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Sperry's Concept of Consciousness

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This paper explores R. W. Sperry's view that consciousness is 'causally' effective in directing voluntary human behaviour. This view, formulated in the course of his split brain research, presupposes an earlier theory that motor behaviour is the sole output of the brain and that mental phenomena were developed for regulation of overt response. His view of the 'causal' effectiveness of consciousness is shown to be based on a theory of emergent properties like that of Bunge. It is also shown that Sperry, like Bunge, is a materialist; appearances to the contrary are due to occasional use of standard terms such as 'materialism' and 'interaction' in unusual senses. It is argued, with specific reference to Chisholm and Searle, that Sperry's hypothesis is helpful towards elucidating the structure and dynamics of action. It is also argued that it is not, as Sperry thinks, a consequence of his position that moral values are part of brain science.

Psychobiologist Roger W. Sperry argues that consciousness is 'causally' effective in directing voluntary human behaviour. This hypothesis was developed in the course of studies of commissurotomy, or 'split brain', patients¹ that issued in his Nobel prize-winning account of the specialized capacities of the cerebral hemispheres. Sperry writes that in the course of this research his concept of consciousness 'has gradually undergone a considerable swing back in the direction of mentalism to settle on a view that is at least distinctly different from the conventional materialist approach on which most of us in behavioral research have been raised in this century'.²

He regards consciousness as a high-level pattern property of cerebral functioning, with 'causal' influence upon events in the brain and upon motor behaviour. I find this an exciting thesis, of momentous import for philosophy and behavioural science; but it requires clarification, interpretation, and occasional amendment from a philosophical point of view. This is the task of the present paper.

By 'consciousness' Sperry means cognitive awareness and the 'volitional intent'³ that issues in voluntary actions. Consciousness, in this sense, is divided in commissurotomy patients. The operation, undertaken to combat severe epilepsy, consists in the severing of the corpus callosum, the bundle of fibres that serves as the main connection between the two hemispheres of the upper brain. As regards epilepsy the operation is effective; but a

striking by-product is the production of two distinct centres of consciousness, one located in each hemisphere. Sperry describes the situation as follows:

[T]he left and right hemispheres, following their disconnection, function independently in most mental activities. Each hemisphere, that is, has its own private sensations, perceptions, thoughts, and ideas, all of which are cut off from the corresponding experiences in the opposite hemisphere. Each left and right hemisphere has its own private chain of memories and learning experiences that are inaccessible to recall by the other hemisphere. In many respects each disconnected hemisphere appears to have a separate 'mind of its own'.⁴

That these persons usually behave in a normal, integrated manner is largely due to the dominance of the left hemisphere, in which language capacities are normally (universally, it would appear, in this group of patients) located.⁵ When this post-operative dissociation was first discovered, there was much controversy about the status of the 'mind' in the mute right hemisphere: is it a human mind or merely an ape mind or a mechanism akin to a computer? This matter has been settled thanks to the development of technology that permits protracted communication with either hemisphere in isolation from the other.⁶ The mute hemisphere has been shown to be a self-aware human mind.⁷

The view of consciousness that Sperry developed in the 1960s presupposes an earlier theory, presented in his 1952 paper, 'Neurology and the Mind-Brain Problem'.⁸ Here he argues that the sole output of brain activity is patterns of motor coordination; hence the role of consciousness is the governing of motor behaviour. The topic of the paper is 'the neural correlates of conscious experience'.⁹ He begins by remarking that centuries of philosophizing about mind and body have produced very little that satisfies 'the tough-minded scientist'. If progress is to be made, he avers, science must furnish philosophy with data with which it can work; for '[i]t is really the "brain" part of the mind-brain relation that needs clarification'.¹⁰

Sperry stresses that little is known about the neural correlates of conscious experience. The theorist must decide, first of all, what kind of differences in brain processes might be correlated with differences in mental experiences. Given 'the colorful richness and infinite variety of quality and meaning in mental experience' and the relative sameness, in constitution, structure, and function, of nerve fibres and cell units, it has not been easy to imagine what sort of correlation there might be. The hypothesis that it is based upon qualitative variance among nerve energies has been tried and found wanting; neuroscientists have come to believe that 'nerve impulses are essentially homogeneous in quality and are transmitted as

