

However, the attack on reductionism comes from two quarters. One indeed is the misty idealism of the dualist position, which P & D refer to uneasily in their conclusion. The second does not retreat from materialism but transcends it; this is the method ignored by most western philosophy of mind over the past century: that of dialectical materialism. I do not argue that dialectics "solves" the mind/brain problem, or that its growth and development has been without tremendous difficulties, both conceptual and political, in the last fifty years, but I do claim that it provides a method for the development of a solution (see Lewontin and Levins 1976, for a clear statement of what the dialectical method in biology involves). For dialectical materialism the statement of identity offered by reductionism remains. Mind *is* brain, but at a different level of analysis and of discourse.

To see how this slogan cashes in, in practice, consider the relationship between the firing of particular hypothalamic cells and the experience of anger. For the reductionist the firing of these cells *causes* the sensation called anger (in fact, it looks from their conclusion as if P & D's dualism can be interpreted in this way too). For the dualist of the Penfield/Eccles ilk, the mind, wishing to produce the manifestation of anger, *causes* the hypothalamic cells to fire, and the body responds according to automatic blind-pilot landing mechanisms.

For the dialectical materialist (at least my sort of dialectical materialism) the firing of the hypothalamic cells *is* anger; that is, "anger" and the "firing of particular hypothalamic cells" are statements that describe the same phenomenon at different hierarchical levels of discourse. A description of the phenomenon is possible in either mind language or brain language. Each language system is valid and can be complete at its own level (the "cause" of the anger may be a perceived insult to the individual's experience; the "cause" of the hypothalamic cells' firing is the antecedent firing of certain other cells, inputs from the sensory systems, etc.). Mistakes emerge and confusions arise when one tries to locate causes at one level in terms of consequences at another level. The task of neurobiology becomes the identification of the translation rules that map mind events onto brain events, psychology onto physiology – the discovery at each level of the necessary, sufficient, and exclusive correlates of events at the other. Such a task needs a cool conceptual head and a rigorous approach to experimentation in which theory and practice in the neurosciences become united.

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*Are the properties of cells relevant for understanding consciousness?* A materialist can respond to the Puccetti & Dykes argument in two ways. A defensive approach is to counter their position on their own terrain, by showing that the cellular anatomy of the brain is not incompatible with a materialist approach. Arguments such as **I**, **III**, and **V** seem to me valid ones of this type. Yet it seems unlikely that a strong positive materialist argument on why consciousness should exist will be developed with this sort of approach.

However the argument by analogy from computer systems [VI] makes it clear that paradoxes, including that claimed by P & D, can arise because the problem is being tackled at an inappropriate conceptual level. It is likely, though, that the hardware/software analogy over emphasizes the independence of the properties of the different knowledge systems relevant to understanding thought and the brain. As a generalization of the computer analogy, consider the analogy between a map and a knowledge system (e.g. histology, phenomenology). If we take a broadly materialist position (and not a reductionist version of it such as that adopted by Armstrong 1970) the materialist/dualist debate can be mirrored in the problem of deciding whether a collection of maps all represent the same part of the earth or different parts. Even if the former, it is most unlikely that they could be placed in a linear string so that each map was "reduced" to the next; this would apply only to maps that differed in scale alone. It could well be that one map (e.g. a detailed contour map) would show considerable similarities between two regions that are represented very differently on another map (e.g. a vegetation map). It would obviously be false to claim, after the fashion of P & D, that the maps represented different parts of the earth.

Using this analogy, not only can a criticism of P & D be developed, but also a model of how strong arguments for materialism could be formulated. A more solid inference that such a collection of maps does represent the same part of the earth could be obtained by finding a strong isomorphism between certain aspects of one map and another map, and so on, so as to construct a network of (partial) isomorphisms covering all maps. For any particular map a crucial issue becomes whether there is any other map, already accepted as part of the network, with which a (partial) isomorphism can be developed. The analogous question is whether, already within the domain of the materialist approach, a (partial) isomorphism can be developed between phenomenology and any knowledge system.

Strong candidates for the appropriate link system are the related disciplines of cognitive psychology and artificial intelligence [See Pylyshyn: "Computational models and empirical constraints" *BBS* 1(1) 1978; Haugeland: "The nature and plausibility of Cognitivism" *BBS* 1(2) 1978]. Cognitive psychology is being increasingly given a materialist base through the development of the neuropsychology of memory, perception, and cognition. Over the last ten years there has been an extensive debate within cognitive psychology on whether bridges can be built between some information-processing concepts and some phenomenological ones (see Mandler 1975 *op. cit.* by Mandler; Shallice 1978). Four main positions have been advocated. Some (e.g. Erdleyi 1974) have claimed that consciousness can be identified with the contents of a short-term memory store. Others (e.g. Turvey 1974) argue that it arises from active constructivist processes in perception. Posner and Klein (1973) have argued that it reflects the operation of a high-level limited-capacity system. Finally, I have claimed that consciousness results from the existence of system constraints necessary to ensure the coherence of thought and action, and thus I attempted to explain, in addition, why consciousness should exist (Shallice 1972 *op. cit.*; 1978).

The variety of theoretical positions adopted by cognitive psychologists on this issue might suggest that no progress is being made. In fact a number of the differences between the positions may be removed by greater precision in characterizing the phenomenological concepts being modelled. All these theories have in common, for instance, that visual experience does not "arise" in area 17. Given this, it follows that for all of them the paradox of P & D is immediately dissolved. Moreover, all these positions attempt to incorporate a variety of nonintuitive empirical phenomena, so they are not merely token theories. Unless this sort of approach can be shown to be invalid, any claim for dualism will remain very inadequate.

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Mentalist monism: consciousness as a causal emergent of brain processes.

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