradigm is inadequate for psi research and has perhaps impeded its progress. Modern parapsychology has suffered from what I call 'physics envy'. The main approach, adopted from the physical sciences--object-oriented, behaviorist, quantitative, and statistical--has been applied by psi researchers sincerely in a valiant effort to scientifically validate their work, but apparently without sufficient examination of basic epistemological methodological issues.

A whole new basis for the life sciences, particularly the human sciences, is needed. The humanistic psychologists have pointed out this need for decades[11,12,13,14]. A truly human science emphasizing human experience as its subject matter is now beginning to emerge[15]. Some new methodologies include qualitative approaches[16], heuristic methods[17], perceptual psychological methods[18], contemporary hermeneutics[19], and phenomenological methods[20]. One important point of agreement is that there is no one best method. Research methods are becoming more appropriately seen as tools. The methodology selected is appropriate to the research question; e.g., qualitative questions require qualitative methods. However, humanistic and transpersonal psychology have not made significant impacts on mainstream academic psychology. They remain a small voice largely unheard within the scientific community at large.

New findings in other frontier areas of science such as bioelectromagnetics, the interaction of electromagnetic fields with living systems, consist of anomalies that also challenge the dominant paradigm. Together with psi research, these are beginning to fit together like pieces of a puzzle demanding a larger scientific worldview to accommodate them. Collectively they specify the features of an emerging paradigm which addresses new realms of the living state: new informational capacities, interactions with electromagnetic fields, and subtle interrelationships between mind and matter[21,22]. New developments in

the frontier sciences may help pave the road toward a new paradigm for psi research as well as a post-modern science.

In order to develop a new paradigm for psi research, we need a new way of looking at the world and interpreting it.

> The most important task today is perhaps to learn to think in a new way. . . if we don't learn to think clearly and appropriately in a way that suits our subject matter and our approach, we run the risk of simply doing analytical science badly[23].

However, it is extremely difficult to see that there are alternatives to our traditional ways of thinking when our ordinary states of consciousness are so entwined with accepted modes of scientific thinking.

Although conventional science does not admit to notions of meaning, a human science cannot ignore it. Psi research should encompass the meaning and value of the psi experience and experiment for both researchers and participants. Data on the "inner dimensions" are just as important as on external phenomena. In this regard, I have some interesting anecdotal data. In an experiment I conducted using one of Helmut Schmidt's random event generator devices with Terry Ross as the operator, I saw from the visual feedback that his scores were insignificant from the very beginning. When I asked Terry about his attitude toward the device, he replied that he disliked it. I asked him whether there was any way that he could change his attitude toward it, even for a moment, and immediately try another run. In a moment of apparent inspiration, he picked up the device and cuddled it like a puppy dog, and in the next run achieved a positive score over three standard deviations above the mean value.

Experiential and phenomenological research could have important interplay with other research designs in a new paradigm for psi research. High calibre experiential research would be most valuable because it is closest to 'real life'. However, use of subjective experience as a source of knowledge requires high standards of the scientist. It is a paradigm for a "state-specific" science, i.e., a science in which you have to shift your state of consciousness in order to do the research, communicate it, and understand communications about it[24]. "Sciences appropriate to different systems levels may be qualitatively different"[25].

In my opinion, psi phenomena manifest from our deepest, most intimate realms of being, and an appropriate science of psi must include not only the psychological but the

spiritual domain to accommodate its full depth and breadth. An appropriate new paradigm for psi research will emphasize the integrity, authenticity, and personal commitment of the scientist in addition to a revisioned scientific philosophy and methodology.

> Scientific methodology needs to be seen for what it truly is, a way of preventing me from deceiving myself in regard to my creatively formed subjective hunches which have developed out of the relationship between me and my material[26].

We cannot study human potential except as humble and aware human beings in pursuit of knowledge as well as self-knowledge.

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A SCIENCE OF HARMONY AND GENTLE ACTION

F. David Peat

Abstract

Bell's Theorem demonstrates the importance of the non-local form of the wave function. This non-locality is a novel and important feature of the quantum theory, indeed, the overall (non-local) form of the wave function should play a significant role in certain cooperative systems. This is certainly the case for superfluids and superconductors.

Vanishingly small effects, such as boundary conditions, when coordinated in a non-local way will drive a sensitive non-linear system, and the effect of small changes on chaotic systems is already well known. It is suggested that such subtle effects may play a key role in biological systems so that "information" enfolded within the form of the wave function may be delocalized throughout such systems. An obvious example is the human brain and nervous system in which, to take a single instance, memory does not appear to be encoded in any local way, but is distributed over the brain. In a similar way an overall "meaning" may be involved in the operation of the immune system.

These ideas, at present crude and simple, point to a deeper possibility. A particularly subtle order may underlie the operation of the brain, and "meaning" and "information" may be appropriate both in the world of mind and of matter.

Introduction

During this conference we were asked to entertain the possibility that science should move into a new area, specifically into the study of consciousness and its relationship with matter. We considered a variety of questions: Does consciousness have an effect at the quantum level? Does it, for example, act to "collapse the wave function"? Does the mind possess extra-sensory powers--can it gather information in ways that preclude normal interactions? Can mind influence matter by, for example, catalyzing material and energetic transformations? Some participants believe that science must inevitably move into the study of consciousness. Others agree that theoretical speculations about the ultimate nature of sub-atomic world make it necessary to take into account the effects of consciousness.

The writings of the founders of twentieth century physics attest to a serious interest in deeper questions that took them far beyond the confines of conventional physics. Wolfgang Pauli maintained a life long interest in the work of Carl Jung and introduced Heisenberg and others to Jungian ideas. Planck, Schrödinger, Eddington, and Jeans were concerned with questions of consciousness, unity, and the ultimate nature of reality. Going back to the time of Kepler it is clear that scientists were fully aware of the sacred nature of their task and did not regard the contemplation of the universe as a neutral activity.

"And I do also beseech my Reader. . . he would praise and admire the Wisdome and Greatnesse of the Creator, which I discover to him by a more narrow explication of the World's Form, the Disquisition of Causes, and the Detection of the Errours of Sight," Kepler writes. An exclusively materialistic attitude which denies the importance of spirit would be entirely foreign to many of the great historical figures in science. The very motivation to understand and celebrate the universe, the underlying energy to question, the aesthetic force of the deepest mathematics and the most imaginative theories attest to this hidden, transcendental nature of science. A full understanding of the universe must surely include the astonishing fact of its celebration and contemplation by consciousness and of our own existence.

A Call for a New Science

A new surge in science is vitally needed today and one that will explore a variety of outstanding questions about the interrelationship between mind and matter, the possible role of information in structuring nature, and the general need for a deeper understanding of the universe. These questions are far reaching. Indeed I would suggest that they go far beyond what I would call the surface phenomena of the mind-matter relationship and point to a fundamental investigation of the whole nature of reality and our position within the universe. But at this point I must confess a prejudice. I am not particularly interested in what I would call the "surface phenomena" of consciousness research such as ESP, telekinesis, precognition and the like. If such effects do exist and can be demonstrated to the satisfaction of the scientific community they may indeed be of considerable interest in themselves. But I would contend that they are no more than the exterior manifestations of something far deeper. Indeed the meditative traditions of east and west suggest that so-called paranormal powers are not of deep significance in themselves but are simply steps on a more important path. There is, however, the danger that a practitioner will become caught up in, or attempt to exploit, such "powers". Strict warnings against mystical dilettantism have always been issued.

I would therefore like to raise the question of the spirit and perspective in which this new science is undertaken. It is vitally important that we should begin in the right way. Is consciousness, for example, to become an object for science, and mind placed under the microscope? The science of the past two hundreds years placed objectivity in the highest position. The orthodox scientist claims to stand outside the subject of study and to eliminate any taint of human value from his or her study. Science, it is believed, should be objective and value free. There is little room for love and compassion when it comes to a study of the material world. But there is always the danger that such an attitude distorts our thought and perception, particularly when our own consciousness is taken as an object of study.

Objectivity has the effect of distancing, it implies a division between the observer and what is observed, a separation in time and space. It is this division which is of concern in

the present enterprise. The science of the past two hundred years has brought with it a degree of fragmentation in the way the world is perceived. Our own century has experienced a profound loss in our sense of meaning at being in the world. Objectivity brings with it an infinite loneliness, a loneliness of separation from the rest of the universe.

Objectivity stresses the significance of the individual and our control and dominance over nature. By contrast a new surge in science involving the study of consciousness and its relation to matter should acknowledge the existential fact of our being in the universe and should accommodate a sense of wholeness, celebration, joy and wonder. It should act to heal our division from nature and from our own bodies.

A new science may draw for its insights on other disciplines such as art, literature, music, religion and native sciences. But clearly to be given the name of science it must combine a passion for truth and rigor; it must question unceasingly; its ultimate goal must be understanding in the widest sense.

Our present fragmented approach to the world cannot continue; the stakes have become too high. Neither can our uncritical acceptance of scientific objectivity and the virtue of unrestricted scientific and technological progress continue. Societies and technologies are running into problems that appear to lie beyond their abilities to resolve. If science is to consider the human dimension, then it must do so in the right spirit. Indeed it is premature at this juncture to talk of new experiments or novel theoretical explanations without simultaneously investigating the metaphysics that underlies the whole enterprise.

Interaction or Harmony

For this reason I would like to question an assumption that seems to underlie some of the work I have seen on consciousness and its interrelationship to matter. A number of papers and discussions are based on the suggestion that the interrelationships between mind and matter involve some sort of influence or interaction. Mind, for example, is said to move

an object or cause a change in matter. A mental act is supposed to influence the output of a random number generator. Mind is said to be a transmitter or a receiver of information at a distance. Mind, it is hypothesized, emits influences and the will or self causes changes in the world. Some physicists even believe that consciousness can bring about the "collapse the wave function". In short, consciousness and matter, mind and body are conceived of as separate entities that are connected in some way by a new and subtle interaction, the one exerting causal influences on the other.

While it is not inconceivable that an undiscovered interaction may exist between mind and matter, I would suggest that a deeper understanding of the whole question points in an entirely different direction. Indeed, the very concepts of interaction, influence, force, cause, signal and transmission have been imported wholesale and uncritically from a paradigm that is based on a more restricted view of the material world. It is clearly inappropriate to the present study.

The notion of a signal that propagates from one body to another, or of an interaction influencing an event is predicated upon the idea of separability and locality. It assumes that individual systems are well defined and spatially isolated one from the other so that a signal can pass between them. Process and change are the direct result of such causal interactions. But this view is entirely incompatible with, for example, the insights of quantum theory that speak of an undivided wholeness between all parts of an experiment. Influences and interactions, on the other hand, imply division in which a force acts between two isolated and well defined objects. Change and process, according to this latter view, is essentially mechanical in nature.

By "mechanical" I mean any approach that is based upon the notion of a reality that can be defined locally, and in which causes operate though the mediation of forces and fields such that the larger the amplitude of the field, the greater the effect of this force. Scientists may, of course, choose to postulate new and exotic forces, yet, none the less, they would generally conform to this mechanistic description. An exception to this critique is the quantum potential introduced by David Bohm, (Bohm and Hiley, 1987). This does not

operate in a mechanical fashion since its effects do not fall off with distance or with the intensity of the potential. A system governed by Bohm's quantum potential is more organic than mechanical. It is essentially holistic in nature and can only be analyzed into relatively independent parts under limiting conditions.

The example of quantum theory and of Bohm's quantum potential suggests that alternative ways exist to discuss process and change that do not rely upon the ideas of separation and interaction. Bohm has also argued that a major area of incompatibility between relativity and quantum theory arises through the privileged position given to the concept of a signal in the former theory (Bohm, 1971). This is entirely incompatible with the quantum theory. The idea of a signal assumes that systems are localizable in space and time and can be connected by means of some interaction that propagates between them. But this idea is entirely at odds with that of the quantum theory which stresses the essential wholeness of things. The indivisibility of the quantum of action means that it is impossible to analyze and separate a quantum system from the apparatus that observes it. Together they form an irreducible whole.

By contrast, causality, of its very nature, implies division. It suggests a separation in time and space that can only be bridged by force. The causal paradigm elevates the importance of the individual in nature. Its implications are control and dominance with the overvaluation of ego and will. Cause and influence become a one way traffic from the mover to the moved. They are predicated on a world that is fragmented and separated and on individuals who are isolated in their brains and bodies. Such a world view is totally at odds with the new spirit implied by a study of consciousness and matter.

The question, therefore, is one of discovering a new language and new metaphors in which to discuss the universe and our relationship to it. This is, in fact, not new to science. At the time of Newton scholars were still dealing in "sympathies" and "correspondences" and with the idea of balance or harmony in the whole of nature. The ancient maxim "as above so below" expresses the essential harmony that extends throughout the universe so that an

individual body becomes a microcosm in which the greater whole is reflected. A variety of symbolic systems were devised to express this harmony.

Whereas today such views would generally be dismissed as unscientific, C.G. Jung has pointed to the remarkable insights and metaphors between psychology and alchemy. Both the medieval alchemists and the sages of ancient China expressed, in symbolic terms, the processes of sublimation, transformation and refinement of matter that mirrored the internal transformation of the self. Jung, working in consultation with Wolfgang Pauli, also developed the idea of "synchronicity", an "acausal connecting principle" which attempts to deal with the origin of meaningful patterns in nature. (Jung, 1973)

Jung's ideas were taken seriously not only by Pauli himself but by a number of the physicist's colleagues. It is unfortunate, therefore, that the current popular view of synchronicity focuses on bizarre coincidences while ignoring its deeper significance. Synchronicity addresses directly the question of meaning in the universe, the flexible boundary between inner and outer, and the subjective and objective. It deals in those numinous patterns that appear simultaneously within the worlds of matter and mind without the need for positing direct causal relationships between them. It suggests the existence of physical and mental correlations that have no direct causal basis.(Peat, 1987)

Such a concept would not have appeared alien to the thinkers of the Middle Ages who dealt in sympathies and correspondences, or indeed to the many other cultures and civilizations whose daily lives were and are predicated on a strong belief in the harmony of nature. Synchronicity suggests that an understanding of harmony be given a place within the scientific world view.

The sinologist Richard Wilhelm has told the story of a Chinese rain maker who was asked how he had caused the rain to fall in a certain village. The rain maker replied that he did not make rain. Rather, the drought-ridden village had been in a state of disharmony which had affected the rain maker when he arrived. The wise man therefore retired to the hut provided for him and brought himself to order. Since the rain maker was not separate

from the society and environment around him, a general harmony was restored and the rain fell as it is its nature so to do. (Peat, 1987)

Recently I witnessed a similar event, a ceremony at a medicine wheel attended by native representatives from all over North America. At the start of the ceremony a Mayan Indian was involved in parting the clouds so as to leave a patch of clear sky above. Sure enough, as he rotated his stick in the air the clouds moved--not all in one direction, but to the east, west, north and south.

At that time I wondered, how could this individual possibly be moving the clouds? The idea seemed nonsense. Or did the connection work in the opposite direction, such that the moving clouds were rotating the Mayan's stick? I then realized that clouds, stick and Mayan were caught up in a greater dance, one that involved all of us who were present. In this dance there was no actor and no thing acted upon; rather, it was a harmonious flowing that passed unimpeded through cloud, wind, rock, mind, and body. The ceremony at the medicine wheel had not been created by my native hosts alone, but was a dance in which we had all been enjoined.

Can these ways of thinking about pattern, connection, process, and change be incorporated into a scientific paradigm that would be more appropriate for a discussion of consciousness and matter? I believe that this is not only possible but desirable.

Non-Local Connection

At this point I would like to refer to the significance of Bell's Theorem. (Bell 1987) John Bell's remarkable result indicates that non-local correlations exist within quantum systems that cannot be explained on a mechanistic, causal basis. The Bell experiment, which has been carried out by Alain Aspect in Paris as well as by other groups, involves a pair of photons or electrons whose combined state is correlated and which are then allowed to separate to a macroscopic distance. Careful experiments show that a remarkable degree of

correlation is maintained between the two particles even when no interaction, signal, or force passes between them.

Of course there is nothing unusual in objects remaining correlated even when they are far apart. Two synchronized clocks will continue to read the same time when they are at opposite ends of the continent. But the Bell correlations are not of this nature. They exceed anything that can be explained on the basis of a "local reality" or a "classical theory" of physics involving mechanical fields, interactions, or signals. Suppose, for example, that photons and electrons possessed individual properties and could be well defined each in their own regions. They would each carry "cards of identity" as it where. Changes of state would then be produced by interactions, forces, signals, or other causes. But Bell's result clearly demonstrates that such "local systems" could never display the degree of correlation that is exhibited experimentally and appears to be unique to the sub-atomic world.

Bell's result shows that quantum systems are correlated in ways that lie outside any appeal to mechanical connection or to a locally defined reality. They have therefore been called non-local correlations, implying that entirely new categories are required for thinking about space and time in the quantum context. This is not to say that some new mechanical interaction operates outside the confines of space and time, but rather that the ideas of connection and correlation must be thought about in new ways. In this context Jung's notion of an acausal connection does not seem entirely inappropriate. Or to put it another way, an acausal connection may manifest itself in the form of non-local correlations that appear to lie outside the normal confines of space and time.

Bell's theorem has been used by a number of writers to explain supposed mental effects and interactions by proposing that such mental interactions are in some way "non-local" and can make instantaneous or faster-than-light connections. But this is to misinterpret the meaning of Bell's result which denies that any force or interaction whatsoever passes between the two particles. (Again, an exception may be made in the case of Bohm's holistic quantum potential).

While Bell's theorem specifically deals with quantum events occurring at the sub-atomic level it does provide a powerful metaphor since the idea of non-locality goes beyond Bell's particular result and suggests that patterns and processes within nature can be looked at in new ways. Thinking in terms of non-local correlations and acausal connections implies a more connected and holistic way of viewing the universe, one in which explanations based on the ideas of influence and interaction become less inevitable. Indeed it is my belief that non-locality, with its inherent connectedness, may be a more natural way of thinking about the universe.