“common currency” throughout the nervous system’.¹¹ All sensory nerve impulses, for instance, are thought to be similar in nature: ‘it is not the quality of the sensory nerve impulses that determines their diverse conscious properties’, says Sperry, ‘but rather the different areas of the brain into which they discharge.’¹² (Here we pause to note his implicit assumption that these nerve impulses *have* conscious properties – in other words, that consciousness *is* a property, or a type of property, of nerve impulses. This is the germ of his later theory.) Thus an electrical stimulus applied to the visual cortex produces a visual sensation; applied to the auditory cortex it produces an auditory sensation, and so on. But the reference of subjective quality to cortical locus, as such, has little explanatory value. For one thing, the structures of the different sensory fields in the cortex are remarkably similar; for another, stimulation of a given cortical area can give rise to a great diversity of sensations, albeit within the same modality. The only kind of hypothesis that seems to remain, says Sperry, is that sensory qualities are correlated with ‘differential patterning effects in the brain excitation’. He summarizes this conjecture as follows:

In short, current brain theory encourages us to try to correlate our subjective psychic experience with the activity of relatively homogeneous nerve-cell units conducting essentially homogeneous impulses through roughly homogeneous cerebral tissue. To match the multiple dimensions of mental experience we can only point to a limitless variation in the spatiotemporal patterning of nerve impulses. The difference between one mental state and another is accordingly believed to depend upon variance in the timing and distribution of nerve excitations, not upon differences in quality among the individual impulses.¹³

if consider "framed" thresholds of each, are they homogeneous? No.

On this matter there is, says Sperry, ‘complete agreement’ among scientists; but he goes on to say that there is no consensus at all on the question of ‘exactly how conscious meaning is related to the spatiotemporal patterning of brain excitation’.¹⁴ One hypothesis, psychoneural isomorphism, Sperry holds to be untenable on anatomical and physiological grounds.¹⁵ ‘Brain code’ hypotheses, such as proposed by Lashley, by Pitts and McCulloch, and by Hebb, are found wanting by Sperry because, he says, they provide no basis at all for resolving the mind–brain problem. He thinks, nevertheless, that some kind of code hypothesis is likely to provide the needed answer, and he goes on to suggest a criterion for such hypotheses.

For Sperry, both psychoneural isomorphism and the code hypotheses he has mentioned have the further defect of being preoccupied with the brain’s sensory input while neglecting its output. ‘In a machine’, he says,

the output is usually more revealing of the internal organization than is the input. Similarly in the case of our thinking apparatus an examination of its terminal operations and finished products may be more enlightening than any amount of analysis of the transport of raw materials into it.¹⁶

He goes on to argue, on phylogenetic, anatomical, and physiological grounds, that the sole output of the brain is motor behaviour.

To the neurologist, regarding the brain from an objective, analytical standpoint, it is readily apparent that the sole product of brain function is motor coordination. To repeat: *the entire output of our thinking machine consists of nothing but patterns of motor coordination.*¹⁷

What of subjective phenomena such as ideas, images, sensations, and feelings? For Sperry they are 'phases of brain function itself, not products of it'.¹⁸ He says that, on his view, mental phenomena came into being to achieve 'better regulation of overt response'.¹⁹ He sees conscious awareness as being developed, in the course of evolution, 'because it improves an organism's ability to make favourable responses'. In his view, perception is basically a preparation for response, and thinking 'an implicit, symbolic preparatory adjustment without commitment in overt action'.²⁰ 'Cerebration', says Sperry, 'essentially serves to bring into motor behavior additional refinement, increased direction toward distant, future goals, and greater over-all adaptiveness and survival value.'²¹

In support of his hypothesis, Sperry cites phylogenetic considerations, noting that low on the vertebrate scale, 'where thought processes are presumably negligible, the bulk of the nervous apparatus is clearly connected with the management of motor activity'.²² He goes on to state that there is no basic difference, in fundamental operating principles, between the brains of fish and of humans. 'From the fishes to man, there is apparent only a gradual refinement and elaboration of brain mechanisms with nowhere any radical alteration of the fundamental operating principles.' Thus, he concludes, '[i]n man as in the salamander the primary business of the brain continues to be the governing, directly or indirectly, of motor behavior'.²³ Study of 'brain architecture', according to Sperry, yields further support for his point of view. 'One searches the cerebrum in vain for any structures that seem to be designed for the purpose of forming, cataloguing, storing, or emanating copies or representations of the outside world.'²⁴ He refers us to his formidable array of arguments, based on anatomical and physiological data, against the hypothesis of psychoneural isomorphism.²⁵ If there is any plan to be discerned in the structure of the brain it is, says Sperry, 'a design patterned throughout for governing excitation of the "final common (motor) pathways"'.²⁶ Available physiological information supports the same thesis. Mental and motor processes, in the brain, are 'intimately associated'.²⁷ Towards the end of his argument, Sperry makes an important qualification: 'Actually the interrelation of motor and mental activity is one of cyclic and reciprocal interdependence.' But, he says, he has emphasized the dependence of the mental upon motor activity

because of 'the nature of the problem and current trends in our thinking'.²⁸ Evidently he sees us as infected by old-fashioned (Cartesian) mentalism.

