

## Preface: a Conversation

**Joanna Rączaszek-Leonardi:** Finally, a book with selected reprints of your work! We've needed it for a long time. I know that your perspective on the reasons for reprinting these papers is different than my own, but the first stimulus for me was the obvious relevance of your papers to the problems in modern cognitive science that are increasingly harder to sweep under the carpet. Problems so fundamental, that many—even the mainstream—researchers feel frustration: During the *Decade of the Brain* (1990s) numerous brain imaging techniques were developed and perfected; the next two decades witnessed an unprecedented quantity of experimental research on human brain and cognition—from the molecular level of single neuron functioning to complex reasoning in social groups. Yet the relation between this immense collection of facts about the biochemical and physiological properties of the brain and our conscious, culturally infused, experience is still largely a mystery. I think your work, even though it concerns the level that appears remote from the functioning of complex organization of human brain and cognition, cuts right through to the reasons for this chasm. So this was the first motivation. The second was a simple annoyance at not being able to find your works, especially those published in the 1960s to 1980s.

**Howard Pattee:** Your interest in reprinting this selection of my papers, which were written over a period of 45 years, made me reconsider the general nature of my subject matter. My papers were published first as biophysics and then as theoretical biology. These were popular fields when I began writing. Later they were motivated by origin of life and artificial life studies, and the interest spread to other areas, as the titles of my papers indicate. Now they are being reprinted here in another area called *biosemiotics*. Today, I would say that the deeper motivation for all these papers, as I explain in my introductory historical commentary, belongs to the branch of philosophy called epistemology. The central issue of traditional epistemology is how the knowledge inside human brains corresponds to what exists outside our brains, but I saw this subject-object problem at a much simpler level beginning at the origin of life where, instead of simply a passive correspondence problem, it becomes a problem of how genetic symbols construct and control the

replicating cell. The recognition that symbolic control is the basis of all life is now the view that defines *biosemiotics*.

**Joanna:** This is probably how “basic” we have to go to rethink our notions of what cognition is. If one thinks about cognitive systems broadly, as systems retaining information to adapt to their environments, then biosemiotics and cognitive science have a much broader range of problems in common than it is usually assumed.

**Howard:** My first papers are about the classic problem of the physical basis of life—not in terms of abiogenic chemistry, but as a conceptual problem of where symbolic function emerges in the context of physical laws—laws that we express in mathematical symbols, but laws that do not control symbolic behavior, and say nothing about it. This conceptual problem of how specific but arbitrary symbol systems interact with inexorable physical laws arises at all evolutionary levels, from the genetic language to human language, logic, mathematics, and computation.

Actually, I see the situation in biology as having a parallel to the one you described for the cognitive sciences. Over the years during which I wrote these papers, there have been enormous increases in knowledge in genetics and molecular biology, as well as in the newer cognitive sciences. In spite of this increase in knowledge, these advances have rarely clarified the epistemological problems of the separation of subject and object, and the relation of symbols to matter—indeed, in the case of quantum theory, I think advances have made the problem even more obscure. Automated instruments, computers, and vast amounts of memory storage have produced far more scientific data in the last 50 years than in all of previous history, but collecting more data is not likely to help. In my view, epistemology is about what it means for individual agents, from cells to humans, to *make sense* of their data. That is the underlying problem in these papers. All the subjects I discuss in the papers in this collection developed from this epistemological problem of understanding how subjective function and meaning arise from the objective stream of events.

**Joanna:** Thus it is studying the subject-object relation at the simplest levels that may offer a step in answering *how* physical events become meaningful for higher organisms. This question may take many forms. For biologists, the question is, quoting the title of your second reprinted paper “How does a molecule become a message”; for cognitive scientists, psychologists and linguists, it may take a form of asking how natural language symbols relate to the dynamics in which they are immersed and from which they arose. The relation between these questions at such vastly different evolutionary levels is far from simple.

**Howard:** Even in the context of classical physics, the origin of symbols is an obscure problem. In quantum mechanics, what is called the *measurement problem* is even more obscure. It arises when a physical interaction of a measuring device with a quantum system results in a classical record. This record has the specificity and arbitrariness characteristic of what is called a symbol. Neither classical nor quantum laws can determine when a measurement occurs. The additional problem with quantum mechanics is that it cannot describe the classical symbolic result. When I began graduate study in physics in the 1940s, many prominent physicists (e.g., Bohr, Schrödinger, Heisenberg, Pauli, Delbrück, Wigner) doubted that life

could be adequately described by quantum laws. In a sense that I explain in these papers, I think that they were right.

However, by the 1960s, after the discovery of the DNA double helix and the genetic code, almost all these doubts about the adequacy of quantum laws were simply ignored, and molecular biology took over, with classical chemistry apparently providing adequate models for biologists. But the measurement problem and the problem of when quantum models can be replaced by classical models is still a foundational issue for physicists. What physicists agree on is that measurement and observation, in both classical and quantum models, require a clear distinction between the objective events and subjective records of events. This is not an ontological distinction, but follows from the necessity of what I call an *epistemic cut*—a concept that in many ways ties together all these papers.