This idea may well harmonize with the Native American view of things. Indians talk to trees, and some of them talk to rocks. In the forest they experience "skanagoah" or the "great presence", an electrifying awareness of unity and balance. To suggest that some energy, influence, or signal passes between tree and Indian would be to miss the essence of the experience. It is best expressed therefore as a sort of active, dynamical harmony. Pamela Colorado, a modern academic who is also Native American suggests that no direct passage of energy or force is involved. Her great grandfather expressed this harmony with animals and plants in the following way:

"We have to understand the nature. That is why we understand how an animal behaves. That is why we have to talk to them. We don't pray to them, we talk to them because they breathe the same air we do. We are put here with them. We are also a part of the plant life. We are always growing, we have to have strong roots." (Colorado, 1988)

When there is no inherent separation between a person and a tree there is no need to propose a connection between them.

New Ways of Thinking

New ways of thinking along similar lines are coming from many areas. Medicine, for example, has in the past been firmly based on causative models in which a disease is caused

by an invading organism and cured by the action of a drug. Today, however, increasing understanding of the immune system has led some doctors to become interested in the question of the meaning of a person's life and its role in the movement towards health. In such a view causative chains play a secondary role within a larger system that extends from the body-mind to the family and society at large as an organic whole.

Some linguists are also rejecting what they feel to be a mechanical view of their subject, including the "transport theory of language" in which words are used to transport a "cargo" of meaning between individuals. Rather than language being seen in terms of an interaction or signal between an active speaker and a passive listener, the emphasis is placed upon how meaning unfolds out of the whole activity of discourse and upon the creativity involved in the building of "mental spaces" by both parties. (Ford and Peat, 1988) Meaning in this sense does not lie exclusively in individual words but is non-local, belonging to the whole language, the conversation, its context, the memories and attitudes of the speakers, and indeed, to the whole society.

There are also indications of new metaphors from the physical sciences. The mathematician Roger Penrose, for example, has been exploring the structure of what could be called non-local spaces. The building blocks of these spaces, called twistors, are non-local in nature. Points and local regions are then built up as secondary objects generated by congruences of the more basic non-local twistors. In Penrose's approach, space-time and the elementary particles are to be generated together out of a common non-local starting point. Only in the limit can localized bodies and the interactions between them recovered. (Penrose and Rindler, 1986)

Non-linear systems, with their regions of stability and instability, limit cycles and chaos, and bifurcation points and fractal behavior, are providing a rich new source of metaphors for what could be termed a non-mechanical view of nature. Non-linear systems are not generally separable but under certain conditions they can generate quasi independent entities--like vortices in a river--that are nonetheless dependent upon an underlying dynamics. What appear at one level to be independent objects interacting

together will, on deeper examination, turn out to be a manifestation of the one underlying non-linear dynamics. Non-linear systems can be so extraordinarily sensitive to the slightest influence that a vanishingly small change in one part of the system can produce an overwhelming change in another. Such systems must be treated as a whole and do not always lend themselves to fragmentation and discussion in terms of interactions.

Gentle Action

The new approach I am proposing is based upon a belief in the harmony of nature that extends from the subtle to the manifest, and from the material to the mental. It is to be discussed in terms of correlations that are non-local and connections that are acausal--although the more conventional explanations in terms of interactions and influences would also play a role. Harmony has been advocated as a fundamental activity in nature by everyone from Lao-tsu to native people all over the world. The Native American, for example, believes in a basic harmony amongst stones, plants, and animals, and that they are placed on earth to aid in maintaining this harmony.

Such a belief carries with it an awesome responsibility. It demands an extraordinary quality of mind and a perception that is based on love and respect for all things. The essence of such a life does not lie in the desire for constant action, in instigating change to correct some perceived mistake, or in the search for solutions to problems, but upon a gentle and constant movement towards harmony. (Peat, 1988). Such a movement may be as much internal as external. It could be compared to the delicate tuning of an automobile which results in the release of great power, or in the very fine adjustment of a television set which allows the signal to pass through the circuit unimpeded.

A further metaphor is of a highly complex system in which its individual phases are subject to fine adjustments. By making a series of small adjustments globally across the system it becomes possible to lock these phases together so that the whole system becomes involved cooperatively in some new activity. Such a system may be quite resistant to any

local, forceful intervention; however, tiny changes that are made in a co-operative or non-local way can result in entirely new behavior. For example, consider the edge of a pond in which a series of ripples are constantly forming and dying away. If the phases of these very small disturbances could be coordinated exactly all around the edge of the pond, then they would interfere constructively and propagate towards the center of the pond where they would create a large splash. By operating in a sensitive yet gentle way it becomes possible to facilitate a system to produce large effects. The emphasis, however, would be on the understanding and maintenance of balance.

Similar effects may also operate within the human body and brain. For example, vanishingly small but non-locally co-ordinated effects operating within a neural network could produce interesting effects. One could envision that memories are stored non-locally in this way. Ripples of activity may interfere constructively, move inward to some center of activity within the brain, spread out again and are then become focussed into some new region.

The hypothesis advanced here is that such gentle, non-local processes are operating very generally within nature. Certain individuals may be able to bring themselves into harmony with such natural flows and participate in them. But clearly the emphasis would not be on intention or acts of will but upon openness, freedom from emotional and conceptual blocks, and a sense of deep respect for the natural world.

The word "love" comes to mind. It has, I understand, been used by Dr. Mae-Wan Ho in the context of biology. I would suggest that a love of nature is exactly what is demanded in this new field of research. Love is a dissolution of boundaries, an acceptance, a harmonious merging and, at the same time, a deep sense of energy. Love does not seek to control or dominate but respects the integrity of the other. Love cannot be tapped on demand, it comes of its own accord and floods the organism with a feeling of well-being and sensitivity.

Conclusion

A new spirit is required for a new science--one that does not seek to dominate, control, or impose its views on nature, but is tempered by respect, the desire for harmony, and compassion for all things. Such an activity must retain the scientific passion for truth and understanding while, at the same time seeking to celebrate nature and restore the harmony of the planet, society, and each individual.

A science that proposes to investigate harmony and maintain balance must clearly be sensitive to its own methods, values, and ethics--particularly when the scientist becomes his or her own object of study. Discovering the basis and methodology of this new science will prove extraordinarily difficult and requires a profound shift in thinking. Current science is based upon the notion of reproducibility and statistical analysis, and upon analysis in terms of cause and effect. Little value is given to an individual event--the Big Bang excepted. How then is science to deal with the personal experience and the value of a numinous event? How will it be possible to combine rigor and subjectivity? These are profoundly difficult issues.

On the other hand, art, poetry, and literature are concerned with truth and the balance between objectivity and subjectivity. Aesthetics and internal value may play a vital role, yet great art still possesses rigor and honesty. Both art and literature are concerned with the possibility of a multiplicity of interpretations, yet who could have been more rigorous in his investigation of subjective reality and the nature of memory and time than Marcel Proust? Will it therefore be possible to draw upon the discipline and values of the arts when moving into a study of the human position in the universe?

In conclusion, therefore, a new science is proposed in which harmony and balance play a leading role and in which ethics and compassion are placed side by side with truth and understanding. A variety of approaches has been suggested in this article such as the limitations of the notions of interaction, signal, and local reality in favor of "acausal connections" and non-local correlations. A balance between objectivity and subjectivity has

been proposed and it has also been suggested that the ethics, compassion, and methodology of the investigator are vitally important. Human values can no longer be eliminated from an investigation of consciousness or our own role in nature.

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A QUANTUM THEORY OF CONSCIOUSNESS

Henry P. Stapp

Abstract

Heisenberg's conception of the physical universe is combined with William James' conception of mind to form a simple model of the full mind/matter universe. This model realizes Sperry's idea of supervenient top-down control of brain process by subjective conscious experience. The fundamental process of nature is seen as a sequence of Heisenberg events, and every conscious event corresponds to a Heisenberg event that actualizes a large-scale metastable pattern of neuronal activity. This pattern is isomorphic in a specified way to the conscious event. The quantum state of the brain determines the propensity or tendency for each of the alternative possible subjective conscious experiences to occur that might occur in a given situation. Heisenberg's indeterminacy principle implies that the selection of the single experience that actually does occur is not fixed by any known law of nature. James emphasized the unity of the conscious event, a unity that led him to doubt the finality of classical physics, which is essentially reductionistic. In the present model, the unity of each conscious event is a consequence of the unity of the corresponding Heisenberg event.

Introduction

Classical physics has no natural place for consciousness. According to the classical precepts, the sole ingredients of the physical universe are particles and local fields, and every physical system is completely described by specifying the dispositions over space and time of these two kinds of localizable parts. Furthermore, the dispositions of these parts at early times determine, by virtue of the basic laws of motion, the dispositions of these parts at all times. The system is logically complete in the sense that it does not logically require, for its full description of nature, anything beyond the dispositions of particles and local fields.

The two cited features of classical physics, namely its local reductionistic and deterministic aspects, do not rule out the possibility that conglomerates can act cohesively as unified wholes. Nor does it rule out the possibility that such conglomerates may control in large measure the motions of their own parts. However, to the extent that classical physics is valid, these two classical features mean that the motion of physical things can be controlled only by things that are dynamically equivalent to the forces of classical physics. Because subjective conscious experience is not included within the concepts of classical physics, any control over brain activity exercised by a conscious experience is, to the extent that classical physics is valid, dynamically equivalent to the control exercised by the classically described forces. This renders conscious experience superfluous; all physical motions would be exactly the same whether it exists or not.

The condition--"to the extent that classical physics is valid"--is critical. This condition is not satisfied in nature; classical physics is unable to explain the basic properties of materials, even in inorganic, nonliving, unconscious systems. The operation of the brain depends critically upon the subtle properties of the tissues that comprise it. Thus there is no scientific reason to suppose that classical physics could provide an adequate understanding of the dynamics of the mind-brain system. On the other hand, there are ample philosophical reasons to reject the notion that classical physics is conceptually

adequate for this task. Three hundred years of efforts have not reconciled the properties of mind with the concepts of classical physics.

Scientists other than quantum physicists often fail to comprehend the immensity of the changes wrought by quantum theory in our basic ideas about the nature of matter. For example, it has been claimed, in connection with the mind-brain problem, that this change is "incremental". That is hardly the case. Classical physics gives a local, reductionistic, deterministic conception of nature in which consciousness has no logical place, and can do nothing but passively watch a preprogrammed course of events. On the other hand, quantum theory provides a nonlocal, nonreductionistic, nondeterministic conception of nature in which each intrinsically unified individual conscious event, conditioned but not bound by the known laws of nature, can grasp a possible large scale metastable pattern of neuronal activity in the brain, and convert it from "possible" to "actual".

Two principal revisions of the physical precepts lead to this enormous change in the role of subjective conscious experience in mind-brain dynamics. First, there is the opportunity, created by Heisenberg's uncertainty relations, of at least the logical possibility that something not strictly controlled by the mechanical laws of physics *could* exercise supervenient downward control over the course of physical events. Second, there is the natural introduction of events into physical theory that are structurally similar to conscious events. Each such physical event, which is only statistically under the control of the mechanical laws of physics, can select for actualization an entire complex, integrated, metastable, macroscopic pattern of physical activity from amongst the many similar ones created within in a complex physical system by the action of the mechanical laws.

Heisenberg's Picture of the Physical World

According to the strictly orthodox view, quantum theory provides no picture of the physical world in the usual sense. The principal founders of the theory, Bohr and Heisenberg, insisted that, strictly speaking, the mathematical formalism must be viewed as

merely a set of rules for making predictions about observations obtained under certain specified kinds of experimental conditions.[1] The detailed form of these predictions renders quantum theory logically incompatible with any local reductionistic model of the physical world.[2] However, Heisenberg did eventually offer a nonclassical picture of the physical world.[3] His picture of nature may not be the only one compatible with the predictions of quantum theory,[4] but it is certainly a possible one. Heisenberg's picture is, I believe, the one presently favored by the majority of quantum physicists, when they move away from strict orthodoxy enough to allow themselves the luxury of imagining a picture of the physical world.

My proposal regarding consciousness is based on Heisenberg's picture of the world. The central idea in Heisenberg's view of nature is that atoms are not real in the normal classical sense. The physical state of an atom, or an assembly of atoms, represents no actual or substantive property. Instead, it represents objective tendencies for events to occur. The fundamental dynamical process of nature is no longer one single uniform process, as it is in classical physics. It consists rather of two different processes. One of these is a continuous, orderly, deterministic evolution, controlled by mathematical laws that are direct generalizations of the laws of classical physics. However, this orderly process does not control the actual things themselves. It controls only the propensities or tendencies for events to occur. The other dynamical process consists of a sequence of unruly "quantum jumps" or events. These jumps are not individually controlled by any known law of physics, but collectively they conform to statistical rules. These quantum jumps are considered to be the actual physical entities in nature.

Heisenberg described his picture of the world in connection with the behavior of a quantum measuring device. In that context, it is important to recognize that quantum theory naturally accommodates transformations of variables. Thus, in the description of large objects, one need not directly use the coordinates of the individual particles. It is often more useful to introduce variables that represent various "observable" features of the object. One such variable is the center of mass of the object, which represents its location.

Direct sensory perceptions of a macroscopic object containing a huge number of particles can be represented by a relatively small number of macroscopic variables. Each of these latter variables can be fixed, by directly sensing the object, only within an interval that is generally very large, and consequently outside the realm where quantum effects would appear. Of course, one could use a second device to probe features not describable in terms of the original observable variables, but the new empirical data would then refer to the observable characteristics of the new device. Thus, we humans are effectively imprisoned in the physical world described by these observable variables. We gain access to the world only through this limited set of variables. This fact is crucial to the application of quantum theory.

In the typical measurement situation described by Heisenberg, there is a measuring device that is being used to measure some property of an atomic-sized quantum system. The device must be in a state of unstable equilibrium, so that a small signal from the system can trigger a chain of events leading to a change of certain observable features of the device. In this situation, there is a possible change of the observable macroscopic state of the device from one metastable configuration to another. Here Heisenberg introduces his key idea, the notion of an "actual event", arising from the fact that the deterministic part of the quantum dynamics is expressed in terms of a quantity, which, from a mathematical point of view, represents probabilities. However, within the mathematics itself there is no clear indication to what exactly these probabilities refer.

Heisenberg supplied an answer by proposing, in effect, that certain probabilities defined by the theory be interpreted as the "objective tendencies", or propensities, for corresponding *actual events* to occur. Each of these actual events is the actualization of one of the distinct metastable configurations of the observable degrees of freedom. The other possible metastable patterns of physical activity that might have been selected, but were not, are eradicated from the world of possibilities.

The introduction of such actual events into the model of the world carries quantum theory far beyond the ontologically neutral stance of the strictly orthodox interpretation of

quantum theory. In that earlier interpretation, the quantum probabilities are interpreted as simply the probabilities that the community of human observers will "observe" these distinct metastable states. The difference between this orthodox interpretation in terms of observations and Heisenberg's interpretation in terms of actual events is completely negligible at the empirical level in all experimental situations that have so far been examined. However, there is an important theoretical difference. Heisenberg's picture allows quantum theory to be viewed as a coherent description of the evolution of the entire physical reality itself, rather than merely a set of stark statistical rules about connections between human observations.

Brain Dynamics

The human brain is a device that can process sensory input, formulate possible responses to the sensed situation, select a response, and oversee the execution of that response. This activity is dependent on the momentary physical state of the brain, which is a product of many factors, such as genetic structuring, conditioning, learning, and self-organization (e.g., reflection), among many others. The brain contains a huge network of neurons linked at synapses. These synaptic links allow electrical pulses in neurons to stimulate or inhibit similar pulses in other neurons. The complex feed-back and feed-forward linkages produce an immense number of alternative possible metastable reverberating patterns of neural pulses. The persistence of such a pattern for a short time apparently conditions the synaptic junctions in a way that facilitates the excitation of this pattern as a component of subsequent metastable patterns of activity.[5]

In the formulation and execution of a physiological response, a key role must be played by the *body schema*, which is the brain's representation of the dispositions of the parts of the body that it is supervising. This body schema is associated with an *external world schema*, which is the brain's representation of the environment of the body that is represented by the body schema. These two schemata are essentially stable and do not change spontaneously. They are changed only by a particular mental process that replaces

the "current" schema by a new one, and places the old one into an appropriate place in an *historical schema*.

In addition to the body schema and the external world schema, there is a *belief schema*, and these three are parts of the self and world schema. This latter schema represents the "present" part of a general historical schema, into which each self and world schema is placed when it is displaced by a new one.

Consciousness

My proposal for identifying conscious events with certain specific kinds of brain events in Heisenberg's quantum mechanical picture of physical reality is based upon three points:

(1) The schemata described are "classical" in the sense that they can be examined and manipulated in ways analogous to the ways we examine and manipulate macroscopic objects. The schemata are not appreciably disturbed by mere examination, and they can be manipulated by suitable processes. Therefore, it is reasonable to suppose that these schemata are represented by physical structures that are describable in terms of variables of the type that in measuring devices were called *observable*. In fact, these brain structures are the *only* structures that can ever really be "observed", as sensory input must be converted into the external world schema (including affiliated buffers) before they can be perceived.

(2) Brain processes involve micro-chemical events, and hence must in principle must be treated quantum mechanically. In particular, the transmission process occurring at a synaptic junction is apparently triggered by the capture of a small number of calcium ions at an appropriate release site. In a quantum mechanical treatment, the locations of these calcium ions

must be represented by a probability function. This effectively smears these particles over large regions, in a quantum statistical sense. Thus, the question of whether or not a given synapse will transmit a signal is a problem that must be treated quantum mechanically. A quantum-mechanical component must be added to the classical uncertainties, such as those generated by thermal noise, which enter into the determination of whether or not the synapse will fire.

There are hundreds of billions of synapses coupled together in a highly nonlinear fashion. Thus, there is undoubtly a huge number of metastable reverberating patterns of pulses into which the brain might evolve.