Sperry's discussion of the neural correlates of conscious experience leads to the conclusion that 'the unknown cerebral events in psychic experience must necessarily involve excitation patterns so designed that they intermesh in intimate fashion with the motor and premotor patterns'.²⁹ Brain code hypotheses which fail to satisfy this criterion can be excluded. Such is his contribution to the specific topic.

In this paper, Sperry does not profess to develop a full theory of mind, but only to address a specific problem. For his hypothesis to serve as the basis for a theory of mind, some qualification or supplementation is clearly needed. One might grant that the brain's entire output is motor; but it is clearly not true that human perception is nothing but preparation for response, nor that all thinking is oriented to possible future action; for instance, we contemplate beautiful objects solely for their own sake, and we think about academic problems with no apparent practical consequences. If Sperry is right, however, our aesthetic apprehensions and intellectual endeavours must be understood as activities of an organ with the main function of governing motor behaviour.

The claim that consciousness directs motor behaviour gives rise to the question: how can material events be mentally determined? Sperry's answer lies in the concept of consciousness that he developed in the 1960s. He makes it plain that this view of his is an hypothesis. Conclusive proof for it is lacking; but, he avers, the same is true of contrary positions such as reductive materialism and behaviourism.³⁰ On his hypothesis, consciousness is 'causally' effective – 'a holistic systemic property and an active part of high-order brain processing'.³¹ He also calls it an 'emergent' property of cerebral functioning. It is of crucial importance to our appreciation of Sperry's theory that we understand clearly just what he means by this. Unfortunately his account of such controversial concepts as holistic, systemic, and emergent properties is not clear enough to be convincing in the present philosophical climate, in which terms such as these are widely viewed with disfavour or suspicion. Happily, however, Mario Bunge has given a clear and viable account of such matters. Although there is no evidence that he has read Bunge, what Sperry has to say about emergent properties and the 'causation' in which they are involved is consistent with Bunge's account, as we shall see.

For Bunge, a system as a whole can have two kinds of property which he calls 'resultant' (or 'hereditary') and 'emergent'.³² The former type of property characterizes both the whole system and each of its parts con-

sidered in isolation. Weight is an example of a resultant property. When a systemic property is emergent, on the other hand, not all parts of the system have a property of that type. Frequently none do. Bunge uses the example of water, which 'as a system composed of myriads of H₂O molecules, has properties that none of its components has - e.g. transparency, a high dielectric power (hence a high dissolving power), freezing at 0°C and so on and so forth'.³³ The reader will note that properties such as these, being collective, *could not* characterize an individual molecule. Freezing, for instance, is a change in the structure of a system consisting of a large number of molecules; it makes no sense to speak of one single molecule freezing. Bunge goes on to argue that the behaviour of a body of water cannot be explained in terms of the properties of the H₂O molecule alone: also needed is 'a host of hypotheses and data concerning the structure of water (i.e. the relative configuration of H₂O molecules in the lattice) as well as hypotheses and data about the dynamics of water bodies'.³⁴

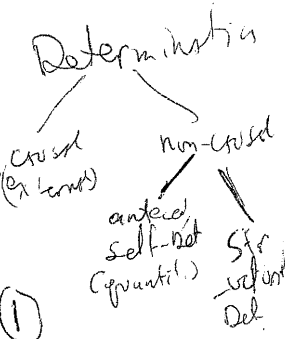
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It follows that a theory, T₂, of water as a body, does not follow from a microphysical theory, T₁, of the H₂O molecule. In Bunge's view, 'micro-reduction', as described by Oppenheim and Putnam,³⁵ is in general impossible. The reductive strategy Bunge holds to be viable, which he calls 'partial (or weak) reduction', has the structure: T₁ U Subsidiary hypotheses and data concerning interactions among components ⊢ T₂.³⁶

wrong

} Oh?

