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On the Modeling of Emergent Interaction: Which Will it Be, The Laws of Thermodynamics, or Sperry's "Wheel" in the Subcircuitry?

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Weaknesses in Roger Sperry's "Defense of Mentalism" that appeared in the Spring issue of *JMB* are described. Sperry's clarification of his mentalist position still appears to lack a plausible mechanism of interaction. The wheel rolling down hill analogy is described as "a ghost in the subcircuitry." Neurological Positivism's (NP) energetic mechanism of brain-mind interaction is summarized. The relationship of systems theory to reductionism is described briefly in terms of NP.

In response to my proposal for a brain-based emergent interactionism (Vandervert, 1991), Sperry (1991) clarified his mentalist emergent interactionism model. In this brief response to Sperry's clarifications I discuss the following reactions: (1) Sperry's (1969, 1991) wheel analogy of downward causation seems to continue to represent what Ryle (1949) referred to as a category mistake—"the ghost in the machine," (2) the critical importance of getting the emergent interaction story straight, and (3) what is systems thinking and systems modeling really all about?

The Wheel Analogy Remains a Ghost in the Subcircuitry

In his clarifications Sperry continues to offer the analogy of the relationship of a wheel rolling down hill to its constituent atoms as an example of downward causation. However, he now emphasizes particle configurations as

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they would appear in the larger frame of reference of *the rest of the world* over any reconfiguring that would occur *within* the wheel itself:

> A molecule within the rolling wheel, for example, though retaining its usual intermolecular relations within the wheel, is at the same time, from the standpoint of an outside observer, being carried through particular patterns in space and time determined by the over-all properties of the wheel as a whole. There need be no "reconfiguring" of molecules relative to each other *within the wheel itself* [Sperry's italics]. However, *relative to the rest of the world* the result is a major "reconfiguring" of the space-time trajectories of all components in the wheel's infrastructure. (Sperry, 1991, p. 230)

It is true that from the standpoint of an outside observer, a major reconfiguring of wheel components appears to occur. However, these appearances do not causally influence the atomic structures inside the wheel—they do not influence the system in question. The space-time trajectory appearances held by the outside observer do not downwardly cause the atoms of the wheel to, for example, transmutate from iron to gold as the wheel rolls down hill. Sperry (1969) himself recognized that the work of the nerve impulse traffic of the brain (atoms of the wheel) must be altered by emergent properties of cerebral activity if the idea of mental downward causation is to be supported, "The subjective mental phenomena that arise from cerebral processes are conceived to influence and to govern the flow of [lower] nerve impulse traffic by virtue of their encompassing emergent properties" (p. 534).

The fallacy of the influence of an outside frame of reference (which I will shortly attribute to a category mistake) applies to brain circuitry configurations. Brains may move through space and time (even roll down hill), and to an outside observer their circuitries would appear to undergo major reconfigurings. However, since the brain circuitries, like the atomic structures inside the wheel, are not influenced by the larger frame of reference of rolling down hill, there is no downward influence on the work of the brain.

Sperry's wheel analogy, no matter what frame of reference is chosen, continues to appear not to provide a viable *mechanism* for downward causation. The move to non-influential outside frames of reference to support mental downward causation seems to represent a category mistake as described by Ryle (1949). It is proposed that the "mistake" occurs as the result of the following erroneous inference: since there are causal mechanisms that operate within a frame of reference, there must be causal mechanisms that operate among frames of reference. Ryle argued that Cartesian mind-body dualism represented a category mistake that resulted in a "ghost in the machine." Has Sperry simply moved, perhaps, from the ghost in the machine to a "ghost in the subcircuitry?"

On Modeling Emergent Interaction in Accordance with Evolutionary Principles and Energy Laws

Neurological Positivism [NP] (Vandervert, 1988, 1990, 1991) is a new kind of "positivism" which is based upon an integration of the following: (1) the principles of natural selection, (2) the isomorphic relationship between (a) the maximum-power principle of the energetics of evolution, and (b) the features and principles of chaotic/fractal dynamical systems (Vandervert, 1991, p. 205). NP represents an emergent interactionism that is described in terms of the foregoing principles.

What Can an Interactionism Be, and What Can It not Be?

It is well understood and universally accepted by modern science, from both the bottom-up and the top-down perspectives, that without a flow of energy (1) no work (no behavior) can be accomplished (including the reduction of uncertainty) by any system, living or nonliving, and (2) no mechanism of causation can be ascertained and verified. In other words, no model of "interaction" is plausible if it is not ultimately reconcilable with the energy Laws—the Laws of thermodynamics. (The reader is encouraged to consult Atkins [1984] for a penetrating, yet easy to follow description of the Laws of thermodynamics and their implications for both living and nonliving systems.)