Computer simulations of brain networks in the classical case indicate that the final stable state into which a brain evolves is strongly dependent upon the synaptic parameters.[6] Although analogous computations are needed for the quantum case, it appears exceedingly probable that in the absence of any quantum jumps, a brain will generally evolve quantum mechanically from a single metastable configuration into a quantum superposition of many such configurations. The reason for this are: (1) the inherent sensitivity of nonlinear systems of this kind to variations in parameters, (2) the strong dependence of the process at the synaptic junction upon the locations of small numbers of calcium ions, and (3) the large number of possible metastable states into which the brain might evolve. Sometimes a brain will evolve into a superposition that ascribes non-zero quantum probabilities to several alternative possible metastable states of the self and world schema. Note that the fatigue characteristics[5] of the synaptic junctions will cause any given metastable pattern to become unstable after a short time. The system will thus be forced to search for a new metastable configuration. It will continue to evolve, therefore, if unchecked by a quantum jump, into a superposition of a set of increasingly disparate macroscopic possibilities.

(3) From the physical point of view, the situation described in (2) is essentially the same as the one considered by Heisenberg, with the human brain in the place of his measuring device. Thus, if one accepts his picture of the world, then one must also accept the idea that if the brain evolves into a superposition of states characterized by different self and world schemata, then an actual event must select and actualize one of these observable states and eradicate the others. I propose to identify each such actual brain event with a conscious event, and conversely, to identify each conscious event with an actual brain event of this particular kind.

The only relativistically invariant way to represent an actual event of Heisenberg is by a change in the Heisenberg state of the universe. In the interim between actual events, there is a global structure of potentialities that extends uniformly over all of spacetime. In keeping with the special theory of relativity, there is no linkage that connects a spacetime point to other points that are "simultaneous with it" in any favored physical sense. However, each actual event is localized: it is associated with a localized spacetime region in which a certain classically describable, metastable pattern of activity is actualized. This event is represented by a sudden shift in the global Heisenberg state of the universe.

Within the general framework of the Heisenberg ontology, an actual event could conceivably occur at the level of the firing of an individual neuron. In this case, an actual event would determine whether a certain individual neuron fires or not. However, von Neumann's analysis of the process of measurement shows that the actual events in the brain need not occur at the level of the individual neurons. According to von Neumann, an actual event can perfectly well actualize the entire large scale integrated pattern of neural excitations associated with a conscious thought. Indeed, von Neumann's words seem to suggest that all actual events are events of this kind.[7] In the Heisenberg ontology adopted here, the actual events are not exclusively conscious events. On the other hand, every conscious event is an actual event that selects one of the possible high level metastable configurations of brain activity from among the host of such patterns mechanically generated by the Schrödinger equation. Each conscious event is, therefore, an entity that supervenes

over the quantum mechanical laws analogous to the laws of classical physics. It corresponds to a Heisenberg event that actualizes one classically describable, metastable, quantum state of the brain, chosen from among the many alternatively possible macroscopic metastable states generated by the strictly mechanical part of the quantum law of evolution.

Remarks

(1) The purpose of conscious thought is to guide the organism. This must be done by forming a projection into the future, and, more specifically, by forming a projected self and world schema. Thus, the projected self and world schema is one step ahead of the current one. This is the thing that is selected by a conscious act. It is the template that directs those subconscious processes that control the motor activities, and the formation of the next projected self and world schema.

(2) A conscious event is structurally the same as what it is physically. Psychologically it is an event or happening that selects a projected self and world. Physically it is an event, or happening, that selects a projected self and world schema. Thus, the correspondence between these events is neither *ad hoc* nor arbitrary. It is an expression of their structural and dynamical equivalence.

(3) To justify the claim of the equivalence of the psychological and physical events, one must compare the intrinsic structure of subjective conscious experiences to that of the actualized aspects of the brain states to which they correspond. An isomorphism must be established between the intrinsic structure of the conscious thought, as it is described by James and other psychologists, and the intrinsic structure of the projected self and world schema that serves as the physical template that directs the unconscious processes of the brain in the way specified by that conscious thought.[8]

(4) The model shows how experiences exhibiting the empirically established characteristic features of conscious experience can arise essentially automatically out of quantum theory,

provided the brain operates in the way suggested by Heisenberg's picture of nature. The theory is predictive in that brain process must be controlled by a top-level process having the specific dynamical and structural features pertaining to self and world schema and memory that are postulated in reference 8.

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THE ELUSIVITY OF NATURE AND THE MIND-MATTER PROBLEM

Brian D. Josephson

Abstract

This paper examines the processes involved in attempting to capture the subtlest aspects of nature by the scientific method and argues on this basis that nature is fundamentally elusive and may resist being grasped by the methods of science. To come to terms with this resistance, a shift in the direction of taking direct experience into account may be necessary for science's complete development.

What is matter and what is mind? Rene Descartes regarded these entities as being of totally different orders and completely separate from each other, although nowadays the conventional view is to consider mental function as reducible to the behaviour of matter. I propose a new theme in the mind-matter problem, with an approach that develops a concept that I shall call the *elusivity*[1] or elusive quality of nature. The fundamental idea is that nature at large is less amenable to being pinned down to a precise description than the successes of science would seem to imply, particularly if we consider science as applying to some "objective reality" that is independent of the scientist. Some phenomena elude the methods of ordinary science more than others. As far as the phenomena of mind are concerned, there is no good reason to suppose that they can be properly described in terms of science at all. It may prove necessary to use subtler methodologies, such as entering into the subtleties of conscious experience directly, as is the way of the mystic or the practitioner of the arts.

To illustrate the concept of elusivity, let us focus on the problem of knowing precisely where a given object is located. The least elusive entities are classical macroscopic objects. The position of such an object relative to a given reference frame can be typically measured by a ruler, or by surveying techniques, depending on the length scales involved (or by more advanced methods using lasers if high accuracy is desired). If, however, the object is moving, then the question of its position becomes problematic, as in the case of the Zeno paradox. If the velocity is very low, then the concept of the current position has meaning. However, if the motion is rapid, the concept of "now" is not well enough defined to make the position "now" meaningful. The concept of time (coupled with the physical apparatus of the clock that gives a measure to this variable) becomes necessary to determine and define the position of the object at a particular instant of time. Defining this elusive quantity, the position, requires the use of an additional apparatus such as a high-speed shutter or light source to "freeze" the position and make it definite.

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[1] If one were to talk of 'the elusiveness of nature', this would sound strange, because on the whole nature is not especially elusive. It is only in the quantum domain that the elusiveness of nature becomes apparent. Therefore, a case can be made for using a different word.

In the microscopic domain, we never determine the position of a high-speed fundamental particle at a given moment of absolute time, but only measure its trajectory. In the quantum domain, the quality of nature I have termed "elusivity" becomes a fundamental feature of nature, as the uncertainty principle sets definite limits to our ability (even in principle) to determine the position of a particle over a finite period of time. Nature in this regime behaves rather like an insect that responds to our attempts to swat it, as we anticipate just where it will be at the appropriate future instant, by changing its position. This ensures that our prediction will be incorrect, with the result that the insect survives.

Arguments can be given (Josephson, 1988) that in the real world (i.e., the world outside the domain of the scientific laboratory) nature may be still more elusive than this. Detailed analysis and discussion of arguments raised originally by Niels Bohr suggest that any attempt to discover the essence of a naturally occurring system in such detail as to be able to describe it within a quantum mechanical framework (namely, by assigning to it a wave function or a density matrix) will alter the system under study so that the description no longer applies to the original system. Again, it may be noted that the phenomenon of deterministic chaos (Gleick, 1988) points equally to the existence of unavoidable limits on the attempt to pin down nature and say exactly what it is.

Thus, some aspects of nature are more amenable to the ways of present-day science than are others. Mind, in its subtler aspects especially, cannot be handled in conventional scientific terms. Even if it is legitimate to equate the workings of the mind with the behaviour of the brain, the question of what exactly the brain is presents grave difficulties, even in principle, if we inquire at a sufficiently subtle level.

But these traditional methods of science, at least for the hard sciences, take little or no account of conscious experience, which is regarded as an epiphenomenon that science does not have to take into account at all. However, our own experiences are generally less elusive than the subtler phenomena of modern science. It may thus be argued that if we are to understand the mind fully, science needs to take fuller account of the phenomena of

conscious experience. However, conscious experience is usually considered to be a subjective affair and thus unsuitable for meeting the requirements of science. I believe this is a mistaken view of the situation. Artists and mystics have, in some cases, described their conscious experiences in great detail, and I see no reasons (other than custom and ideology) why these should not be taken into account in assembling our world view. A closely related topic is the question of meaning, which David Bohm has suggested (Pylkkanen, 1989) constitutes a fundamental aspect of reality. Again, in the arts we find meaning to have dimensions that the methods of reasoning employed in science have yet to discover (Langer, 1957).

If we wish to come to terms with the resistance that the natural world appears to have to being grasped by the methods of science, then a shift toward taking direct experience into account may be necessary for the future development of science. Furthermore, this will necessarily entail a drastic reevaluation of what are thought to be appropriate areas of exploration for the scientist.

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DIMENSIONS OF THE OBSERVABLES AND THE NATURE OF NATURE

Rajen K. Mishra

Abstract

Every physically ascertainable quantity including space, matter, energy, time--anything in the "event-horizon"--can be shown to have four dimensions occupied simultaneously. These are concomitantly and inexorably present. One of these comprises a physical description, i.e., susceptible to the laws of physics. The other is the mental or the psychological one and includes perception, identification, description, esthetics, innovation, emotion, and "oughtness". These obey laws, but different laws. The third dimension consists of ubiquitous responsivity, i.e., given a proper stimulus a typical response occurs. The fourth is the set of "laws" or Truth, independent of all the rest, but responsible for all, and comprehending all. Comments are made on the incompleteness of observation, and a general system state and dynamics are implied. A place is found for ethics and esthetics by following the dictum that "Nature prohibits abrupt changes in the force field." This may seem to differ from conventional thinking, but this appears to be hitherto the target of the formalism of Prigogine, Thom, and Haken.

Introduction

The visible is the Universe. Let us be more accurate; let us say that by using devices we may extend the visibility both in the microscopic and the macroscopic domain. Then, in the ultimate limit, we see this "event-horizon", beyond which events cannot be noticed. Things are travelling, things are happening but not for us, ever. Within these limits is the visible Universe in our part of the cosmic space. We use light and observe its refraction, reflection, interference, polarization, and fluorescence and by means of these titrate the shape, position, extension, nature, and excitation of matter. We may use very short or very long light waves generated by static objects or moving particles. We may use other fields like those associated with magnetism or the motion of objects among themselves and uncover aspects of the constitution of matter--for example, viscosity. But in every case are posited the gates of our sensorium: electromagnetic fields, the vibration of fluids or solids, light, molecules, pressure, deep touch, light touch, motion, and time. Using these ingredients we observe objects, such as the blue sky on an expanse of snow, the warmth of a fire, the wind howling outside, somebody knocking on the door, and the fleeting colors in the setting sun, which are gone before we call others to observe. All these are dimensions of the observable, the physical dimension, which we can infer by seeing, hearing, or touching something. We reach out with our hands or eyes or ears and get impressions. The daughter, the son, or the crystals come to us, and we apprehend them. There is this inexhaustible catalog of objects, persons, shapes, names, and numbers recorded by their concomitants in the field of vision or sounds. These descriptions commit objects and persons to themselves, to their distinguishability, to their identity.

Scientific observations represent a refined, measured, and controlled version of this. Between objects and our sensorium now intervene scientific instruments and the rules of the game, which are given names such as mathematics, logic, statistics, hypotheses, theories, and "laws". These provide windows through which and through which alone the physically real can be observed in order to be accepted as scientifically valid, although the senses constitute the ultimate common pathway. We will discuss these later. Science must necessarily be concerned with the general acceptance of a body, or the phenomenon of a "body" or an

integer, i.e., the identity of an object that has a locus in space/time coordinates such that the locus cannot offer residence to any other bodies or phenomena. The violation of this constitutes displacement or transformation and creates what is called a cause-effect relationship. In science, a law results if the cause and effect are unique. Given an observation, its antecedent events can be uniquely traced; there are no other antecedent events or facts that can duplicate the effect. However, this invokes no "intelligence", no discrimination. It abrogates choice among several different foreseen results. There is no "intelligent cause"; law is merely a temporal history of objects or their images. The test in all cases is provided by the reliability and reproducibility of circumstances recorded by the sensorium.

But now a profound difficulty occurs. Modern investigations show that all views of the observable are mere possibilities.[1-6] We can refer to the same objects and phenomena and thus converse and communicate, but our descriptions must always remain private to each of us. This is more evident now than in the philosophy of times past. So vital are these discoveries in the realm of the unconscious that one must mention at least the major grounds of these discoveries.

Major attention has been paid to the problem of attending to one stimulus more than any other, because we are exposed to more stimuli, internal and external, than we can manage.[2] What is important is that we are not aware of the precognitive processes. There is some kind of unconscious filtering that allows us to choose one over the other. It is important to note that "meaning" is not a factor in this preselective awareness. Here we depart from the belief that given good eyes and ears, we see, hear, and interpret the stimulus exactly alike.

A second group of experiments that casts serious doubt on the identity of experience, given the same situation, arises from processing involved in the retinotopy and the awareness of visual experience. If an image is stabilized such that its locus on the retina is invariant, when the eye is moved, there comes a time when the image disappears.[4] This is so even though retinal evoked potentials exist, indicating the existence of

electrophysiological events. One is not aware of the image, as if "mind" has turned itself off. The evoked potentials may exist even without subjective perception while there is retinal rivalry, i.e., when two separate stimuli are presented without overlap on both retinas. The two eyes will compete for dominance in perception, although cortical potentials exist as if both stimuli are being seen. In metacontrast[7], if two stimuli of different shapes or forms are presented on adjacent regions of the retina, one after the other, the second one is perceived, whereas the first one is not. In the Crawford Effect, the same stimulus of differing intensities is projected, but only the stronger one is perceived.[5]

In subliminal perception[6], stimuli are too weak to enter into consciousness no matter how long one is subjected to them. But these have a detectable influence on conscious processes or in dreams. There is, so to say, a "restricting effect on awareness".

As stated by Shervin[1], there may be factors related to the stimulus, the state of the individual, and motivation which determine perception. These vital aspects cast serious doubt on the identity of experience. When it comes to recording, analysis, and communication, the situation is worse, given non congruent sense data pertaining to an object. Cultural factors may severely condition communication and debate. Whatever one observes with or without an instrument, the inadequate experience as a measure of description is bewildering. We claim to observe so much when we really see so little, and know even less! Anyhow, these findings raise strong doubts about the notion of physical objects as congruent under different perceptual conditions, whether observed through scientific apparati or not.

The Dimension of the Intangible

While the tangible, physically graspable exists tainted by the described limitations, there remains a vast dimension not necessarily geometrically or temporally coextensive with the physical, which can only be inferred by effect or affect but cannot be touched, weighed, or shown as a separate body or identity. This dimension of objects and events provides the

emotive consequence, the dynamism which is a crucial hallmark of life, which distinguishes life from death or a person from his photograph. In other words, mind agitates matter. This dimension is demonstrable; although it is not an objective body, it is real. It has real consequences. Resulting from the drives of sex, self preservation, and a myriad others, we accept, reject, are ambivalent, laugh, shed tears, are happy or unhappy, sing, or dance on the wings of music. We create and respond to art, sacrifice, and justice, and transcend the visible existence. We repress, suppress, make fantasy, and sublimate. Even in games of science such as mathematics, the intangible exists. It gives meaning, validity, and credibility to mathematics. For example, one writes down a series of steps, the first one represents the given physical datum, which, let us say, relates to and symbolizes the physically real. After fifty steps, one gets the answer in such terms that one wants. We may risk the danger of pointing to the twenty-third step and ask the mathematician, "What does this represent in the real world? What precisely does this step mean?" There will be no answer, only a grimace, a quizzical look, or even anger. For him, this step is merely a necessary operation leading to the solution. In itself, it is difficult to infer meaning. It may even be impossible to say what it stands for. Mathematics is a triumph of rules, discovered or undiscovered. Their *raison d'etre* is the nice, acceptable, parsimonious result that they yield. They eliminate confusion, providing a road that leads to the same consistent result. Herein is the prestige, the value of mathematics. It leads to an end which one could not have foreseen if one is not intuitively endowed. But this proves our point: the intangible is a guide to the tangible, the verifiable, the consistent, the heuristic, and therefore an active dimension of existence. Confusion results when we wish to understand behavior in this dimension by the rules of physics, i.e., in the first dimension. Let us agree that there is an unseen world of intangible forces. It is the dimension of the compulsive act, in receiving, perceiving, storing, identifying, and comparing images. It compels one to act in the light of one's own state, accumulated experience, genetics, race, and circumstances. There is the hidden roughness, the hidden depths and wells and forces and flows, that will determine a whirlpool in which the river of life is caught, willy-nilly. This nature of humanity rises and captures the smooth and quiet flow of life. One lives and dies for one's country, for one's flag, for a child, mother, or somebody one loves. The body becomes immaterial; the intangible becomes real. It appears as if man's life is a vessel of ideas that move his matter. A man goes out

and cries for his son, although reason tells him not to. Neutrality to another's grief is impossible. One may appreciate the poet's version of a thorn, but the thorn that pricks him is real; the pain is real. The proof is that the pain masters him. It is his warm tears of grief and pain, far greater than this thorn, that show that he is human. A calamity raises one's being to a new state of existence, to new action and quite unexpected expression as far as logic goes.

The Dimension of Responsivity

Although there may be the efficient and sufficient manifest causes of phenomena attached to bodies in nature,[8] one may still ask what makes it so. This could be an inquiry into the mechanism and the location of 'I'ness.[9] This was examined before, and it appears that a crisscross of connecting fiber and appendages of neurons in the base of cerebral end of the third ventricle is the thoroughfare of informational traffic in the nervous system. Herein man resides, philosophically speaking; it is a microcosm of man represented in space-time. The "image republic", the ensemble of synaptic points stimulated by an object that correspond to the image of the object, and the oncoming images may interact, and in balance, produce the force that induces one to act.[10] Compulsion may arise for selecting order, esthetic experience, and ethical conduct of resonances in behavior. But we now ask another question, a more basic one. Why should there be any action at all? We ask nature to reveal its intrinsic nature, arriving at this question after discarding all sheaths that enclose the primordial ubiquitous reality. We no longer want to think of parts and qualities. We select the commonality, the quality in all modalities of nature, i.e., space, time, matter, and energy. Here we come to a staggering but quite evident observation. There exists a response, unique and proper to the eliciting stimulus. For physicists there is an eigenresponse to an eigenstimulus. Contraction of space, the laws relating to time, matter, and energy all declare this, a *unique response potential*. With this is also the primordial recognition and choice of stimulus. The stimulus-response dyad constitutes an inherent property of all creation, co-extensive with nature, i.e., the most basic knowledge in nature.