Bunge is a determinist, but not a causal determinist. He holds that the ontology of science includes several different 'categories of determination', of which efficient (external) causation is but one, albeit an important one. Where most philosophers use 'cause' broadly, to designate any determining antecedent, Bunge defines causal determination as 'determination of the effect by the efficient (external) cause'. When a determinant is not an external event, the determination belongs to a non-causal category. Two such categories are relevant to our topic. The first, 'quantitative self-determination: determination of the consequent by the antecedent', is a category that applies to 'the continuous unfolding of states that differ from one another in quantitative respects only'. Such changes have no (external) cause. Bunge cites two examples: '(a) The successive positions of a freely moving macroscopic body are uniquely determined by its position and velocity at any prescribed instant of time. (b) The spontaneous transformations of an isolated thermodynamic system are such as take it to states of increasing entropy.'³⁷ In the latter example we can distinguish between two levels of complexity - that of the system and that of its component molecules. In such cases, according to Bunge, 'quantitative self-determination may be shown to emerge from processes characterized by other categories of determination, among them causation'.³⁸ In this example the



transformations of the system emerge from (i) the spontaneous movement of its component molecules – another case of quantitative self-determination – and (ii) the behaviour of these molecules as a result of collisions, which falls under the category of (efficient) causation. The use of the word 'emerge' is especially appropriate in this case because entropy is strictly a collective or systemic property; it cannot characterize individual molecules.

A second category, 'structural determination', is of crucial importance. Bunge introduces it as follows:

Structural (or wholistic) determination: of the parts by the whole. Illustrations: (a) the behavior of an individual (a molecule in a fluid, a person in a social group) is determined by the over-all structure of the collection to which it belongs. (b) the functioning of an organ is partially determined by the needs of the whole organism."

Here we have another form of determination that emerges from processes at levels of lesser complexity. Towards seeing how it works, let us focus on the first example, the behaviour of a molecule in a fluid. A fluid is a system of molecules held together by attractive forces. A body of a fluid such as water has emergent, molar, behavioural dispositions; these have received systematic statement as the laws of fluid mechanics. The occurrence of an eddy in a stream can be explained in terms of these laws, given descriptions of factors such as the stream's velocity and the topography of the water-course. The explanation is a causal one, in Bunge's sense of causality. Now let us imagine the behaviour of a single water molecule, *m*, that is one part of an eddying body of water. This molecule will be describing a roughly spiral path. How is this motion to be explained? We have a predilection to look for an efficient cause; this would be an event or set of events, external to *m*, sufficient to produce its spiral motion. The obvious candidate is the motion of other molecules nearby. But the relation between *m*'s motion and that of any nearby molecule, *n*, is not efficient causation, since each both determines and is determined by the other. The fact of the matter is that *m* moves as it does chiefly because it is part of a body of water that is behaving in accordance with its molar dispositions, the laws of fluid mechanics. As it does so, its component molecules are, as Sperry would put it, dragged along. As this is going on, the whole system swirling around, *m* is also behaving characteristically as an individual molecule, moving about spontaneously, within the limits imposed by attractive forces, and colliding with other molecules. So it is that I have described its path as just roughly spiral and as chiefly determined by the motion of the stream. *M*'s motion is the 'resultant' of its own micro-behaviour and its part in the macro-behaviour of the system, the latter being the major determinant.

oh?
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this view
only possible if
signif. it negates
his rejection of
micro reduction.
(last p.)

So it is that the behaviour of a whole can determine that of its parts, with the latter to be explained chiefly in terms of the former. Now our simple example illustrates several important characteristics of this kind of determination. To begin with, a body of water is composed of H₂O molecules. Thus Bunge says, 'the whole, far from being prior to its members, is in turn determined by them'.⁴⁰ This qualification is potentially confusing since 'determined' is used in a sense other than the one it bears when he speaks of behaviour of an individual being determined by that of the system to which it belongs. I take him to mean that the system consists of nothing other than its parts and that its emergent properties are explainable, in principle, in terms of the properties of its individual components, their relevant relational properties, and the structure of the system.⁴¹ Thus water's having certain molar properties, such as transparency, a high dielectric power, and freezing at 0 degrees C, cannot be explained on the basis of the properties of the H₂O molecule alone; but given knowledge that it has these molar properties and that it is composed of H₂O molecules, the theoretician sets to work to produce a hypothetical model adequate to explain how a system with such components could have such systemic properties. In so far as this effort is crowned with success, the emergent properties of water come to be explicable. The same is true of the emergent properties of any other system. For neither Bunge nor (as we shall see) Sperry does emergence connote inexplicability in principle. On the other hand, understanding of the mechanisms involved does not alter the fact that, in instances of 'structural determination', the behaviour of the whole determines that of the parts.