**Joanna:** The concept of epistemic cut, which involves complementarity of a discrete symbolic and continuous dynamic mode, was missing also from the approaches to cognition that dominated over the last 50 years. Your papers allow us to step back to the period of the mid last century, when cognitive sciences were born in the excitement of the postwar technological developments, and at the same time disappointment with the then dominating (at least in the USA) behaviorist framework. There were probably many ways in which to oppose behaviorism and recognize that inner states and processes are important in the explanation of human behavior. But for some reasons, only two models established themselves as independent schools: the information processing paradigm, searching for processes compatible with Artificial Intelligence, based on computer simulations (and largely funded for that reason); and the opposing views of ecological psychology (founded by J. J. Gibson).

Your work shows that already in this time, at the beginning, a third way existed. Your arguments are based on fundamental physics, but their philosophical basis appears compatible with certain schools in philosophy, such as the phenomenological approach. However this does not mean that they are a threat to more analytically-based approaches in cognitive sciences. By showing the indispensability of symbols and their role in a dynamical biological organization, this view has a potential for bridging the complementary symbolic and dynamic approaches to cognition, as well as specifying the role of the observer-researcher in the discovery process. As a cognitive scientist I am excited about this perspective of reconciliation. But there is also another, not less important consequence of applying your framework: that of situating the problems of human language and cognition within a broader theory of information in all living systems.

**Howard:** I found that the interest in reprinting these papers also comes from ex-students and colleagues, as well as from biosemioticians who agree with my view that the origin of life, all of evolution, and all languages exhibit an agent's symbolic control of matter. The choice of papers was influenced by the recommendations of these groups, and by an attempt to cover the diverse fields and audiences for whom they were written. These fields include physics, molecular and developmental biology, evolution, cognitive science, artificial intelligence, artificial life, sociology, semiotics, and linguistics. I have learned something about these other fields mostly by reading their literature and participating in their meetings, but I do not consider

myself an expert in any of them. However, at the epistemological level, the questions I address apply to all of them.

**Joanna:** The diversity of your subjects may be a problem for some readers. Do you have any advice on how the papers should be read? Personally, I was impressed that your papers – which, after all, belong to the domain of physics, theoretical biology and theory of information – can be so readable and instructive for a psychologist or cognitive scientist.

**Howard:** My introductory commentary explains the personal historical motivations for many of the papers. I think the scientific field for which each paper was written is clear from the title and the references. The papers are presented here in the order they were published. This may be of historical interest, but the papers are not meant to be read together, or in any order. They are self-contained and can be read individually. Perhaps readers interested in the cognitive sciences may find it helpful to first read your *Afterword* that reviews relevant issues in cognitive science, and places some of my papers in that context.

**Joanna:** I am very happy that the Biosemiotic series Editor and Springer publishing house gave us the opportunity to consider the birth and evolution of this wider framework in its original form and evaluate its usefulness from many perspectives. Physics, biology, and cognitive science have travelled a fascinating path since the publishing of the first papers in this volume, yet the problems posed there are still of utmost importance. I would like to thank Marcello Barbieri and Catherine Cotton, for believing in this project and encouragement, and Ineke Ravensloot for her editorial work. I would like also to thank Scott Kelso, who first introduced me to your work in the context I describe in my *Afterword*, and who never ceases to force me out of comfortable conceptual equilibria. To Don Favareau I am indebted for his advices and thorough review of my chapter. I also thank Carol Fowler, Riccardo Fusaroli, Stephen Cowley and Joerg Zinken for their valuable comments. But most of all I thank you for being a patient teacher. Working on this book afforded me a great opportunity: to discuss with you at length the problems I see as fundamental in the present cognitive science.

**Howard:** Unfortunately, I can no longer recall all the teachers, students, and colleagues that contributed to the ideas expressed in these papers. I must add, however, Robert Rosen and Michael Conrad to the scientists mentioned in my introductory history. They both catalyzed and criticized many aspects of my thoughts, beginning nearly 50 years ago and continuing over several decades. Rosen's ideas on hierarchy theory and on the modeling relation had common features with my own largely because many of them were developed during our discussions. Conrad's understanding of evolution, adaptability, and the limitations of computer models are reflected in my papers. My introductory history and commentary has benefitted from the advice of Peter Cariani and from Donald Favareau's editing. Finally, my sincere thanks go to Joanna who initiated the publication of the present volume and who, in her *Afterword*, has extended my early ideas to the more recent areas of the cognitive sciences.

LAWS, LANGUAGE and LIFE

Howard Pattee's classic papers on the physics of  
symbols with contemporary commentary

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2012, XVI, 336 p., Hardcover

ISBN: 978-94-007-5160-6