

Although the field of cryptozoology is highly controversial, the book represents a useful and informative contribution to public knowledge of anomalies. A curious reader interested in the field will benefit from it—at least until a more scholarly encyclopedia on the subject is published. An easily readable style and extensive bibliography are particularly useful, even though there is no division between scholarly and popular publications, as are informative lists of museums, exhibitions, periodicals, and Web-sites.

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**Understanding Tomorrow's Mind** edited by Larry Vandervert (a special issue of the *Journal of Mind and Behavior*, volume 18).

This special volume of the *Journal of Mind and Behavior* (spring and summer 1997 issues of volume 18) is devoted to papers relating chaos theory and quantum mechanics (QM) to psychology and the study of consciousness. The collection is titled "Understanding Tomorrow's Mind," and the implication is that further understanding of consciousness and the mind will require the use of tools such as the mathematics of chaos theory and the physics of QM. Although this is a fairly popular idea in some cognitive science circles (particularly in some corners of artificial intelligence and artificial life research), most work in psychology makes no connection with developments in the forefront of physics or mathematics. The claim that fundamental advances in these fields have anything to do with the study of behavior and consciousness is a bold one, because it is often thought that cognition arises at a much higher level and is controlled by principles far removed from the laws governing the bedrock of matter, within which mentality is embedded. This book presents an interesting sample of approaches that aim to make progress in cognitive research by using tools from fundamental physics and mathematics.

The volume presents a sample of applications of nonlinear and quantum modeling approaches for the dynamics underlying psychological phenomena. It starts with a brief preface and a set of guidelines for using this book as a teaching tool. This is a very useful inclusion; however, it would have been even more useful if it had included some references and pointers to areas of work specifically not included in this collection (more on that below).

Chapter 1 is a tutorial on chaos by B. West—a very readable, easily understandable piece on the fundamentals of low-dimensional, deterministic, nonlinear, dynamical systems theory (*i.e.*, chaos theory). The chapter has almost no formulas, but it does have enough graphs and a very lucid explanation of the fundamentals—what this theory is and what it is not. There is enough meat here to emphasize the relevant conceptual aspects of nonlinear sciences. Particularly useful is a table contrasting various aspects of scientific research as they are viewed from the classical versus the “nontraditional” paradigms of systems theory. The key concepts of chaos theory are given as: emergence, deterministic but unpredictable behavior, large effects caused by small inputs, discontinuous and nonlinear behavior, no characteristic scale (interesting detail appears at a wide range of magnifications along some parameter), and the necessity for qualitative understanding of the system. West covers examples in topology, physics, mechanics, embryogenesis, psychophysics, business/economics, and evolution. This is a very valuable paper in every way and should prompt every interested reader to delve more deeply into books such as West (1990), Barbi (1998), or Liebovitch (1998).

The next chapter, by H. Stapp, is an introduction to QM. The introduction is a very good one; it begins quite abstractly, without the usual examples of basic physics experiments that demonstrate quantum “weirdness.” Such examples are, I think, necessary to a good understanding of what QM is all about, and one can get a flavor for them in many good books understandable by the nonexpert. Examples include Herbert (1985) and Gribbin (1995). Stapp’s approach is interestingly different from most expositions of QM and is quite relevant to the psychological theme of this collection. He discusses QM in relation to the work of William James, epistemology, and the notion of truth. He sums up the implications of QM as that “the complete description of nature at the atomic level was given by probability functions that referred not to underlying microscopic space-time realities but rather to macroscopic objects of sense experience.” (p. 127) There are of course other intersections of QM with philosophy of mind, including issues of predictability (Dennett, 1984), dualism versus materialism versus idealism (Beloff, 1989; Smythies and Beloff, 1989), and the role and nature of consciousness in the material world (Wigner, 1979; Hodgson, 1991).

The next 10 chapters are papers on aspects of cognitive science, which range from general metaphysical issues (such as “The Science of Consciousness and the Hard Problem”) to very specific QM or chaos–mathematical models of neurobiological phenomena (such as “Phase Transitions in Learning”). The selections are generally quite interesting. There is not enough space to discuss them all, but a few specific comments can be made.

An often-mentioned point (on which there is no consensus among the experts) is that QM, the ultimate theory of materialism (a rock-bottom theory of matter), seems to bring in dualism through the fundamental concepts of the observer and the wave function collapse (Wigner, 1979). In his chapter, Chris King makes an interesting analogy relevant to the issue of free will. QM has several properties that begin to sound as if they might provide a substratum to

free will, a concept that finds no comfortable place in pre-quantum science. Quantum processes are often nonlocal, unpredictable, and “ghostly” (Davies and Brown, 1986; Gribbin, 1995). A single particle in QM can occur anywhere within its wave function, despite a probability distribution strictly governing the aggregate. King proposes that free will in a single brain corresponds to quantum uncertainty in the ongoing brain state. He cites Eddington’s 1935 estimate that “the uncertainty of position of a synaptic vesicle was as great as the width of the membrane, thus constituting a possible trigger for an unstable cascade.” (p. 156) The approach of leveraging free will from unstable, nonlinear magnification cascades (à la chaos theory) set off by quantum events has been much discussed. However, by itself it merely injects an element of randomness into behavior: Pure randomness coupled with deterministic brain algorithms is not what we really mean by “free will,” although it may provide for one aspect of it—unpredictability. These ideas are analyzed by Dennett (1984), who argues that ultimately not only do we not know what we mean by *free will*, but also the popular concept of it that we hold to simply does not correspond to anything in the real world. A somewhat similar approach is used by John Eccles (Popper and Eccles, 1984), but there, the quantum uncertainty and chaotic amplification is a point of contact with a nonphysical consciousness; thus, an attempt is made to allow control by an immaterial mind while answering conservation of energy arguments against dualistic interactionism.