In relation to Sperry's conjecture that consciousness or subjectivity is an emergent property of cerebral functioning, the brain scientist's task is analogous to that of the theoretician who studies water: to produce a hypothetical model of a system with neural components that has these molar properties. Science is very far from this goal, although, as we shall see below, Sperry expects it to be achieved. One condition necessary for achieving it, surely, is a careful study of consciousness; for a clear account of a system's emergent properties is a precondition for explaining them. A recent study that presents such an account is that of Searle. On his analysis, an intentional action may or may not be intended in advance. If there is a prior intention, it is the efficient cause of the action. But every intentional act includes within it an 'intention in action' which is the efficient cause of the intended bodily movement or state of the agent.⁴² At first sight this analysis, with its exclusive use of the category of efficient causation, seems irreconcilable with Sperry's view. But such is not the case. In the first place, Searle's sense of 'efficient causation' is very broad, akin

but, for ex. computer could simulate
 finite element analysis only - w/ no "understanding" of prop. of "whole"



) well



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to Bunge's 'determination'. 'There is just one kind of causation', says Searle, 'and that is efficient causation; causation is a matter of some things making other things happen.'⁴³ In the second place, he develops a concept of 'Intentional causation' (Searle's capitalization) which encapsulates the claim that cause and effect, in the domain of Intentionality, are not logically distinct.⁴⁴ Clearly Searle does not regard all instances of causation as having the same structure. Now Searle's analysis makes exclusive use of molar concepts, chiefly prior intention, intention in action, and intended bodily movement (or conditions of satisfaction of the intention). It might well be possible to achieve a comprehensive theory of action, including its Intentional and physiological aspects, by combining the insights of Searle and Sperry; but this project lies beyond the scope of the present paper.

Returning to the example of the eddy, let us note a further point - that the whole does not act upon its parts. It makes no sense to say that the body of water acts upon or interacts with molecule *m*, for these are relations that characterize distinct entities. Similarly, on Sperry's hypothesis, there cannot be interaction between mind and its cerebral components. Sperry uses an example similar to that of the molecule in the eddy in order to clarify what 'form of control' he holds that 'conscious phenomena' exert over 'neural events', viz. a wheel rolling downhill, 'in which the displacement in time and space and the subsequent fate of the entire population of atoms, molecules, and other components within the system are determined very largely by the holistic properties of the whole wheel as a unit, like its shape, size, weight, etc.'⁴⁵ (In the same connection he refers to the manner in which 'drops of water are carried along by a local eddy in a stream';⁴⁶ my doubt that drops retain their identity in a stream led me not to use this example.) The wheel example can be analysed in the same way as that of the molecule in the eddy. Sperry follows it up with an example from the domain of mind and brain:

but here, "holistic" is just a completely convenient way to express reductionist info.

Similarly, the cerebral process for a unitary mental experience, like a visual image, is presumed to possess an inertia, coherence, and related dynamic properties as a unit that cause it to behave and to be treated in cerebral dynamics as a distinct entity. As in the wheel, the component parts of such an excitatory neural process are carried along and thus controlled by the dynamic properties of the whole system.⁴⁷

Sperry sees the brain as hierarchically organized:⁴⁸ molecules are systems of nuclear and subnuclear elements; cells are systems of molecules and, in their turn, members of cerebral circuit systems. These, in their turn, are incorporated into more comprehensive systems. At the top of the hierarchy are the processes characterized by consciousness. It must be stressed that consciousness, for Sperry, is an emergent property of cerebral functioning. He does not hold that subjective experience and certain brain processes

epiphenomenon (NO!). ?

but here, wheel is "pre-destined" Mind isn't (?)

are somehow correlated, but that they are one and the same, even though he sometimes speaks as though the former were his view.⁴⁹ Thus the passage quoted above continues as follows:

[T]he process as a whole is facilitated, suppressed, perseverated, or whatever, on the basis of its holistic qualities. The present interpretation suggests that visual images, for example, would be perceived, stored and retrieved primarily in terms of their subjective properties. It follows directly that the cerebral machinery must be so organized that it can use the subjective qualities of the excitation process.⁵⁰

(like Keller) A name is needed for the type of determination to which Sperry refers, in this passage, when he speaks of 'causal influence'. Bunge, as we have seen, calls it 'structural or wholistic determination'. Popper, following D. T. Campbell, calls it downward causation.⁵¹ The term 'causation' is appropriate since it is used, in this connection, by Sperry, albeit with no qualifying adjective. I shall use the term 'structural causation'; it is more convenient than Campbell's term, since it permits us to describe events as being structurally caused. This usage is at odds with Bunge, who, as we have seen, uses 'cause' only in the context of determination by an external event.

In sketching the hierarchical structure of the brain, Sperry speaks of the 'chain of command', with conscious phenomena at the highest level and subnuclear particles at the lowest. This means, in general, that the behaviour of items at lower levels is structurally caused by higher-level behaviour. Sperry gives the following sketch of the dynamics of a hierarchical system.