The Dimension of Essence: Where Mind Turns Back

One may go a step beyond this third dimension of nature and realize that the laws of life exist independently of the matter that expresses them. Given space-time, matter, and energy, the laws will declare themselves. Given two bodies in a dark, field-free void, gravitation expresses itself. The design, or in other words, the patterns in nature are the very essence of creation. These four dimensionalities constitute the description of nature and its essence.

We discard here all overlap with the dimensions discussed previously. We discard knowledge and non-knowledge, since they are decided by us, and we are an insignificant fragment of creation. We discard "seeable", usable, collectable, thinkable, talkable--all of our determinations--because they are unreliable as a description of the whole of nature. And of course, we must absolve the nature of nature as some kind of phenomenology, because it is the cause of phenomena. It must remain unique, alone, singular, and yet all-powerful. We are immersed in nature totally without residue. We are a part thereof, like ice in water, and we search for the wateriness of water. Indeed, we are speaking of a reality wherefrom our little minds must come back silent, weighed down with the enormity of experience, the sight of the unutterable.

Enmeshed as we are in the business of our lives, of pleasure and pain and reward and punishment, we are blind to nature. We react so often, so continuously that we neglect pondering more deeply and forget to act. Here, too, we are subject to an inexorable law. Nature prohibits abrupt changes of force fields, yielding an unbroken tranquility, instantaneous, far from equilibrium, and irreversible. It may be constituted of forces, objects, dissipitations, and bifurcations; all these are but a changing cloud-scape. They may be created by cosmic forces and motion, but in all of nature, their destiny is toward unbroken peace. Against this grand spectacle there exists the profound tragedy of man, as in the myth of Sisyphus. We make and mar, over and over, and yet over again; we play the game, bounded by the laws of nature.

These four dimensions are not a foursome, but a unity. We pass from the thraldom of the physical world, to the broader dimension where the enchantment of feelings reigns and on to cold clear judgment within our minds and the grand powers of all forces of nature, to enjoy, to exult, and to express gratitude.[1]

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[1] Many esoteric phenomena like clairvoyance, psychokinesis, and heuristic dreams, upon proper examination perhaps do not qualify as scientific and universally reproducible truth. Indeed, terms such as "laboratory sensitive experiments" have been applied to these. However, if there is any reality to these phenomena, one possible route toward explanation would be weak electromagnetic or magnetic effects. If they exist, they would be included in the physical reality discussed here. They would, of course, require adequate tests of the third dimension of responsivity.

Acknowledgements

This account is a modern version of the Mandukya Upanishad, which consists of twelve couplets in Sanskrit. Extensive commentaries on it by Gaudapada, Govindacharyya, and Shankaracharyya are all in complex and compounded Sanskrit, clothed in intricate Hindu symbology, and therefore not readily accessible to modern students, even in India. This paper is a tribute to all these great teachers. The view of the third and the fourth dimensions might appear to be new, if indeed such a thing as "new" is at all possible in philosophy. It is perhaps more expressive of the original perception of the possibly pre-Christian, unnamed, and unplaced savant and seer. We know not where and when this person existed, for he/she remains unknown and untraceable. For him/her honor, fame, name, or parents' names became unmentionably trivial. I can do no more than pay my homage and say that this voice from the ageless past of humanity's heritage is not forgotten. We rest hereby with him/her.

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THE PARADOX OF MIND AND MATTER: UTTERLY DIFFERENT YET ONE AND THE SAME

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Abstract

This paper examines the question of mind, matter, and their interrelationship from an historical and philosophical perspective. The "mind-matter problem" of Western philosophy is seen to be rooted in a heritage of dualism especially prevalent since the time of the Renaissance. Through a Heideggerian reflection on human history, the problematic schism between mind and matter is interpreted as indicating a loss of wholeness which accompanies the "concealment of Being" (*aletheia*). It is shown that restoring wholeness will require a confrontation with paradox. The need for *embodying* paradox is discussed, and to that end, an exercise in visual phenomenology is conducted.

A perennial question of philosophy is that of mind, matter, and their interrelationship. In its modern form, this problem has persisted since the time of Descartes. Twentieth century, positivistically oriented philosophers are inclined to trivialize the mind-matter (or mind-body) problem, dismissing it as merely the result of "linguistic confusion" or simply declaring it a "non-problem". However, philosophers who are still in meaningful contact with the essential questions of their tradition are likely to acknowledge that the question at hand has neither diminished in importance nor been satisfactorily resolved. This paper explores the possibility that we may meet the challenge of mind and matter through an act of overcoming our deeply ingrained heritage of dualism. The crux of our problem is the loss (concealment) of wholeness, and that if wholeness is to be regained (disclosed), a fundamental confrontation with paradox is necessary.

In contemporary experience, mind is associated with our interior sense of self or ego, with that which lies under or grounds our awareness, with sub-ject, from the Latin, *subjicere*, "to throw under." Matter, on the other hand, is associated with what is manifested in the external world, with that which is sensed to lie outside us, appearing against our subjectivity, cast before us as ob-ject, from the Latin *objicere*, "to throw before." Now, as heirs to the post-Renaissance Cartesian tradition, we take the division between mind and matter as a radical one. We sharply distinguish it from, say, mere differences among objects--in their sizes or shapes, for example, or in their functions, structures, or inherent natures. For us, the mind-matter difference is *ontological*: not a difference among entities *within* a category of being, but *between* such categories; not a distinction among objects, but an absolute distinction between objectness and subjectness as such. In the words of philosopher W.T. Jones, who summed up Cartesian philosophy, "Body is body and mind is mind, and never the twain shall meet" (Jones, 1952, p. 685). However, in the concrete sphere of our everyday experiences, matter and mind obviously do interact; life is somehow all one piece. Then the mind-matter problem is, how can such fundamentally different entities--one inward, unextended, immaterial, and the other outwardly manifested in the physical realm--interact?

If solving the mind-matter problem meant finding a way of bringing together entities between which a radical separation has always existed, entities separated on *a priori* grounds,

we certainly would be faced with a difficult if not impossible task. But I submit that the split between mind and matter actually has a *history*. When the 17th century philosopher Rene Descartes posited this stark schism, he was not merely identifying a state of affairs that had been eternally given in the same way. Rather, as a prime agent of a new mode of understanding, he was helping to *create* it. We should not underestimate the depth of the transformation that took place. Cartesian philosophy evidently reflected more than just an intellectual overlay on an unchanging substrate of concrete human experience. Some observers have gone so far as to suggest that Cartesianism was symptomatic of a sweeping change in consciousness, in human being itself, that occurred with the Renaissance and found expression in the art, literature, science, and philosophy of the time, as well as in ordinary life.

Philosopher Martin Heidegger is among the most perceptive contemporary thinkers to bring out the significance of the Renaissance[1]. He noted that at this time the very meaning of the terms "subject" and "object" underwent a reversal (Heidegger, 1977a). Prior to the Renaissance, it was the surrounding world, nature at large, that had been sub-ject, experienced as thrown under one, as supporting or undergirding one's sense of identity, of self. The word *object* "denoted what one cast before himself in mere fantasy: I imagine a golden mountain" (Heidegger, 1977a, p. 280). Then self withdrew from communion with the world of concrete things, people, and events, contracting to an interior perspective point, the "I" imagined to lie inside one's forehead, behind one's eyes, the ego *a la* Descartes[2]. Divested of subjectness, *nature* now became *object*. No longer lived in its immediate presence, nature became that which was to be represented within a "uniform space-time context" (Heidegger, 1977a, p. 268), a framework in which all bodies could be precisely located, probed, and experimented upon; submitted to mathematical analysis; and ultimately, shaped and manipulated through the enterprises of science and technology.

Others have similarly acknowledged the profound transformation of human experience occurring around the time of the Renaissance. Philosopher Owen Barfield, for example, noted that in the pre-Renaissance era:

> the world was more like a garment men (and women) wore about them than a stage on which they moved (. . .) Compared with us, they felt themselves and the objects around them and the words that expressed those objects, immersed together in something like a clear lake of (. . .) 'meaning' (Barfield, 1988, p. 95).

Philosophers David Lavery (1983) and Jean Gebser (1975) pointed to the introduction of perspective in art as indicative of this underlying change in perception; the artist now stood apart from others and from nature, observing them at a distance from the fixed point of reference inside his head. Correlated developments in the field of written expression have been examined by language theorist Walter Ong (1977). Ong particularly stressed the far-reaching impact on consciousness of the advent of print (ca. 1450), how this new medium standardized, objectified, and spatialized language, thereby bringing to a close the more personal and participatory era of script and orality.

Note that according to Heidegger, the dynamic unity of experience existing prior to the Renaissance was not utterly obliterated, but was relegated to oblivion, forgotten, or repressed. It was after this act of forgetting, which divided self from other, mind from matter, that we left ourselves to wonder how such "fundamentally different" entities could interact. Is it not obvious that as long as we continue to operate within the Renaissance framework of forgetfulness, the mind-matter problem cannot authentically be solved? Operating within that framework is precisely what is responsible for the problem. In the various "monisms" and "dualisms" of modern philosophy, many attempts have been made to address the mind-matter question in a meaningful fashion. However, as I have argued elsewhere (Rosen, 1985a), none of these efforts at solution has succeeded because modern philosophy, maintaining the Renaissance way of knowing and being, remains dualistic at bottom. Implicitly if not explicitly, it presupposes an unbridgeable separation of mind and matter that obscures the concrete wholeness of experience. So it seems that if we are going to approach the problem in a genuine manner, somehow we will need to lift the repression imposed at the time of the Renaissance, to recover something of the original, pre-Renaissance sense in which there was no problem because mind and matter had not yet been starkly, categorically separated. Whereas wholeness needs to be retrieved, this does

not mean going back to it in the simple sense of wiping the slate clean, eradicating the division between mind and matter as if it had never occurred. We can not go back in such a way, nor should we want to.

Pre-Renaissance awareness is not something to be idealized. As Gebser (1975) and Ong (1977) made particularly clear, it was less differentiated, less lucidly focused than the mode of awareness that succeeded it. The differentiation that gave rise to the mind-matter problem served to create a sharper understanding, a greater capacity for reflection and intellectual achievement, and thus it helped us to fulfill our human potential. In any case, I do not believe we *could* go back.

The division of mind and matter arose through an historico-evolutionary process that, in a certain important sense, is irreversible. Here the thinking of Heidegger is once again relevant. Heidegger was deeply concerned with history, but for him, "History is neither simply the object of written chronicle nor simply the fulfillment of human activity," but rather, "a sending," a "starting upon a way," a "destining" (1977c, p. 24). If history were "simply the fulfillment of human activity," it would lie at the arbitrary discretion of human design, be freely constructible under the command of the Cartesian ego, to be done or undone as suits the will. Such a history indeed would be subject to wholesale revision, be utterly reversible. For Heidegger, however, history has a weight, an indelibility beyond the caprice of human design, and therefore, it cannot merely be undone. However, in the first part of his comment, Heidegger states that history is not "the object of written chronicle" either, i.e., not an objectively fixed truth received by us passively like the tablets handed down on Sinai, arriving ready-made from a determining source that lies outside us. History, as a "destining that starts us upon a way," is "never a fate that compels," says Heidegger (1977c, p. 25). There is freedom in this destining, not one of "unfettered arbitrariness," but one that goes beyond "the constraint of mere laws" (Heidegger, 1977c, p. 25).

Evidently, the antithetical views of history to which Heidegger objects have a common source--the transformation of subject and object. It is for the narrowed-down, contracted subject, the self withdrawn from communion with nature, that self-determination

means only the ego's latitude to work its will, impose its arbitrary designs on its surroundings. And when this subject fails in its attempt to shape and determine nature, it fatalistically declares that nature (now experienced as ob-ject) is determined by "fixed laws" operating impersonally, or by an omnipotent "Person." But if history is determined neither by persons nor by impersonal laws, neither by subjects (mortal or divine) nor in a merely objective manner, how is it determined?

Heidegger's answer would be that history is not determin*ed*. The syntax of saying, "history is determined by . . . ," tacitly implies the operation of an agency that itself is outside or independent of history, an agency external to that upon which it acts. Again we have the split between actor and acted-upon, subject and object. Instead of saying, "history is determined by . . . ," Heidegger would say it is a determin-*ing*, i.e., a self-determining process, a *destining* that encompasses a wholeness beyond that possible when one's thinking is split into determin*er* and determin*ed*. Heidegger associates the wholeness of self-destining with *Being*--precisely that concrete, dynamic unity, that radical communion which pre-dates the subject-object split. Although history cannot be reversed in the sense of erasing the deep division between mind and matter as if it never had occurred, as a destining, history itself operates from out of the wholeness of Being; indeed, when Heidegger speaks of the "history of Being," he is intimating that history, in its essence, *is* Being, and Being is history. As Being is not just framed by history but is its own "silent voice," it could never have been obliterated in a bygone epoch, but must always be present in an immediate way, always be "presencing," to use Heidegger's expression. It follows that Being's divisive self-forgetting must also be occurring every moment, not discernibly, from one moment to the next, but as what lies concealed "within" each moment. Let me emphasize that the forgetting in question is no errant deviation symptomatic of a fundamental conflict or cleavage within Being. As radical wholeness, Being never could be at odds with itself in any simply oppositional way. The "cleavage," the "hole" within Being, is the self-concealing (w)holeness of Being itself. Similarly, Heidegger suggests that "self-concealing, concealment, *lethe* [i.e., forgetfulness of Being], belongs to *a-letheia* [unconcealment of Being] not just as an addition, not as shadow to light, but rather as the heart of *aletheia* " (1977b, p. 390). In sum, the unmitigated unity I am attempting to adumbrate is not merely one in which unity prevails over separation, but

one in which the unity of mind and matter (aletheia) and their separation (lethe) are themselves apprehended as inseparably united!

This then, is the sense in which the unity of mind and matter must be raised from oblivion, recollected or remembered: not by an act of going back to the simpler, pre-Renaissance unity, but by grasping the more radical, all-embracing unity of pre-Renaissance unity and post-Renaissance division. It is a paradox, the term "paradox" here understood in the Zen-related sense of a wholeness so uncompromising that it confounds the dichotomies built into ordinary thinking. Perhaps the paradoxical recollection that is called for will occasion a new phase of development, a "new Renaissance," or as Heidegger has hinted, "a turning" (1977d), "another destining, yet unveiled" (1977d, p. 37).

Interestingly, according to philosopher D. M. Levin (1985), despite Heidegger's great contribution, he actually did not go far enough in overcoming the dualistic tradition of Western philosophy. He stopped short of a full recollection of Being because his holistic contemplation, profound as it was, largely was limited to the sphere of the intellect, did not encompass more concrete, embodied levels of Being. In Levin's view, for the repression on Being to be lifted in earnest, its all-encompassing wholeness must be awakened and lived at *every* level of human existence--in our bodily gestures, feelings, and concrete perceptions, for example, as well as in our conceptual activity. "Our thinking," says Levin, "will not find its way back to a more primordial presencing of Being without first 'losing itself' as a metaphysical 'thinking' and going very deeply *into* the body of experience" (1985, p. 56). Accordingly, Levin has sought to supplement the Heideggerian approach with that of Merleau-Ponty, the phenomenologist who placed primary emphasis on perception and the bodily dimensions of experience.

If the recollection of Being needs to be more deeply embodied, say, through a concrete act of perception, and if this recollection entails paradox, we may ask what this "body of paradox" would "look like." The answer I offer begins with an adaptation of a comparison I have employed in several other forums (Rosen, 1985a, 1986, 1987, 1988).

In Figure 1a, the opposition of mind and matter is symbolically expressed in terms of visual perspective. If you were initially viewing a solid cube from the angle shown in the left-hand member of Figure 1a, you would obtain the point of view of the right-hand member by moving 180 degrees around the cube to the diametrically opposite side. The faces of the represented solid that are visible from the right-hand perspective are precisely those that would be concealed from the left-hand point of view, and vice versa. Of course, in our ordinary experience it is impossible to view both sides of an object simultaneously; all six faces of the cube cannot be apprehended in the same glance. Opposing faces remain mutually exclusive.

As mentioned herein, the appearance of perspective in Renaissance art indicated the loss of organic (comm)unity, its repression in forgetfulness of Being. The underlying effect of perspective was to "remove the garment of reality" (Barfield, 1988), to establish decisively the uniqueness and distinctness of the observer's point of view, to locate it inside his head, thereby separating this subject from the objects around him or her, setting the viewer in opposition to that which she or he was viewing. This wedge driven between inside and outside, subject and object, mind and matter, carried over to the observed objects themselves, giving them the appearance of depth and creating the diametrical opposition of sides illustrated in Figure 1a.