G. Globus’s paper (p. 195) contrasts the approaches of connectionism (the science of the properties of neural networks) with traditional representationalist information-flow-based AI paradigms. He draws an analogy between optimization of the behavior of neural net with the minimization of a neural Lagrangian operator (a quantity associated with the velocity and acceleration of ionic currents in the brain). “I am nonlocal control and my meanings are cybernetic variables.” (p. 195) His view is that consciousness is quantum fields “hoisted” by biosubstrates. It is not clear what this “hoisting” process is, and why only biological systems can accomplish it. There are many complex dynamical systems. What are the features of biology that make cognitive systems special? Globus then discusses the nature of the “I,” or central controlling self; such a thing has not been found by neuroscience, and much discussion has taken place (Dennett, 1980; Hofstadter and Dennett, 1981) on whether this is an illusion and how (and why) this illusion is maintained. Globus’s suggestion is that this issue is resolved by nonlocal control exhibited by quantum dynamical systems. He avoids category mistakes by identifying the “I” with *being* a brain under quantum control, not with the brain itself. A remaining problem of course is that for any physical mechanism (whether classical or quantum) proposed to account for the “I” or “self” is found, the natural response is still “yes, that is what explains the *behavior* of the system, but where is the first-person subjective experience, the unified self perspective we all share?” In light of this issue (which of course is viewed as a pseudoproblem by many), the identification of nonlocal controls of the brain’s dynamics is more a contribution to the “easy” problem (*i.e.*, basic neuroscience) than the hard problem (philosophy of mind).

Jibu and Yasue (1995) present some interesting ideas that have been influential in several of the contributions to this volume. They develop models based on quantum ordering of water in the brain and show derivations of mathematical properties of such systems as they relate to dynamics of brain states. Their ideas are more fully treated in their book. There are a couple of confusing statements in their contribution though.

Molecular biology is a branch of biophysics developed phenomenologically by gathering fragmentary knowledge of molecule-based organic chemistry, quantum chemistry, and quantum statistical mechanics. Patching those fragments into a single system of knowledge is made by the longstanding and excellent intuitions of biologists. Nevertheless, molecular biology does not succeed in explaining the essential aspects of the brain functioning directly related to the highly advanced mental "objects" (p. 207).

This is a mischaracterization of molecular biology, which is neither phenomenological nor fragmentary, nor does it focus on quantum chemistry. And of course, molecular biologists do not work toward explaining brain functions. Perhaps the authors are actually making a deeper claim: that the reductionist approaches of molecular neurobiology are insufficient to ever explain brain functioning. If so, I would have liked to see a discussion of their opinion of the theoretical shortcomings of the currently popular approaches based on the neurophysiology of real networks in the brain. Such models have worked fairly well in explaining aspects of visual processing and memory. I would also have liked to see some specific predictions of their model.

W. Freeman presents a very interesting paper on the neurodynamics of intentionality (his inroad of choice toward the mysterious edifice of consciousness). The paper discusses brain dynamics of voluntary actions, as well as representations in the brain. He concludes that "there are no representations in brains, only meanings" (p. 301). These issues have been given good discussion by Libet's group (Libet, 1993).

In summary, this is a very valuable book. Interestingly, it has no contributions by some prominent researchers in the area of quantum theory and cognitive science (such as Brian Josephson, Roger Penrose, Stuart Hameroff, *etc.*). On the one hand, this is good, because it left more room for contributions by ideas from very different schools of thought. Thus, this is a great complement to books such as Hameroff, 1987; Hameroff *et al.*, 1996; Penrose, 1996. On the other hand, it would have been nice to have at least a couple works from those authors included for comparison. A concluding essay would also have been very welcome, if it had summarized the approaches and conclusions of the papers and compared and contrasted different approaches to the role of QM and chaos theory in cognitive science. An overview of future prospects and on-going research would also have been useful to outline possible areas for new and interested researchers.

In general, this book is quite useful but is more for the expert in the field rather than for the required reading of all psychology students that the intro-

duction suggests. Most of the essays (except the excellent first two chapters of overviews) discuss topics at a level suitable for specialists but do not spell out the basics. Of course, this is impossible to do in a book with reasonable space constraints, given the complexity of all three of the subjects involved (QM, chaos theory, and cognitive science). Some of the papers (such as that by Sabelli *et al.*) are so densely packed with new ideas, models, and analogies that they are very hard to follow and read as a compressed, concise set of notes taken by someone who has had daily discussions with the author and understands the implications thoroughly. This book is best digested after familiarity with the contents of, for example, Churchland (1988), Gribbin (1995), Gleick (1988), Peitgen *et al.* (1992), *etc.* It is a great companion to Lockwood (1991), Searle (1985), Ramachandran and Josephson (1979), *etc.*

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