(how do we know?) ? The causal power attributed to the subjective properties is nothing mystical. It is seen to reside in the hierarchical organization of the nervous system combined with the universal power of any whole over its parts. Any system that coheres as a whole, acting, reacting, and interacting as a unit, has systemic organizational properties of the system as a whole that determine its behavior as an entity, and control thereby at the same time the course and fate of its components. The whole has properties as a system that are not reducible to the properties of the parts, and the properties at higher levels exert causal control over those at lower levels. In the case of brain function, the conscious properties of high-order brain activity determine the course of the neural events at lower levels.⁵²

? In the following passage, he deals more specifically with the relation between the mental and the neurophysiological, affirming the independence of determinations on the macro- and microlevels. The whole, that is to say, does not act upon its parts.

When it is inferred that conscious forces shape the flow pattern of cerebral excitation it is not meant to imply that the properties of consciousness intervene, interfere or in any way disrupt the physiology of brain cell activation. The accepted biophysical laws for the generation and transmission of nerve impulses, for example, are in no way violated. The electrophysiologist, in other words, does not need to worry about any of this, provided that he restricts himself to analytic neurophysiology. He does need

about to get in trouble, then
~~find~~ volition

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to be concerned, however, if he wishes to follow a sensory input to conscious levels and to explain how a sensation or a percept is produced, or how the subsequent volitional response is generated.⁵³

Clearly Sperry believes that in cerebral dynamics there is nothing analogous to the Coriolis effect. The analytic physiologist can go about his business of tracing neural circuits without finding anything anomalous that would impel him to look into the systemic properties of the circuitry. This conviction of Sperry's has a good deal of confirmation; it is notorious that consciousness has been a mystery to neurophysiologists.⁵⁴ Yet one is inclined to think that the independence of the macro- and the micro-, in this area, cannot be complete. Data from the domain commonly known as biofeedback suggest that consciousness can indeed intervene in physiological processes. For instance the results of V. F. Harrison and O. Mortenson, and also of J. V. Basmajian, show that a person can control the activity of a single nerve-muscle cell by 'willing' changes in a depiction of the cell's activity via an oscilloscope or an auditory rhythm.⁵⁵

but this contradicts idea of downward causality.

Trick!

Naah... wrong cause.

The term that Sperry uses most frequently to refer to the relation between the dispositional properties of a whole and those of its parts is *supersede*. For instance, in describing the hierarchical structure of the brain he tells us that 'the forces operating at subatomic and subnuclear levels within brain cells are molecule-bound and superseded by the encompassing configurational properties of the brain molecules in which the subatomic elements are embedded'. He also says that 'the properties of the brain cells are in turn superseded by the larger network properties of the circuit systems in which they are embedded'.⁵⁶ It is important that his use of this term not be misunderstood. The dictionary meaning of 'supersede' is 'replace or cause to be set aside'. Now subnuclear and subatomic forces are replaced or set aside, in molecules, in the sense of being relieved of supreme command. Their behaviour is largely determined, in the mode of structural causation, by that of their encompassing molecule. But they are not set aside in the sense of being turned into merely passive passengers. As we have seen, the properties of a system are dependent upon those of its components. For instance, the existence of chemical compounds depends upon the electrical properties of the bonding electrons. In the passage last quoted, Sperry tells us that brain cell activity, in a system characterized by consciousness, obeys 'the accepted biophysical laws for the transmission of nerve impulses'. That the properties of these cells are 'superseded by the larger network properties' thus does not mean that the cells cease to function in their normal manner. Sperry describes the situation as follows:

[T]he conscious properties of cerebral patterns are directly dependent on the action of the component neural elements. Thus, a mutual interdependence is recognized



between the sustaining physico-chemical processes and the enveloping conscious qualities.⁵⁷

In Sperry's 'modified concept of consciousness' the pragmatic motor orientation of his 1952 paper is preserved: consciousness is seen as having 'a use and a reason for having been evolved'.⁵⁸ Viewed in 'functional and operational terms',⁵⁹ it is not seen merely as an outgrowth of neural organization. 'The neural mechanisms for conscious experience', says Sperry, 'are not just more complex, they are specifically structured on an operational, functional basis to create particular sensations, percepts and feelings, and to provide a rapid representation of external reality'.⁶⁰ The brain, in his view, is organized 'as a decision-making system monitored with value priorities, and in which conscious phenomena confer certain operational advantages over and above those obtainable in systems that lack consciousness'.⁶¹

The view that voluntary motor behaviour is under conscious direction requires the abandonment, or at least the revision, of traditional stimulus-response and central switchboard concepts of central nervous control. Sperry's theory suggests the existence of a central domain of consciousness with a good deal of autonomy, that receives sensory input and prepares responses. As he puts it:

The present view suggests the presence of ongoing central processes specifically organized for conscious awareness around the different sensory modalities. These central mechanisms have their own intrinsic organization and special dynamics that in large part are determined centrally and autonomously. The sensory input becomes incorporated into the central process, altering the dynamics of the system and thereby its conscious properties. The initial train of sensory inflow is largely absorbed and transformed within the higher level central mechanism, and only indirectly through its perturbation of the holistic properties of the central process does the sensory input influence awareness or the volitional motor response. The present view places greater emphasis on the central processes and their specialized organizational features that create out of neural excitation the higher order phenomena of mental experience.⁶²

As we have seen, the commissurotomy evidence indicates that the brain's system for conscious awareness is chiefly located in the cerebral hemispheres and the upper brain stem.