The Laws of thermodynamics apply equally to energy and information (Tribus and McIrvine, 1971). Within the thermodynamic scheme of things, brains and their mental models are looked upon as algorithmic configurations that guide energy flows (Vandervert, 1991) that operate, like everything else, in accordance with the energy Laws, (see Atkins, 1984, chapter 9; Tribus and McIrvine, 1971).[1] Energy to information ratios of brains, and of various mental models can be determined, and these, in turn, can be used to determine their respective algorithmic efficiencies (Odum, 1988; Tribus and McIrvine, 1971; Vandervert, 1991). The thermodynamic mechanism of brain-mind interaction proposed by NP (Vandervert, 1991) is as follows. The energy-to-information ratio and algorithmic organization of the brain can be shown to be superior to that of its collection of mental models—its mind. Therefore, mental model algorithmic configurations created in/by the brain

[1] A problem, no matter how small, cannot be solved without an energy flow that will act to reduce uncertainty. Stated another way, any reduction in uncertainty, say a bit of information, requires energy. An energy flow cannot solve any particular problem without algorithmic guidance. Technically speaking therefore, there are necessarily no "non-algorithmic" approaches to problem solving. Thermodynamically one cannot get from a problem state to a solution state for nothing. See Tribus and McIrvine (1971) for a technical discussion of these ideas.

can only self-referentially "mine" the superior algorithmic organization (superior state of certainty) of the brain (unless there is a ghost in the machine that does otherwise). In terms of the laws of thermodynamics, it is thus proposed by NP that brain downwardly constrains mind.

It does not seem prudent to take "a stand that admittedly goes well beyond the facts," as Sperry says of the mentalist position (1965, p. 77), when NP's thermodynamical modeling of emergent interaction is well within the region of plausibility. In NP there are "mental phenomena" which do work in accordance with their algorithmic organization within a hierarchy of mental models (Vandervert, 1991, pp. 205–206). These mental phenomena are not mistakenly categorized, I think, *within* a unified world, brain, and mind reality; wherein the lower uncertainty/entropy algorithmic organization of the brain downwardly constrains the acquisition and application of higher uncertainty/entropy mental models.

Systems Theory and Systems Thinking

It does not seem appropriate to focus attention upon the pros and cons of General Systems Theory (GST) in this response to Sperry's defense of mentalism. However, in light of Sperry's (1991) criticisms of GST, a few comments might help clarify what the systems approach is all about.

Among those whose professional training has been oriented toward strong reductive explanations of phenomena the value of systems–theoretical modeling is sometimes difficult to appreciate. Boulding (1956) long ago made note of this situation in his often-cited paper, "General Systems Theory: The Skeleton of Science":

> General Systems Theory is the skeleton of science in the sense that it aims to provide a framework or structure of systems on which to hang the flesh and blood of particular disciplines and particular subject matters in an orderly and coherent corpus of knowledge. It is also, however, something of a skeleton in a cupboard—the cupboard in this case being the unwillingness of [reductionistic] science to admit the very low level of its successes in systematization, and its tendency to shut the door on problems and subject matters which do not fit easily into simple mechanical schemes. Science, for all its successes, still has a very long way to go. General Systems Theory may at times be an embarrassment in pointing out how far we still have to go, and in deflating excessive philosophical claims for overly simple systems. It also may be helpful however in pointing out to some extent *where* we have to go. (p. 208)

The systems skeleton of science, like science in general, undergoes a continual process of evolution involving systems thinking, systems theory, and real-world application:

> Systems thinking is a framework of thought that helps us to deal with complex things in a holistic way. The formalization of (giving an explicit, definite, and conventional

> form to) this thinking is what we have termed systems theory. Conventions are subsequently adopted in the thinking process. However, theory and thinking are never synonymous, as it is the latter that remains looser and provides the lubricant for application. (Flood and Carson, 1988, p. 4)

The important thing to take note of in the foregoing two quotes is the complementary relationship between systems thinking and systems theory on the one hand, and conventional scientific thinking, theory building and application on the other.

Within the framework of NP I have proposed that the linked human tendencies toward both holism and reduction in science represent a cultural level appearance of the algorithmic organization of the brain and its mental models (Vandervert, 1990, pp. 9–10). While it is my belief that reductionism and holism are reciprocally sustaining through a mechanism of reciprocal projective mapping (Vandervert, 1988, in press), I believe also that the algorithmic tendency toward holism leads the way toward higher levels of organization:

> Neurological positivism asserts that isomorphies across "different" fields emerge because all knowledge achieves homological unity as its various structures approximate the neurological order more and more closely. The more intensely we abstract trivialization (through adaptive projection) from culturally derived high-level natural languages, the more homological unity emerges between them; thus systems thinking itself emerges. Brains and nervous systems are *systems* problem-solving devices; they solve problems in maintaining body temperature, walking, emotion, memory, perception, intuiting and knowing in the same general way—through hierarchies of sub-systems, homeostasis, adaptive evolution, feedback, etc. Therefore, all knowledge eventually reduces to these fundamental commonalities of the neurological order [reduces to a unified algorithmic isomorphy]. (Vandervert, 1988, p. 317)

According to NP, system–theoretical mental modeling will ultimately result in models with algorithmic efficiencies equivalent to that of the brain itself. Systems thinking and systems theory are thought to represent nascent stages in the development of brain–mind thermodynamic equivalence—a true central-state "identity" (Vandervert, 1991, pp. 214–215). This notion of equivalence should be compared to Bertalanffy's (1964) notions of brain–mind *isomorphism*.

Conclusion

Sperry's (1991) clarification of the analogical dynamics of mental supervenience over brain circuitry activity seems not to provide a true mechanism of causation. The idea of mental causation proposed by Sperry appears to turn out to be a "ghost in the subcircuitry." On the other hand, by recognizing (1) the inseparable nature of information and energy flows, and (2) that energy pathways are causal pathways, NP has provided the basis for a description of brain–mind interaction and world, brain, mind isomorphy that squares with the Laws of energy.

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