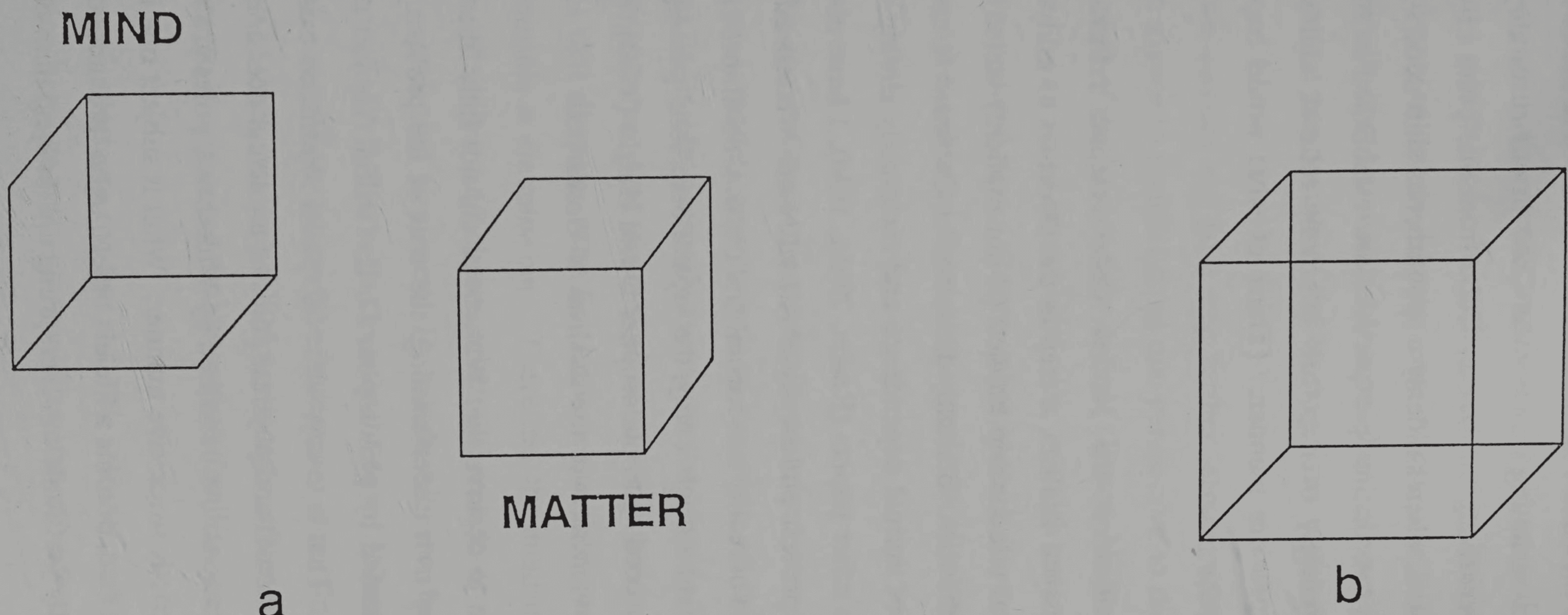

Figure 1. Cartesian Perspectives (a) and Necker Cube (b).

Figure 1b is known to modernist art and phenomenological psychology as the Necker Cube. Both of the perspectives shown in Figure 1a are incorporated in the body of 1b. An *ambiguity* of perspective results, assuming we view the Cube in our customary manner of viewing things. You may be perceiving the Necker Cube from one point of view, say, as hovering above your line of vision, when suddenly a spontaneous shift occurs and you see it as if it lay below. Although two distinct perspectives are established in the course of gazing at the Cube, they completely overlap, are internally related, and are spatially integrated in a totally interdependent manner. (Think of what would happen to one perspective if you tried erasing the other!)

As I interpret its significance, the Necker Cube relation reflects a certain contemporary advance over classical dualism, a step in the direction of unity. Time and again, I have seen this structural relationship implied (if not explicitly stated) in modern process and phenomenological theories. Blatantly dichotomous Cartesian formulations are abandoned in favor of notions of mutual dependence and reciprocity closely akin to that embodied by the Cube. In two other papers (Rosen, 1985a, 1986), I have considered an important example of this: the process philosophy of Alfred North Whitehead (1978). In place of Descartes' sharp division of reality into mental and physical substances (*res cogitans* and *res extensa*), Whitehead posited a single entity, the "actual occasion," possessing mental and physical aspects or poles. According to philosopher David Haight (1983), Whitehead's dipolar monism is a clear improvement over the dualism of Descartes.

However, Haight goes on to observe that Whitehead did not fully liberate himself from Cartesian influence. In my own understanding, the crux of the problem lies in the Whiteheadian "rule of thumb" stated by philosopher D. R. Griffin: "subject *then* object" (Griffin, 1986; emphasis added). That is to say, while no spatial separation exists between subject and object, between the mental and physical poles of an actual occasion, there is a *temporal* separation between occasions. As described by Whitehead, poles are taken to be related in a simply sequential, strictly successive manner. What is subject one instant, has completely "perished" by the very next, become a lifeless object, to be "prehended," mentally enfolded by a newborn subjectivity that somehow has sprung up. Subject then object, mind

then matter, inside then outside--that is the rule, and by virtue of this simply successive relation, though given subjects are transformed into objects on each occasion, subjectivity and objectivity as such remain unaffected; their mutual exclusiveness and diametrical opposition are maintained. In such a conception, subject-to-object transitions can be apprehended only as utterly discontinuous events, pole-to-pole "quantum leaps" that leave us incognizant of what happens in between. Just such a transition is illustrated in the leap we take from one perspective of the Necker Cube to the other.

But we actually can go a step further in our perception of the Cube. Instead of allowing our glance to oscillate from one perspective to the other, we can attempt to view *both perspectives of the Necker Cube at once* (Rosen, 1985a, 1986, 1987, 1988). This can be accomplished by an act of mere abstraction, in which case the Cube will simply flatten into an array of connected lines. On the other hand, it is possible to retain the awareness of depth; when this is achieved there is an experience of self-penetration--the form appears to go *through* itself.

In the conventional, perspectivally polarized way of viewing the figure, when the quantum jump is made from one pole to the other, all the faces of the Necker Cube that were seen to lie "inside" presently appear on the "outside," and vice versa. But it is only at "polar extremes" that faces are perceived as *either* inside *or* outside. With the fusion of perspectives that discloses what lies *between* the poles, each face presents itself as being inside and outside *at the same time*. Therefore, the dualism of inside and out--symbolically, the dualism of subject and object, mind and matter--is surmounted in the creation of a *one*-sided experiential structure in which all six faces are simultaneously given. Simultaneously? Well, that is not exactly the case. What we actually experience with this perspectival integration is neither succession nor simultaneity alone, nor a linear combination of them, but their full-blown merger, a blending of time and space so thorough that they are no longer recognizable in their familiar, categorically dichotomized forms.

Let me underscore the fact that this self-intersecting structure does not just negate the distinction between sides (as would a perspective-flattening act of abstraction). Faces

are inside, and yet *outside* as well, so the feature of duality is not lost; rather, a unity is gained that is deeper than that of the simply di-polar structure. Without merely flattening opposition, the complete interpenetration of opposites is embodied. This paradox, if we had been limited to words alone, if we had been restricted to the abstract, intellectualized medium of language that has been dominant since the Renaissance, would leave us with naught but a sense of uncanniness, incomprehensibility. By the concrete act of perceiving the Necker Cube, the paradox is fleshed out. It becomes a tangible living presence. Through this body of paradox, we literally can *see* how mind and matter can be entirely distinct, yet one and the same. We palpably can sense what Heidegger was getting at when he hinted at the nonseparation of *lethe*--the concealment of Being that underlies the mind-matter split--and *a-letheia*, unconcealment of the primordial unity of Being.

I am convinced that the only way to "solve" the mind/matter problem is to follow the exhortation of D. M. Levin. We need to overcome the post-Renaissance, "ego-logical" (Levin, 1985) framework of dualism in which the problem is rooted, and we can do this by engaging in ever more embodied recollections of Being. By re-membering, fully re-embodying that within us which is "old," we may arrive at the threshold of the *new*--a "new Renaissance," a new, transegoic phase of human being (Washburn, 1988), perhaps even an entirely new order of being[3].

If we sought to carry this out merely by circumventing the intellect and engaging the body, dualism would still be at play. In attempting to lift the repression from the body in a way that surmounts mind-body dualism, the transition from the hitherto dominant intellect to the flesh-bearing body must be so thoroughly fluid that, in effect, it is a "non-transition." In other words, we cannot simply leave the province of intellect, cross the boundary of mind and immerse ourselves in flesh, for such boundary-crossing is itself an act of simple division expressive of the intellect. Like the proverbial Chinese finger puzzle, the more we would strive to free ourselves in this way, the more we would be entrapped.

Rather than seeking to disengage ourselves and go outside the intellect, I propose we move in the "other direction," into its depths, down through its heart and essential core,

where we may discover its " *inner* boundary." "The essence of intellect is not the intellect," Heidegger would have said. Crossing this "boundary" from the intellect to its "non-intellectual" essence, what do we find on the "opposite side?" The end of opposition! Not body-as-opposed-to-mind, but bodymind. The "inner boundary" of the intellect is the "boundary" of boundedness itself. Again, we have paradox. What we are seeing is that it is *paradox* which forms the true horizon of bodymind non-duality, of the wholeness that is authentically recollective of Being. In voicing paradox, the mind is confounded and a pathway is opened to the "silent voice" of bodymind. To begin moving down that path, we must move to more embodied expressions of paradox, such as that presented in the exercise with the Necker Cube. The self-penetrating inside-out structure revealed in the special way of viewing the Cube allows a tangible insight into the "boundaryless boundary" of bodymind (or "mattermind").

In previous efforts, I have attempted to "materialize" the body of paradox in ways still more palpable[4]. To address the challenge of mind and matter in the most authentic way, it seems we will need to radically internalize the body of paradox, embody this all-embracing wholeness with our very own bodies, through our gestures, movements, feelings, and acts of deepest intimacy. It is my conviction that a full-fledged re-membrance of Being will require us to enter the body of paradox so deeply that, in a full and literal sense, we *become* it.

Notes

1. Heideggerian reflection on history reveals that the Renaissance actually constituted only one of several watersheds in the ongoing transformation of *dasein*, of human being-in-the-world. However, in this presentation I will not explicitly consider any of the others. See Heidegger, 1975, for an idea of the change that occurred at the dawn of Greek thinking, and Heidegger, 1977b, for an indication of the most recent transformation of *dasein*.

2. Heidegger gives Galileo's phrase, "I think in my mind of something moveable" (1977a, p. 267), as a prominent example of the early working of this new sense of self.

3. Elsewhere I have proposed that in closing the circle of human development, a new circle of life is opened. See Rosen, 1980, and Rosen, 1988, where the details of this evolutional process are worked out in the context of cosmogony.

4. In all the works cited in this paper (as well as a number not cited), I have explored two paradoxical structures found in the qualitative mathematics of topology: the surface of Moebius and Klein's bottle. See also my novel, *The Moebius Seed,* 1985b.

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Evolution as the Expansion of Coherent States

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Abstract

It is shown that some consistent models of evolution, such as Darwin's theory, may be necessary but insufficient approaches, as they lack power of predictability.

Based on the biophoton concept, evolution can be understood in terms of the $f(\lambda)$=constant-rule, i.e., the coherent excitation of living matter such that the phase space is occupied with equal probability for all quantum energies $E_u < h\nu = \frac{hc}{\lambda} < \infty$. The lower limit E_u depends on the evolutionary development of the species under consideration. By increasing the developmental stage, E_u decreases. The guideline of $f(\lambda)$=constant for $E_u < h\nu < \infty$ provides a predictable evolutionary principle where the expansion of coherent states at an optimum signal-to-noise ratio simultaneously extends a more and more complex basis of communication. Development is predictable by this principle. The content of information that can be transferred by increasing development on this extending basis remains, however, unpredictable.

Introduction

Ernst Mayr, a reputed evolutionary biologist at Harvard University and author of numerous monographs on evolution, claims[1] that the history and interactions of living systems are, at present, well understood in terms of the generally accepted theory of the origin of life, i.e., the theory of evolution by natural selection. It was first enunciated by Charles Darwin more than a hundred years ago and since then has been modified and developed by means of genetics. Today, the theory of evolution is accepted as the most important organizational principle of biology. According to this theory, evolution is a two-step process, where (1) by recombination, mutation or similar random events a genetic variant is produced, and (2) a new order arises by selection.

Following Manfred Eigen's theory[2], this biological principle can be traced back to the molecular level, where the "alternate play between cooperation and rivalry among the molecules stimulated the fashioning and utilization of the original genetic information". According to this theory, self-replicating DNA strands of different sequences that are associated with proteins competed for energy-rich monomers which served them as food. The durable production of new mutant sequences led to a permanently renewed assessment of most of the fit species. Later, as the RNA-dependent protein synthesis became significant, a new kind of dynamical interaction between the molecules came into play. This induced "hypercycles", e.g., the development of self-organized associates. In a sense, the role of chance is now partially taken over by natural laws, based on the binding forces between atomic and molecular units.

Those postulates can never fail, since the mechanisms are described so generally that any strategy of evolution, even a teleological one, fits into this concept. Of course, any kind of interaction can be divided into a competing "repulsive" and a cooperating "attractive" one in such a way that all of these explanations of evolution always evoke the question of a tautology or an after-the-fact justified description of processes, which in terms of the subjective assessment of "rivalry" and "selection" challenges our understanding. Such theories have no predictive power. In fact, all of the other modifications and versions of evolution theory, for example, neo-

Lamarckism[3], neo-Darwinism[4], mutation theory (H. de Vries[1]), synthetic theory[5,6], saltationism[7], punctualism[8], neutralization[9], critical evolution theory[10], semantic theory[11], or systems theory[12] have by no means changed this situation.

As Wuketits[13] writes, the goal of all these scientifically well-established theories of evolution is to reject any sense. This means that any predictable future in terms of an enveloped determinism is disapproved. The future development remains subject to the free game between randomness and necessity, based on natural laws. "Self-organization", a modern but not very new term in evolutionary science, implies that evolution originates from free unpredictable decisions of the "self", on the one hand, and from the organizing power of natural laws, on the other hand, as a yin yang consequence of the elementary "deterministic chaos" of the world.

Those self-consistent explanations of the conventional scientific viewpoint of evolution do not permit the question of the goal of evolution. Similarly, arguments for evolutionary goals based upon mere belief are also unjustified.

Nevertheless, the question arises whether it is not more useful to look for a goal in evolution. Without such a goal, evolution seems to be more of a senseless process than an "evolutionary" one. Searching for a goal might be more useful than the usual quarrels about the modifications of a neo-Darwinian or neo-Lamarckian approach; adapting always-new scientific insights to old models which, in principle, cannot become falsified.

In contrast to the statements of established evolutionary theories, the author of this paper is concerned with the postulate that a deterministic guideline of evolution actually does exist. This guideline, as indicated by experimental results of biophoton analysis of organisms, speculates that the search for a goal of evolution is the goal itself. However, at the same time this guideline seems to forbid a definite answer. Is the sense of evolution to be seen in the goal of "discovering" it, where "discovering" means not only to understand it intellectually, but to "feel" it and to become aware of it?

Critical Remarks on the Established Theories of Evolution

Presently no one doubts the existence of optimization processes of living systems. However, no stringent trial beyond the scope of a self-consistent explanation in terms of selection is known which interprets the biological optimization by elementary physical rather than chemical principles. Despite modern approaches based on the discovery of the openness of living systems, the consequence of long-range interactions playing a dominant role in evolution, rather than short-range molecular forces, has yet to be taken into account. Without supra-molecular, long-range interactions, evolution, i.e., the development of increasingly higher levels of organization, would be impossible and, of course, senseless. Thus, we are not surprised that, for instance, the role of the sun apart from its elementary significance for photosynthesis has been considered negligible.

Evolutionary biologies focused on genetic regulation and considered it a closed system. In relation to this, E. Schrödinger wrote the following in 1955[14]:

Hence the awkward expression 'negative entropy' can be replaced by a better one: entropy, taken with the negative sign, is itself a measure of order. Thus the device by which an organism maintains itself stationary at a fairly high level of orderliness (=fairly low level of entropy) really consists in continually sucking orderliness from its environment. This conclusion is less paradoxical than it appears at first sight. Rather could it be blamed for triviality. Indeed, in the case of higher animals we know the kind of orderliness they feed upon well enough, i.e., the extremely well-ordered state of matter in more or less complicated organic compounds, which serve them as foodstuffs. After utilizing it, they return it in a very much degraded form; however, not entirely degraded because plants can still make use of it. (These, of course, have their most powerful supply of "negative entropy" in the sunlight).

It seems that the permanent struggle for life is considered to be so time encompassing that the absorption of food could not be taken as important and serious enough. However, the food itself plays the most elementary role if "selection, self-

organization", or whatever evolution to more highly organized structures is called takes place.

The failure to take into account the openness of biological systems has confined our thoughts to such an extent that we never ask the question whether or not the development of individuals or populations, or indeed, the evolution of life itself is a driving force at the very origin of evolution. Evolution may be a physical, cosmic process that envelops all the other spatiotemporal events including the unfolding of living systems.

Reminiscent of the transition from the Ptolemic worldview to that of Copernicus, there are similar problems now in moving from the independent self-processing to the interaction between subject and observer. Hence, we may not wonder at the misunderstanding of the "self" itself. This becomes evident at the molecular as well as at macroscopic levels. Even today, scientists maintain that DNA is more or less an equilibrium, closed system. On the other hand, if DNA were to be considered an open system, it would display completely different properties compared to that of a biochemical matrix in a homogeneous reaction mixture. The C-value-paradox (which demonstrates that the amount of DNA is not strongly correlated to the state of molecular development), "selfish-genes" and similar contradictions result from restricted reasoning in terms of equilibrium or quasi-equilibrium systems.

At the macroscopic level this focusing on the "self" results in completely wrong separations of "subjects" and "objects". Quantum theory tells us that this induces many insoluble questions. The situation becomes even more problematic if it is assumed that the surroundings of an organism can be strongly separated, or, if the relation to the environment is regarded only in a "first order approach", consisting only of the nearby, localizable environment. Despite their present non-scientific character, the interaction of the living systems with even universal influences, as displayed, for instance, in circadian or other long-time rhythms, or, even more, in "hope" and "belief", gladness and fear, i.e., in terms of consciousness, play a more important role for evolution than randomness, the puzzling game of dice. In our opinion, the dignity of life suffers from this scientism of evolutionary processes.