Sperry's hypothesis is a great help in elucidating the structure of action. Let us consider an act such as my reaching up to the left-hand side of the top shelf of my bookshelf and removing my copy of *Intention*. From my point of view as the agent, this is a simple act. I do not perform any mental act – intention or volition, perhaps – which causes my hand and arm to move appropriately; I am *in* my hand as it rises, grasps the book, and takes it off the shelf. From the physiological point of view, on the other hand, what takes place is a complicated process involving efferent and afferent

neural causal chains and coordinated contractions and relaxations of muscles. The events involving my hand have, as efficient causes, various items of muscular behaviour. Philosophers of action have been notoriously unsuccessful in their attempts to reconcile the phenomenological claim that *I* move my hand with the fact that my hand is caused to move by muscular events of which I may well know nothing. Closest to success is the subtle and penetrating theory of Chisholm, of which I shall present only a rough thumbnail sketch. Chisholm distinguishes two types of causation, which he calls 'transeunt' and 'immanent', or else 'occurrent' and 'non-occurrent'.⁶³ In both cases the first term designates efficient causation – in Chisholm's ontology 'a state of affairs causing a state of affairs to obtain'. The second stands for 'a person causing a state of affairs to obtain', persons being regarded as 'substantial concrete things, in the strictest sense of the term "thing"'. Armed with this distinction, Chisholm sets out to analyse the structure of intentional action. His strategy is to assume a certain undefined locution and to exhibit the structure of other more complex concepts in terms of it. There are several versions of this locution in Chisholm's writings; a typical example is: 'At *t*, he contributes causally to its happening that --- in the endeavour to contribute causally to its happening that . . .'.⁶⁴ Chisholm notes that this statement is not 'teleological' with respect to its first component: that is, it does not say that the agent intended that --- happen. Consider, for instance, 'He knocked over the lamp in the endeavour to kill the fly'. Now the application of this locution to action is, roughly, that the agent contributes causally to the occurrence of certain neurophysiological events in the endeavour to contribute causally to its happening, say, that his arm rises. The causation of the physiological events is immanent or non-occurrent; they, in their turn, are transeunt or occurrent causes (given the transitivity of the causal relation) of the arm's rising.

The reaction of most philosophers to this theory is typified by the title of Thalberg's unpublished paper, 'How does Agent Causality Work?'. Chisholm provides no account of just how a substantial thing such as a person can influence causally a cerebral state of affairs; in the absence of such an account, the hypothesis is viewed with cool tolerance at best. The theory has a serious shortcoming even if such an account could be given. We have seen in our example that the agent experiences an immediate relation between himself and the book that he grasps; he is *in* his hand as it rises. On Chisholm's theory the relation would be remote, since the agent non-occurrently causes certain neurons in his brain to fire, and these events occurrently cause the physiological process that occurrently causes the relevant motor behaviour. It is hard to see why such a remote relation would be experienced as if it were immediate. The sense of immediacy

might, of course, be an illusion, but the claim that it is so requires support. In view of this difficulty with any view of peripheral behaviour as remotely caused by brain events, I once suggested that 'we think in a holistic manner of the process linking brain event with behavior'. On this position a volition would be identified 'with the entire process that begins in the brain and effects the object of volition'.⁶⁵ Sperry's theory makes possible some fleshing out of this rather vague conjecture. He notes that although both sense perception and voluntary motor behaviour involve very complex neural processing, all of this occurs without conscious mediation. 'This', says Sperry, 'is another reason to identify the conscious properties with the relatively simple holistic features rather than with the whole intricate inframechanism of brain processing.'⁶⁶ So it is that the phenomenological and physiological accounts of my removing the book from the shelf can be viewed as referring to the same complex event, the agent experiencing it as a whole and the physiologist analysing it into its parts. From the agent's point of view the act is a matter of self-determination, whereas for the physiologist the process is an intricate network of efficient causes. All the events that constitute this network are structurally caused by the molar event, the act.