Coherence

Coherence is usually meant to be the ability of electromagnetic waves to interfere. Take, for example, two waves

$$E_1(t) = \mathcal{E}_1 \cos \omega t \quad \text{and}$$
$$E_2(t) = \mathcal{E}_2 \cos(\omega t + \varphi)$$

where $\mathcal{E}$ is the field strength, ω the frequency, t the time and φ a phase, the superposition results in

$$E(t) = E_1(t) + E_2(t) = \mathcal{E}_1 \cos \omega t + \mathcal{E}_2 \cos(\omega t + \varphi) \ .$$

The intensity i at a time t is proportional to the square of the amplitudes. Thus, we have

$$E^2(t) = \mathcal{E}_1^2 \cos^2 \omega t + \mathcal{E}_2^2(\omega t + \varphi) + 2\mathcal{E}_1 \mathcal{E}_2 \cos \omega t \cos(\omega t + \varphi) \ .$$

If during a time interval τ (which is called coherence "time") the phase relation $\varphi(t)$ is always "forgotten", then for $t > \tau$ the last term $\cos \omega t \cos(\omega t + \varphi)$ vanishes in view of the radnomness of the averaging procedure. In such a case, there is no contribution of this interference term to the energy flux. The intensity is then just the sum of the intensities of the single waves.

If, however, $\varphi(t)$ is a well-definable function of t which doesn't exclude that $\varphi(t)$ could remain constant as well, the intensity fluctuates periodically in such a way that it can completely cancel out at certain times, or, taken at other times become twice as high as before. These periodic intensity fluctuations are called temporal coherence, while the corresponding spatial interference patterns of the form $\cos kx \cos(kx + \varphi)$ with $E(x) = \mathcal{E} \cos(kx + \varphi)$ determine the spatial coherence of the field under investigation.

By analogy to this classical definition of coherence, at first E. Schödinger[15], and later R.J. Glauber[16] introduced the "coherent state" into quantum optics. Furthermore, it not only represents the capacity of interference, but displays more generally a fluctuationless field. This means again that the phase $\varphi(t)$ is completely determined at any time t. The field amplitude $\mathcal{E}$ can take any value from o to ∞, which means it is wrong to believe that coherent fields always provide high intensities (as have been technically achieved in laser optics). The frequencies of the waves under investigation are insignificant for coherence. Fields of arbitrary amplitudes and compositions of frequencies may produce arbitrarily high degrees of coherence. As valuable measures of coherence we can estimate correlation function of the following kind:

$$K(\tau) = \int E_1(t)E_2(t-\tau)dt \ .$$

For simplicity, let us confine discussion here to the case of ideal coherence in which there is a complete lack of phase fluctuations. In quantum optics this coherent state $|\alpha\rangle$ is defined according to

$$a|\alpha\rangle = \alpha|\alpha\rangle \tag{1}$$

where a is the annihilation operator and (1) determines the coherent state of $|\alpha|^2$ photons as the eigenstate of the annihilation operator with the eigenvalue α. Roughly speaking, (1) means that if we take a single photon out of a coherent state, it remains stable and doesn't decay into an incoherent one. This property is by no means trivial. For instance, if a single excited molecule decays into its ground state and releases a photon by it, it spontaneously changes its physical and chemical properties. A laser, on the other hand, remains rather stable if it loses one photon or even more. During the coherence time, which takes about 10^{-2} seconds for technical lasers, the phase relations in the photon field remain relatively stable. The molecules or atoms that participate in the emission of light are also relatively stationarily coordinated.

With increasing coherence, significant characteristics that are particularly essential to biological phenomena change. These include the following: (1) efficiency

of energy consumption; (2) ability of communication; (3) pattern recognition ("visibility"); and (4) stability.

One of the first scientists to claim that coherence plays an important role in biology is Herbert Fröhlich (1968[17]), who discovered the mechanism of superconductivity. In his paper Fröhlich postulated that "biological systems are expected to have a branch of longitudinal electric modes in a frequency region between 10^{11} to 10^{12} s^{-1} ... The supplied energy, therefore, is not completely thermalized but stored in a highly ordered fashion. This order expresses itself in long-range phase correlations; the phenomenon has considerable similarity with the low-temperature condensation of a Bose gase".

A Possible Evolutionary Strategy Beyond Darwin and a First Approach to this Problem

Due to the importance of sunlight as the most fundamental source of nutrition, biological systems display a natural tendency of delaying the thermalization of the sun's energy as long as possible. This can be most effectively achieved by the formation of a coherent platform that expands the photon field into a coherent state of growing bandwidth. In contrast to Fröhlich's postulate, not only the accumulation of certain frequencies is important, but also the expansion of the spectral distribution into the most extended frequency band. Therefore, one of the essential quantities is the probability distribution $f(\lambda)$ of occupying modes of wavelengths λ, in relation to the goal of integrating them into the communication system. This distribution is subject to an optimization procedure, and the principle of optimizing $f(\lambda)$ from a scientific point of view can be considered as a "teleological" concept of evolution.

Sunlight can play the role of the driving force of such a process. This follows, for example, from a variety of remarkable facts: (1) According to the van Cittert-Zernike theorem, the coherence area of sunlight on the earth is of the order of 10^{-6} cm^2 [18]. This is about the surface area of a cell. (2) The resolution is the shortest distance that a light wave can pass before it collides with a thermal photon of the

phase space. For sunlight in a cell, this resolution is a value of the order of $4 * 10^{-8}$ cm[19], corresponding to approximately the vertical distance between adjacent base pairs of DNA.

The foregoing and other similar indications[19] point to a close relationship between the formation of biological structures and their induction by sunlight. Before we go into more detail, let us briefly discuss some experimental results that support this hypothesis.

Biophotons

In 1976, when our coworker B. Ruth showed evidence of a very weak but permanent photon emission from living tissues[20,21], we were convinced by means of theoretical studies that this light could only be a coherent one[22–24]. Standard objections to this are that ultraweak photon emission from biological systems is merely spontaneous chemiluminescence. This argument has been based on Zhuravlev's "imperfection theory"[25], according to which metabolic processes produce activated species that are permanently and randomly excited. Obviously they will decay after a very short time into their ground state, and consequently a permanent weak light emission will take place. This is also in accordance to Seliger's hypothesis[26] which maintains that biological matter is always subject to metabolic excitation. Consequently it has to display a permament tendency to decay to thermal equilibrium, thereby emitting weak light.

Thus, the goal of our research group has been to prove experimentally that the "biophoton" emission (as we call it) is coherent and not merely spontaneous chemiluminescence.

Table 1 contrasts the differences between chaotic and coherent field emission[27]. None of our experimental results support the theory that biophotons originate from spontaneous chemiluminescence. Our results are, however, in complete accordance with the hypothesis of a coherent photon field within the living system.

Criterion	Chaotic field	Coherent field
Localization	"Spontaneous" chemiluminescence	Delocalized and factorizable electromagnetic field
Correlation to physiological or	"Imperfections" - no correlation -	*Correlation to many*, if not all *processes*
Temperature dependence	"Arrhenius"-plot (exponential kinetics)	Non-linear reactions (*overshoot-reactions, hysteresis-loops, etc.*)
Excitation-temperature	Near equilibrium (quasi black-body radiation)	*Far away from equilibrium* non-equilibrium-phase-transitions
Energy transport	Diffusion-controlled	Cooperation phenomena: *transparency*, but also protection (absorbance) possible
Sensitivity to external influences	Small	Possibly *high*
Photocount statistics for one mode	Geometrical distribution	Poissonian *distribution*
Spectral decay behavior under ergodic conditions	Exponential	*Hyperbolic*

Table 1: Expected properties of a chaotic (spontaneous) luminescence field versus an ideal coherent (regulatory) field. The experimental results are italicized, where experimental evidence has been provided.

In particular, the experimental fact that upon exposure to weak light illumination the relaxation of the photon emission from living tissues cannot be described by an exponential decay curve, but agrees fairly well with a hyperbolic decay function, demonstrates the coherence of light emission. Since this point is of considerable importance, let us discuss it in more detail. Figure 1 shows the hyperbolic decay behavior of the spectral photon emisson at $\lambda = 676 \pm 10$ nm of a plant, *Bryophyllum daigremontanum*, after exposure to a weak white light illumination. An exponential curve (dashed line) has to be clearly rejected, while the hyperbolic curve fits the data sufficiently well.

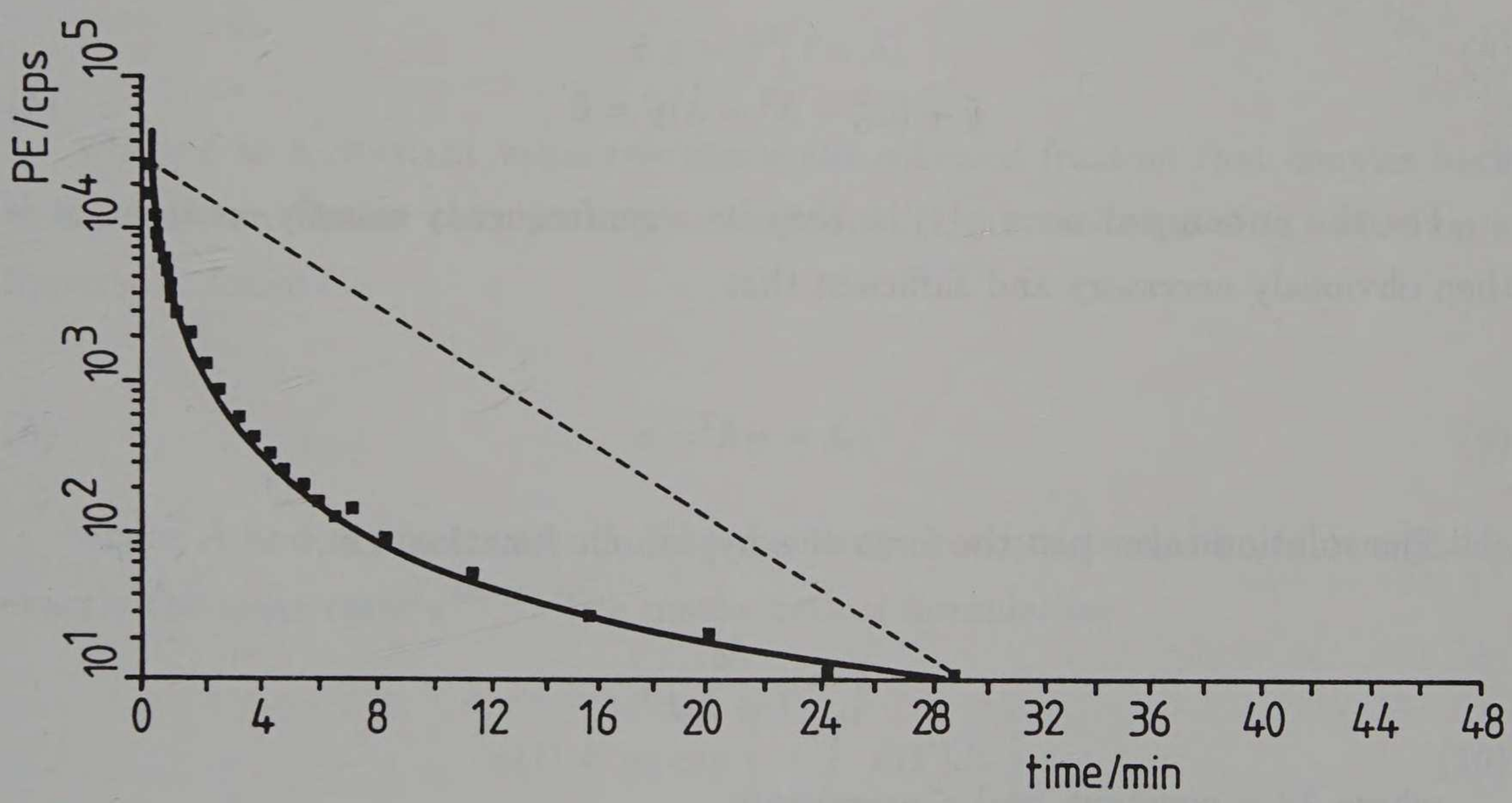

Figure 1 Instead of an exponential decay (dashed line), living cell populations (here tissue of *Bryophyllum daigremontanum*) exhibit a hyperbolic relaxation of photon intensity after exposure to white-light-illumination. This holds for total as well as for spectral observation (here at 676 + 10 nm). Under ergodic conditions, hyperbolic decay is a sufficient condition of coherent rescattering[31].

To understand this strange behavior, let us consider the simple case of a classical oscillators of an amplitude $x(t)$, a time-dependent damping $2\lambda(t)$, and the frequency ω. The well-known oscillator equation

$$\ddot{x} + 2\lambda\dot{x} + \omega_0^2 x = 0 \tag{2}$$

can be separated into a damped and an undamped term $y(t)$ according to

$$x(t) = exp\left\{-\int_0^t \lambda(t')dt'\right\} y(t) \ . \tag{3}$$

Upon inserting (3) into (2) one gets

$$\ddot{y} + (\omega_0^2 - \lambda^2 - \dot{\lambda})y = 0 \ . \tag{4}$$

For the undamped term $y(t)$ to keep its eigenfrequency exactly constant, it is then obviously necessary and sufficient that

$$\dot{\lambda} = -\lambda^2 \ . \tag{5}$$

The solution takes just the form of a hyperbolic function, i.e.,

$$\lambda = \frac{\lambda_0}{1 + \lambda_0 t} \ ,$$

where λ_0 = constant, and consequently

$$x(t) = \frac{y(t)}{1 + \lambda_0 t} \ . \tag{6}$$

Hence, (6) describes a hyperbolic decay and not an exponential one which had been obtained in the case of a constant λ. However, in that case a frequency shift had occurred. In contrast to that, if a system stabilizes its frequencies, it does not decay exponentially, but according to a hyperbolic function. In addition, the mean

potential energy $\langle \ddot{x} \rangle$ of an oscillator equals (for a non-coherent oscillation according to the hypervirial theorem) just its kinetics counterpart, $\langle \dot{x}^2 \rangle$. From this

$$\ddot{x}x = \dot{x}^2 \tag{7}$$

follows the solution $x = x_0 \exp(\lambda t)$, where λ is a constant.

However, as soon as part of the decay product, e.g., the photon that is emitted from the oscillating antenna, couples back coherently to its source, then a certain stationary fraction of the kinetic energy is reabsorbed (or restored) as potential energy. Thus, instead of (7) we then have

$$\ddot{x}\, x = \dot{x}^2(1+\delta) \tag{8}$$

where δ as a constant value represents the coherent fraction that couples back to the emitter. Rather than an exponential function, the solution of (8) takes on a hyperbolic form:

$$x = A(t+t_0)^{\frac{1}{\delta}} \tag{9}$$

where A and t_0 are constants. The quantum description of the problem yields exactly the same results[28–31]. The mathematical formulation

$$\dot{n}(t) = n_0 \exp\left\{-\int_{t_0}^{t} n(t')dt'\right\} \tag{10}$$

connecting the photon intensity $\dot{n}(t)$ of a coherent photon field with the number of photons present in the field is very elegant. It (10) takes account of the fact that the photocount statistics (PCS) of a coherent field requires at any instant a Poissonian distribution[28–31]. The solution of (10) is again a hyperbolic function.

Before continuing the discussion on evolution, let us first show evidence of coherent states in biological systems, at least in the optical region.

The $f(\lambda)$=Constant-Rule

Figure 2^{27} displays the results of careful measurement on the spectral distribution of biophoton emission compared to the Boltzmann distribution of a thermal equilibrium system at physiological temperatures. It shows the values $f(\lambda)$ according to

$$f(\lambda) = \frac{i(\lambda)\,\lambda^4}{8\pi c} \,. \tag{11}$$

where λ represents the wavelength, c the velocity light and $i(\lambda)$ the number of emitted photons per units of time, surface area, and wavelength. $f(\lambda)$ is the probability of occupying phase space cells of energy $E = \frac{hc}{\lambda}$ of the corresponding phase space. For thermal equilibrium $f(\lambda)$ takes the Boltzmann distribution

$$f(\lambda) = \exp\left[\frac{-hc}{kT\lambda}\right] \tag{12}$$

where k is the Boltzmann constant and T the temperature of the system under study.

At first, Figure 2 shows evidence that the biological system is spectrally far away from thermal equilibrium. This has considerable implication for the reaction rates of biochemical reactions. According to the well-known theory of activation in chemistry, the reaction rate increases proportionately to $f(\lambda_A)$, where $\frac{hc}{\lambda_A}$ represents the activation energy of the reaction under study[29]. This implies that enzymes are, in principle, not necessary for metabolic activity. Although they lower the activation energy, the photon field is really the catalytic force of metabolic activity. For example, even with the appropriate enzymes present a biochemical reaction at low temperature will not take place because the photons are not present. On the other hand if no enzyme is present, the activation energy can be provided by an external

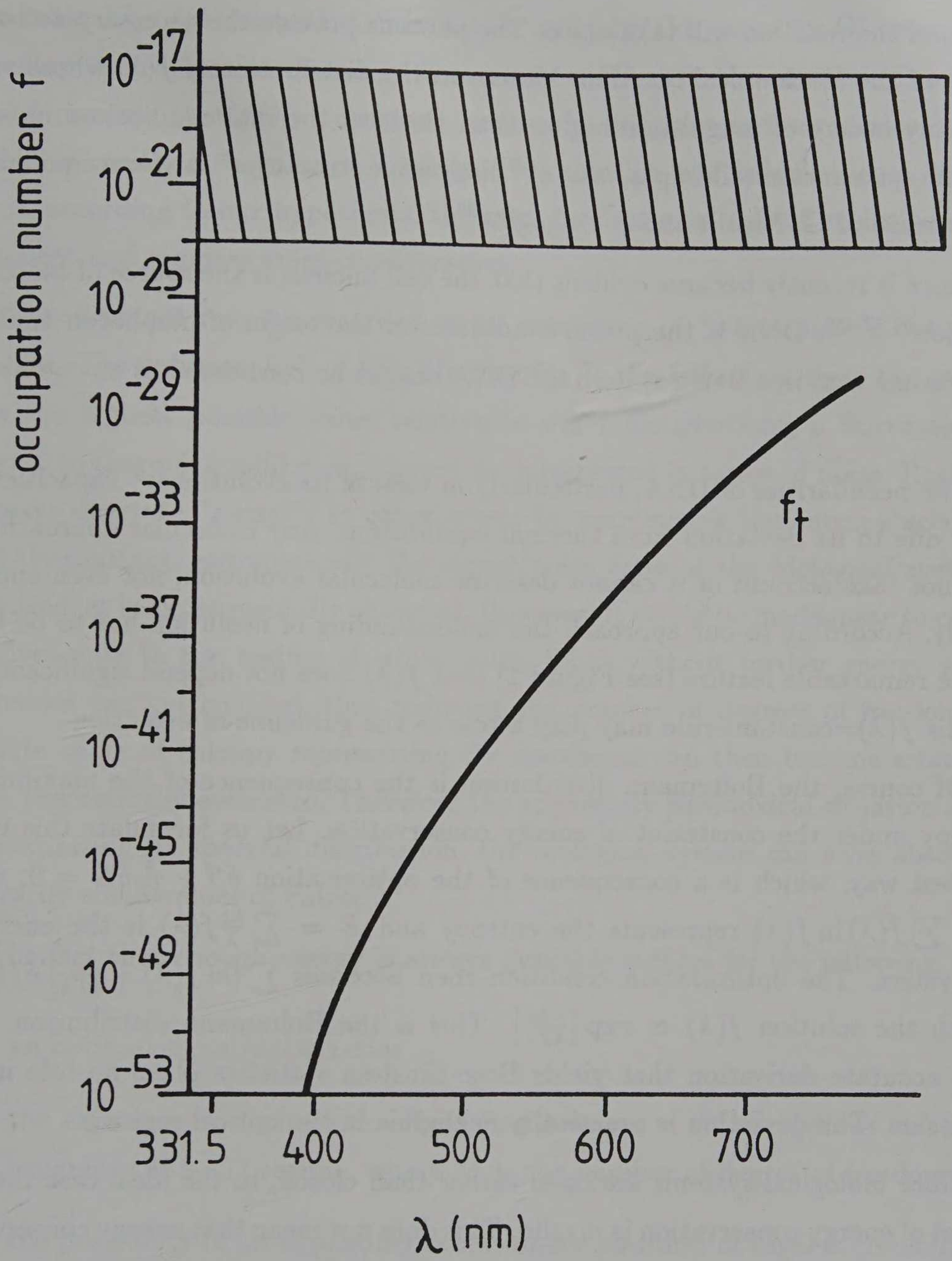

Figure 2 The probability f of occupying the (vacuum) phase space is for living systems completely different from that of a thermal equilibrium system (f_t, which follows a Boltzmann distribution). From the spectral intensity of "low level luminescence" one calculates that f of living tissues lies "far away from equilibrium" in the hatched zone, exhibiting (almost) no wavelength dependence ($f \simeq$ constant).

field, and the reaction will take place. The photons provide the necessary activation energy of the biochemical reaction. Moreover, the distribution of $f(\lambda)$ whose values are many orders of magnitude higher than those of thermal equilibrium indicates that the system can build up a basis of "dissipative structures" far from equilibrium, in the sense of G. Nicolis and I. Prigogine[32].

Since it recently became evident that the cell nucleus is the source of biophoton emission[31,33–35], DNA is the prime candidate for the origin of biophoton emission. This means that in a living system the DNA cannot be considered as an equilibrium system.

The peculiarities of DNA, particularly in view of its evolutionary capacities, are likely due to its deviation from thermal equilibrium. Any molecular approach that does not take account of it cannot describe molecular evolution, not even approximately. According to our approach the understanding of evolution has to be based on the remarkable feature (see Figure 2) that $f(\lambda)$ does not depend significantly on λ. This $f(\lambda)$=constant-rule may play a role as the guideline of evolution.

Of course, the Boltzmann distribution is the consequence of the maximum of entropy under the constraint of energy conservation. Let us formulate this in the simplest way, which is a consequence of the optimization $\delta S + \frac{1}{kT}\delta E = 0$, where $S = \sum f(\lambda) \ln f(\lambda)$ represents the entropy and $E = \sum \frac{hc}{\lambda} f(\lambda)$ is the energy of the system. The optimization condition then becomes $\sum \left[\ln f(\lambda) + \frac{hc}{kT\lambda}\right] \delta f(\lambda) = 0$ with the solution $f(\lambda) \simeq \exp\left[\frac{-hc}{kT\lambda}\right]$. This is the Boltzmann distribution. (The more accurate derivation that yields Bose-Einstein statistics plays no role in this discussion. The deviation is practically negligible in the optical region).

Since biological systems are open rather than closed, in the ideal case the constraint of energy conservation is invalid. This does not mean that energy conservation is violated, since biological systems together with their surroundings are further subject to energy conservation. Also, this does not mean that there is always an overflow of energy within the system. It only means that enough energy is always available for the system under consideration. Biological systems do not generally suffer from a shortness of energy. Upon needing energy, their high storage capacity will make

it available. The $f(\lambda)$=constant distribution indicates this capacity. Of course, after cancelling the constraint of energy conservation $\delta E = 0$, the remaining condition $\delta S = 0$ requires that $f(\lambda)$= constant, where the constant is the reciprocal of the number of modes or degrees of freedom. This solution which looks like a "trivial" case is, according to our hypothesis, the most fundamental rule of evolutionary development and requires more consideration.

$f(\lambda)$=constant may be regarded as an expression of "white noise", but not in this case. The "philosophy" of this distribution is the following: since the entropy takes the highest possible value relative to other distributions, a fluctuation, in contrast to thermal equilibrium, cannot be interpreted in terms of noise. Rather, it is always due to a "signal". In other words by maximizing the entropy according to $f(\lambda)$=constant, automatically the signal/noise ratio of the biological system is optimized, as is experimentally observed. However, it would be inadequate to confine ourselves only to the regime of white noise. Since without further energy supply the modes can get coupled, thus reducing the number of degrees of freedom, the absolute value of entropy representing the maximum can then become arbitrarily small, theoretically even zero. Therefore the apparently paradoxical situation arises: by maximizing its spectral distribution, the biological system can have absolutely arbitrarily small values of entropy.

The fact that enough energy is always available suffices for the following:

1. an optimal signal/noise ratio;

2. the existence of a phase threshold just between a chaotic ($M \to \infty$) and a coherent ($M \to 1$) regime, where M is the number of degree of freedom; and

3. the possibility of an expanding evolutionary platform of highest commutative capacities by the process $f(\lambda)$=constant for $0 < \lambda \to \infty$, where the arrow ($\to$) indicates the extension of this process to longer and longer wavelengths.

To understand the evolutionary power of sunlight that could build up this platform, let us take account of the entropy of light itself.

According to M. Planck[36], the spectral entropy of a light beam can be written as

$$S = \frac{k}{\tau}[(1+i\tau)\ln(1+i\tau) - i\tau \ln i\tau] \tag{13}$$

where i is the count rate (number of quanta per unit of time), and τ the coherence time[37]. The probability $f(\lambda) = \frac{n_\lambda}{g_\lambda}$, where n_λ represents the number of photons, and g_λ the number of phase-space cells in the spectral region under study, equals the product $i\,\tau$, which means

$$f(\lambda) = i(\lambda)\tau(\lambda) \ . \tag{14}$$

Like Fröhlich[17], we introduce here a chemical potential according to the definition

$$S = \left\{\frac{\mathcal{E}-\mu}{T}\right\} + \text{constant} \tag{15}$$

where $\mathcal{E} = \frac{hc}{\lambda}$ represents the photon energy. By comparison of (13) and (15) we have:

$$\begin{aligned} \delta S &= \frac{(\mathcal{E}-\mu)}{T}\delta i - \frac{\delta\mu}{T} i \\ &= -S\frac{\delta\tau}{\tau} + k\left(\delta i + i\frac{\delta\tau}{\tau}\right)\ln\left(1+\frac{1}{i\tau}\right) \end{aligned} \tag{16}$$

In case of a stable coherence time $\delta\tau = 0$ the identity

$$\ln\left(1+\frac{1}{i\tau}\right) = \frac{\mathcal{E}-\mu}{kT} - \frac{\delta\mu}{kT}\frac{i}{\delta i}$$

is obtained, and consequently

$$f = i\tau = \frac{1}{\exp\left\{\left(\frac{\mathcal{E}-\mu}{kT}\right) - \frac{\delta\mu}{\delta i}\frac{i}{kT}\right\} - 1} \ . \tag{17}$$

For $\delta\mu = 0$ we get the well-known Bose-Einstein statistics that approach the Boltzmann distribution for $\mu = 0$ in accordance with the laws of equilibrium thermodynamics. However, for $\delta\mu \neq 0$ we arrive upon insertation of (16) into (17):

$$f = i\tau = \frac{1}{\exp\left(\frac{\delta S}{k}\right) - 1} \tag{18}$$

This is the point where the creative force of coherent photon storage can work as the driving evolutionary force. According to the van Cittert-Zernike-theorem[18] a storage area of 10^{-6} cm^2 or less will provide the coherence of sunlight. According to the Brillouin theorem[38] the change of entropy S of a photon with two possible directions of polarization is just $\delta S = k \ln \omega = k \ln 2$.

Consequently, we obtain:

$$f = i\tau = \frac{1}{\exp(\ln 2) - 1} = 1 \ . \tag{19}$$

In other words, as soon as the coherent photon storage of sunlight takes place, a non-equilibrium structure can be organized that displays the $f(\lambda)$ value of 1. This is just the laser threshold over this region. It is obvious that this rule remains valid in the sense that $f(\lambda)$=constant (where the constant may take much lower values than 1) as long as the environment of this structure doesn't dissipate with respect to specific frequencies.

In fact, from (13) in case of a complete utilization of the entropy change $\delta S = -S$ (which corresponds to a complete conversion into structure and organization) there follows the relation

$$\delta i = -i\frac{\delta\tau}{\tau} \tag{20}$$

that is obviously just the rule $f(\lambda) = i\tau$=constant.

At this point we see again the connection to the hyperbolic decay. Since $f(\lambda)$ is a constant, $i\tau$ remains constant which means that the hyperbolic law

$$i(t) = \frac{f(\lambda)}{t} \tag{21}$$

is valid as long as $t < \tau$, where τ is the coherence time of the system. It is self-evident that all of these idealistic considerations are actually disorted by external influences. This is expressed by the modifications of the $f(\lambda)$=constant-rule under actual conditions. It is worthwhile to note that only by these external modulations "information" comes into play. Without those impulses the $f(\lambda)$=constant-rule provides only the ideal platform of communication, not its contents. Of considerable importance is the circumstance that the rule $f(\lambda)$=constant can be seen as the guiding principle of evolution, where the basis extends from $0 < \lambda \rightarrow \infty$ due to a broader and broader integration of communicative systems over longer and longer spatiotemporal distances. Deviations from $f(\lambda)$=constant are the informative modulations of this band, exhibiting in contrast to $f(\lambda)$=constant, the feature of unpredictability. The situation is displayed in Figure 3.

It should be mentioned that all of the other experimental results of biophoton emission, e.g., the temperature dependence, the optical transparency, and dynamic parameters, are completely in accordance[27,31,39–45] with this interpretation.

Change of Paradigm for Cell Communication

The hypothesis $f(\lambda)$=constant with $0 < \lambda \rightarrow \infty$ is only based on measurements of biophotons. However, it explains a variety of unexplained phenomena such as cancer development or the evolution of species. At the same time it excludes the validity of established theories of evolution.

At present the postulated but very weak long-range interactions between living systems (which should establish this basis $f(\lambda)$=constant) are not intense enough to be measurable by means of the relatively insensitive technical equipment available. However, the present technical impossibility to measure them doesn't suffice to exclude them. Indeed, there should be methods of showing indirect evidence of these couplings.

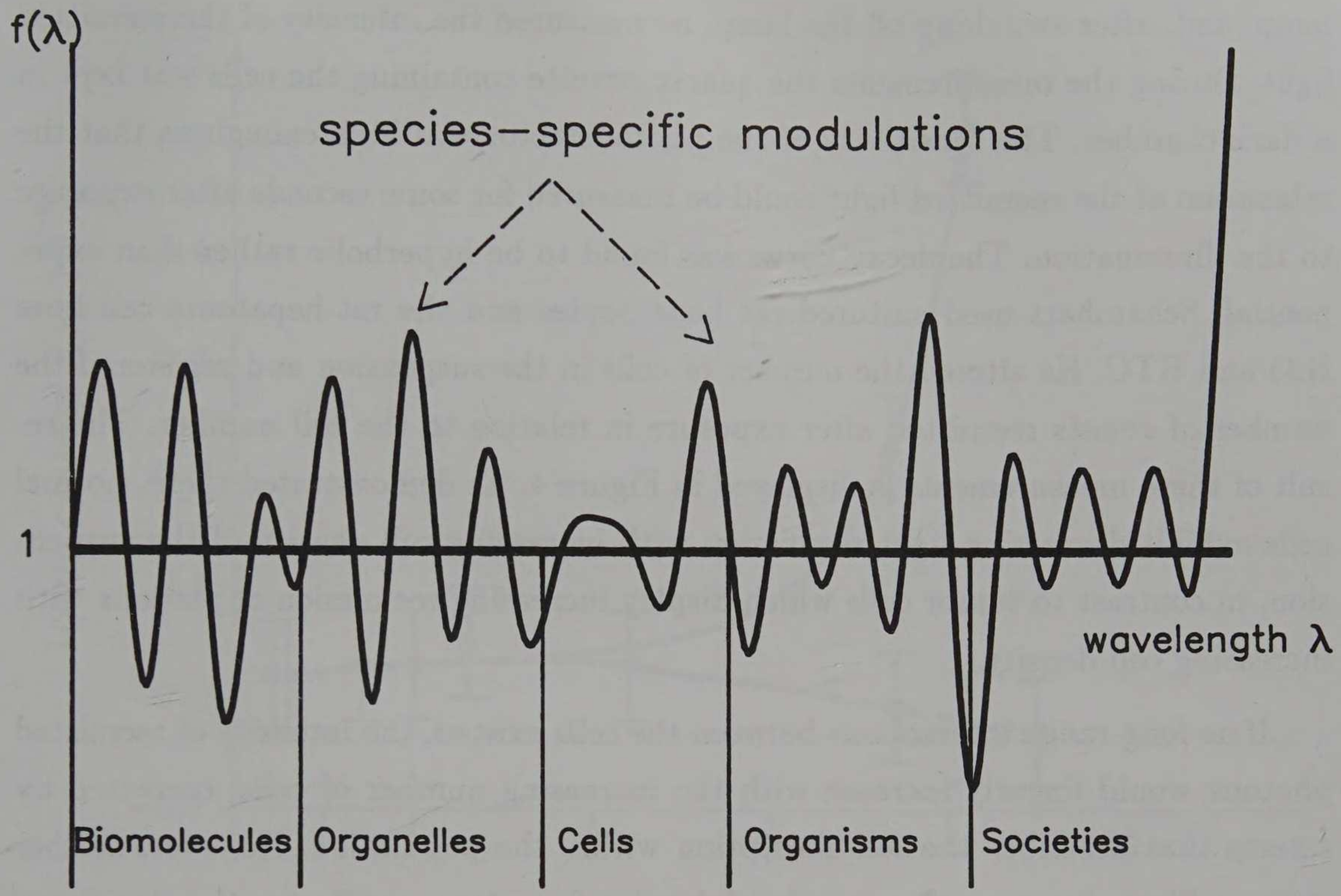

Figure 3 The $f(\lambda)$=constant-rule provides that evolution expands around $f = 1$ of the DNA-System of the living state. The more this development is extented to the long-wavelength-range, the higher the evolutionary development has to be looked upon. With extending wavelength the size of coherence volume and communication increases as well as the range of social interactions. Since $f = 1$ is confined to an average value, time-dependent and species-specific modulations around $f = 1$ determine the species of the living system under investigations.

A first experiment in this direction has been performed by D. Schamhart of the State University in Utrecht in our lab in Kaiserslautern University[46]. He exposed a cell suspension for a few seconds to the white light illumination of a 150 W tungsten lamp, and, after switching off the lamp, he measured the intensity of the reemitted light. During the measurements the quartz cuvette containing the cells was kept in a dark chamber. The sensitivity of the photodetector was high enough so that the relaxation of the reemitted light could be measured for some seconds after exposure to the illumination. The decay curve was found to be hyperbolic rather than exponential. Schamhart used cultured rat hepatocytes and the rat hepatoma cell lines H35 and HTC. He altered the number of cells in the suspension and registered the number of counts reemitted after exposure in relation to the cell number. The result of these measurements is displayed in Figure 4. As demonstrated there, normal cells exhibit decreasing light reemission with increasing cell density of the suspension, in contrast to tumor cells which display increasing reemission of photons with increasing cell density.

If no long-range interactions between the cells existed, the intensity of reemitted photons would linearly increase with the increasing number of cells, corrected by a term that describes the self-absorption within the population. However, neither the non-linear increase of reemission intensity from tumor cells nor the significant decrease of reemission from normal ones can be explained without the existence of long-range interactions of the cells[31,45,46]. Moreover, a photochemical reaction as the cause of this effect can be excluded. Actually, the order of magnitude of reemitted quanta is very low at only a few counts per cell per day. It is unimaginable that a biochemical reaction of this rareness should be sensitively dependent on intercellular distances of a few cell diameters. Summarizing, we have to conclude that there must be long-range interactions between the cells that are responsible for their social behavior; such as the disaggregation of tumor cells and the attractive long-range forces between normal ones.

In fact, these phenomena can be interpreted in terms of the theory of R.H. Dicke[47]. According to Dicke, the spontaneous reemission of photons from an ensemble of emitters bifurcates into the two branches of superradiance and subradiance

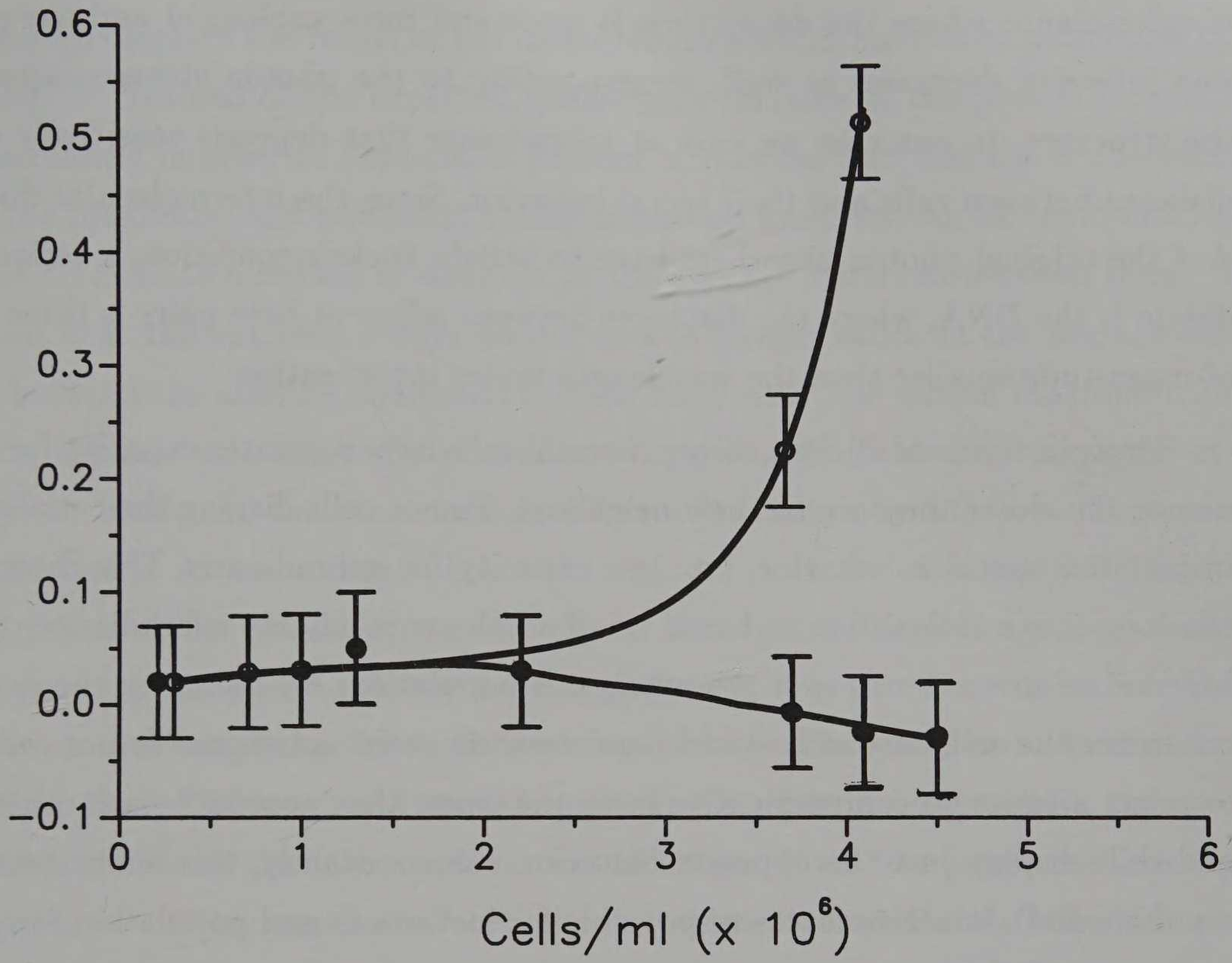

Figure 4 "Delayed luminescence" from tumor cells (upper curve) and normal cells (lower curve), as measured by Schamhart[46]. The different curves can be approximated by a non-linear (cubic) dependence of intensity from cell-number n.

as soon as the wavelength becomes large relative to the distances between the absorbers. Superradiance results from an increase of reemission intensity simultaneous with a shortening of the relaxation time. The opposite branch describes the regime of subradiance where the decay time is more and more prolonged and the reemission intensity decreases as well, corresponding to the photon storage capacity of the structure. In our case we look at subradiance that depends sensitively on the distance between cells and their social behavior. Since the intermolecular distances d of the original photon absorbers have to satisfy Dicke's condition, a serious candidate is the DNA, where the distances between adjacent base pairs is three orders of magnitude smaller than the wavelength under investigation.

Thus, in terms of Dicke's theory, normal cells have a greater capacity for subradiance the closer they are to their neighbors. Tumor cells display their malignancy in just the opposite behavior, i.e., less capacity for subradiance. This means that the long-range interaction is based on the coherence of this subradiance; the coherence volume extends over the whole cell population. By changing the degree of coherence the cells can control and regulate their social activities. Tumor cells seem to reject a common communicative basis the closer they approach each other. Normal cells display just the opposite behavior. Concomitantly, this is the reason for repulsive and attractive forces responsible for metastasis and population formation, respectively[48,49].

To examine this interpretation, H. Niggli[50] isolated cell nuclei from human fibroblast cells and compared their reemission activity with that of the cytoplasm. In all cases it turned out that the nuclei contribute the highest if not the entire reemission intensity.

Since the $\frac{1}{\delta}$ value of equations (8) and (9) is a measure of incoherence, we calculated these values from measurements of the reemission curves of normal human cells (amnion cell cultures) and the corresponding malignant ones (Wish cells)[49]. The result of Schamhart's measurements could be reproduced, showing the characteristic decrease and increase of reemission activity with increasing cell density for normal and malignant tissue, respectively. In addition, the $\frac{1}{\delta}$ value of tumor cells increases and that of normal ones decreases, as expected, with increasing cell den-

sity (Figure 5). Even more distinct results are obtained if organisms instead of cells, such as daphnia, are used, and if the biophoton emission is measured instead of the reemission intensity.

Figure 6 displays the result of the measurements which have been performed by M. Galle[31,55]. Instead of the expected quasi-linear increase of the photon intensity with increasing number of daphnia, a pattern of maxima and minima is observed, where the maximum and minimum values of photon intensity can be reproducably assigned to definite numbers of daphnia or the average distances between them. It turns out that the extrema always correspond to integer ratios of the average distances between the animals compared to their body size. The second maximum, for instance, appears at a mean distance of one body length. Table 2 displays the experimental results and their mean errors. The results cannot be interpreted in terms of biochemistry. As an example, however, a model in terms of antennae interacting by means of the resonance wavelengths of their geometrical dimensions would fit the experimental data. Whatever we hypothesize, it is necessary to include the observation that long-range interactions actually exist. They are the basis of group formation, Gestaltbildung, and growth control. The link to body size in the case of daphnia indicates that the condensation of longer waves has progressed already to microwaves of the mm-range[31]. Further experimental results of Galle indicate that biological rhythms as well as the selection and the differentiation of species are consequences of this basic phenomena.

From a quantum theoretical point of view, the expansion of coherent states according to the rule $f(\lambda)$=constant, for $0 < \lambda \rightarrow \infty$ means that evolution is the minimization of the uncertainty principle by increasing spatiotemporal extensions. Actually, coherent states have the property to display the smallest possible uncertanty of all states[31,51,52].

We have to conclude that Darwin's interpretation together with all of its modifications cannot actually describe evolutionary development, since any teleology is disputed for even the best fitting models. In contrast to that, we hypothesize an optimization principle that cannot be traced back to a "survival of the fittest". The

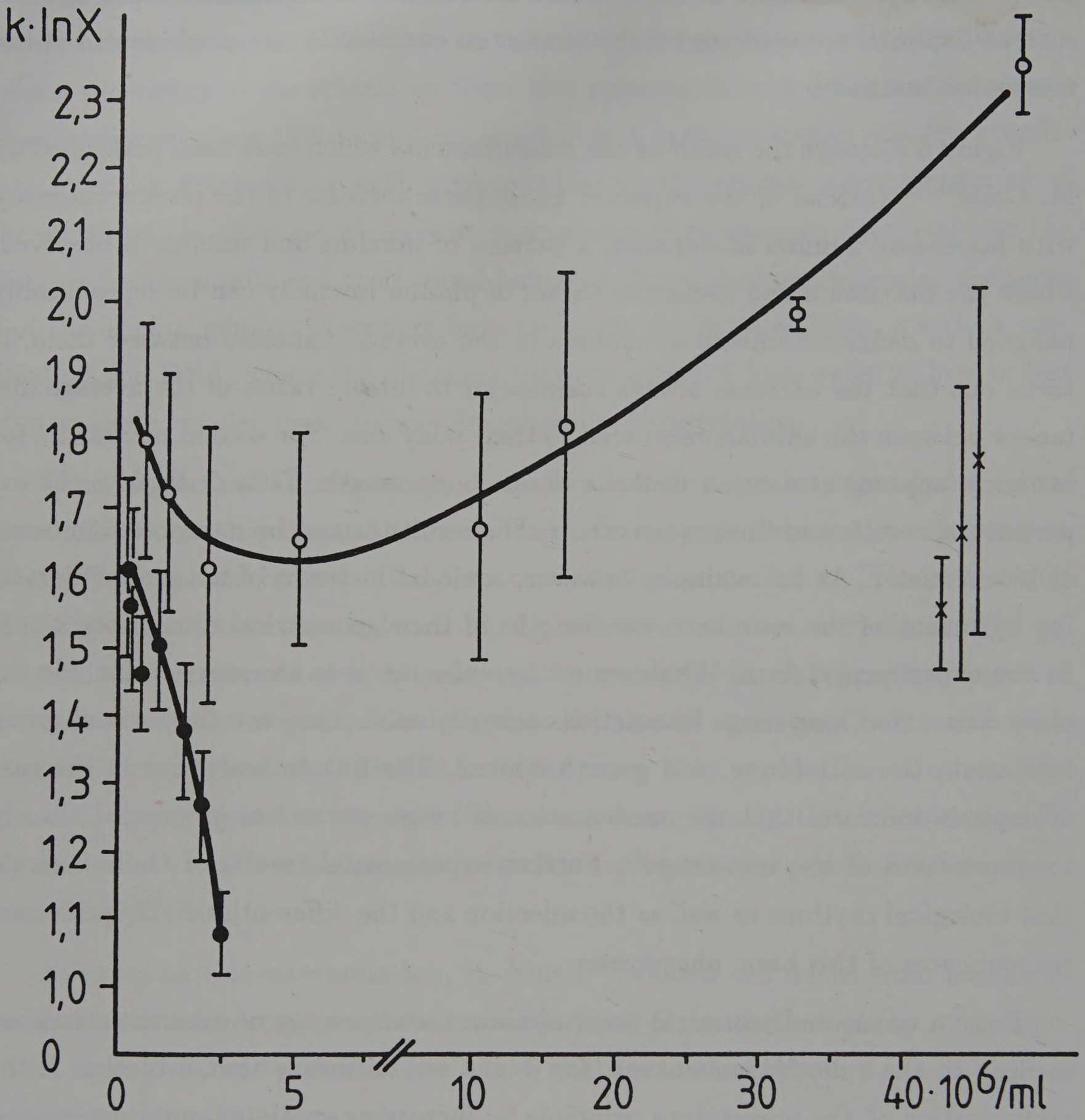

Figure 5 The decay parameter of the hyperbolic approximation that is adjusted to the relaxation dynamics of the afterglow of different cell suspensions after exposure to weak white light illumination is shown versus cell density. The lower curve displays the behavior of normal amnionic cells. The upper curve shows the opposite dependence exhibited by malignant Wish cells. The three measurements at the right side of the figure correspond to the nutritive medium alone.

actual origin of our hypothesis is the expansion of a spatiotemporal basis of communication with well-defined optimum properties. Living systems are then neither subjects alone nor objects alone, but are in our viewpoint, both subjects and objects.

In contrast to the neo-Darwinian point of view, the capacity of living systems for evolutionary development does not originally depend on their rivalry and power in the fight for life. Rather, their evolutionary development depends mainly on their capacity for communication. They can be looked upon more strikingly as expanding antennae systems, which has been postulated by P.S. Callahan[53] for many years. In this way, prey may be considered as a pumping source of enfolding the evolutionary base, analogous to a laser rather than mainly as fuel.

In a sense, the whole entity of living systems is a more or less considerably interlinked developing unit. Just as the cells in an organism perform different tasks for the whole; different populations enfold themselves not only for their own, but principally more for the totality of all living systems, toward expanding a "consciousness" of the whole, and becoming more and more aware of it. For humans the role of the "brain" may be significant.

We may ask what the advantages would be for such a process. From the viewpoint of the natural sciences, the satisfaction of elementary curiosity can be discovered. This process displays the property of unsatisfiability since the more questions are answered, the more new questions can be asked. By conquering the world of "actual information" the other world of potential information, i.e., the world of possibilities, expands. This is an always increasing process. It amplifies the capacity to look forward to future events and to remember the past by increasing the power of memory, as well as to become more aware of the present. According to the uncertainty relation such a process is unlimited, since this uncertainty is the essence of the individual's "freedom" and consciousness. We cannot exclude the possibility that Planck's constant itself is a subjective quantity, a consequence of our biology, based on the limited structure of our DNA. However, in that case we have reason to take a serious look at the subjectivity of our worldview.

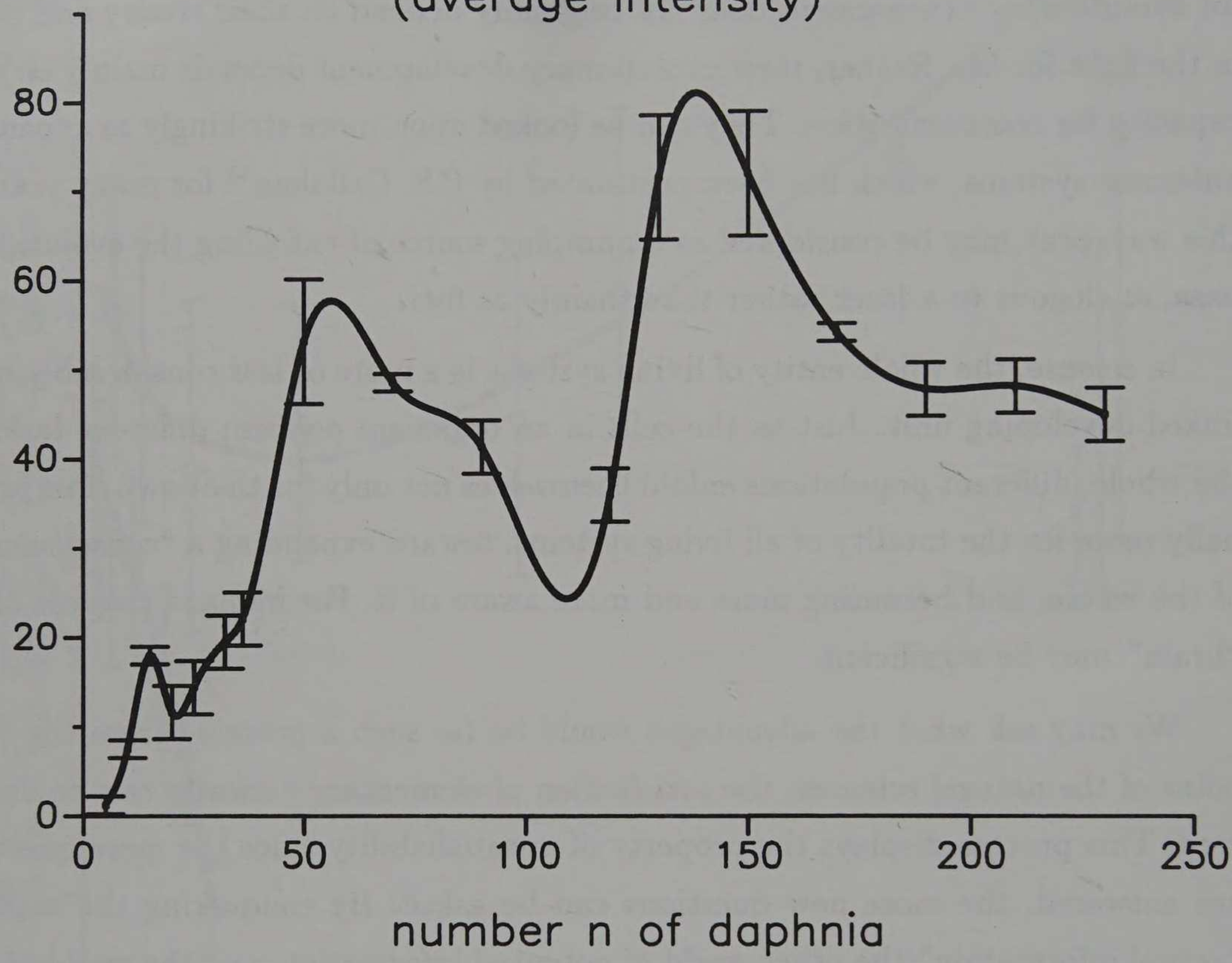

Figure 6 Mean values of the photon intensity of adolescent daphnia in 15 ml volume with the weighted standard deviation.

Photon Intensity	E	T	M
3rd Minimum	0.667 ± 0.058	$0.625 = 5/8$	1/4
3rd Maximum	0.761 ± 0.072	$0.750 = 6/8$	1/2
2nd Minimum	0.845 ± 0.095	$0.875 = 7/8$	3/4
2nd Maximum	Reference	$1.000 = 8/8$	1
1st Minimum	1.308 ± 0.238	$1.125 = 9/8$	5/4
1st Maximum	1.557 ± 0.094	$1.250 = 10/8$	3/2
0 Minimum	–	$1.375 = 11/8$	7/4
0 Maximum	–	$1.500 = 12/8$	2

[a] $$E = \frac{d_x}{d_{max2}} = \sqrt[3]{\frac{\rho_{max2}}{d_x}} = \sqrt[3]{\frac{N_{max2}}{N_x}}$$

Table 2: Comparison of the theoretically expected values (T) for the ratio of the mean distances of animals within the minima and the maxima of photon emission expressed in terms of integer ratios of the body size, and the corresponding ratio of the mean distances as calculated from the experimental data (E) according to the formula[a], where N_x represents the mean number of animals in the cuvette underlying the minima and maxima of intensity except the mean number underlying the peak given in the numerator, and ρ the density (d_x=mean distances of the centers of the sheres, that means animals, at the minima and maxima of intensity). M indicates the theoretical value of the mean distance in units of body length between the animals. The minima and maxima are ordered according to their empirical appearance (see also Figure 6).

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