Moreover, on Sperry's theory, Chisholm's conjecture is not far from the mark. There are indeed two different kinds of causation, efficient and structural; but the latter is a matter, not of a substance as such producing a state of affairs, but of the molar behaviour of an entity determining the behaviour of its components in the manner with which we have become familiar. Chisholm's undefined locution is consistent with Sperry's position provided that the first blank is understood to stand for the entire process at the microlevel. The second blank is to be filled in the same way in both theories: on the present example it would be, 'I, with my right hand, remove *Intention* from the shelf'.

Actions provide striking examples of structural causation, determination of the behaviour of the parts by that of the whole. In our example, the arm motion needed to obtain the book might be identical with no other arm movement I have ever made; nevertheless my intention or volition (terms belonging to the molar domain of consciousness) bring into being just the physiological process that is needed to produce the requisite motion of the limb. Had I wanted some other book on the shelf, the process necessary to reach it would have been produced by the relevant intention or volition.

I have stated above that Bunge's view of reduction – that 'strong' reduction of a macrotheory to a microtheory is normally impossible, and that what is possible is 'weak' reduction – is consistent with Sperry's view.

Now Sperry does not admit the possibility, in any sense, of 'reduction' of the mental to the neural; but the reason is that he uses this term strictly in the sense of strong reduction. He describes his view as follows:

In the present view conscious experience is not conceived to be identical to neural events, as in 'psychophysical identity theory'. In the present view, conscious phenomena are different from, more than, and not reducible to neural events, although it is correct to say that conscious phenomena are built of neural events as elements and perhaps also of glial and other cerebral events.⁶⁷

The point about the components of conscious processes is implicit in what we have already seen of Sperry's view – for instance, his claim that consciousness is a dynamic emergent property of brain activity and that the conscious properties are dependent on the action of the neural components. Evidently he views contemporary expositions of psychophysical identity theory as reductive in the strong sense; but he does not hold this to be necessarily true of an identity theory. 'The identity theory', he says, 'might conceivably be expanded to include the kind of psychoneural interaction [*sic*] we now envisage, but not without significant changes in its present approach and formulation.'⁶⁸ This confirms one's natural conviction that Sperry's view is a theory of psychophysical identity since he holds that conscious states and other mental phenomena are processes in the brain. In the following passage he deals with this issue in greater detail:

Given our present perspectives, it is not difficult now to stretch the meaning of terms such as 'neural events', 'brain events', 'brain processes', etc. to include their emergent (i.e. holistic, configurational, organizational, gestalt, pattern) conscious properties and thus to bring psychophysical identity theory into line with the current emergent interpretation. On these terms identity theory tends to fuse with emergentism and is then forced to espouse [?] reductionist philosophy to retain identity. Either way we come out with much the same concept.⁶⁹

(On pain of self-contradiction, Sperry cannot mean 'espouse'; perhaps he meant to say 'eschew' or 'expunge'.) This confirms that Sperry holds a psychophysical identity theory, but that he dissociates himself from that label since, in his view, those who wear it are reductionists.

But what does Sperry mean by his claim that conscious phenomena are not reducible to neural events, or, as he puts it elsewhere, 'that a full explanation of the brain process at the conscious level will not be possible solely in terms of the biochemical and physiological data such as we are now perforce engaged in gathering'.⁷⁰ We might say that to try to explain mental processes in these terms would be analogous to the endeavour to explain the behaviour of a body of water in terms of the properties of H₂O molecules; Sperry says of 'mental phenomena like sensations, percepts, ideas, images, illusions, feelings, etc.':

For a full explanation of these gnostic functions, we are going to need, in addition, a further description and account of the higher order pattern activity in the cerebral

process, the emergent properties of which are conceived to constitute the qualities of consciousness.⁷¹

To do this we shall need, according to Sperry, 'new technology that will enable us to record the pattern aspects of cerebral functioning which at present can only be extrapolated from indirect or highly particulate sampling procedures'.⁷²

In just one other context is this issue dealt with in detail. Following a discussion of the dynamics of pain, which Sperry uses as a paradigm of conscious qualities, he goes on to consider the explanation of such phenomena.

To try to explain the pain pattern or any other mental qualities only in terms of the spatiotemporal arrangement of nerve impulses, without reference to the mental properties and the mental qualities themselves, would be as formidable as trying to describe any of the endless variety of complex molecular reactions known to biochemistry wholly in terms of the properties of the electron, proton, and neutron and their subnuclear particles plus (and this, of course, is critical) their spatiotemporal relationships. By including the spatiotemporal relations, such a description becomes feasible in theory, probably, but fantastically impractical.⁷³

Now Bunge would deny that such an explanation – accounting for a complex chemical reaction in terms of microphysical principles, without referring to molecules or to chemical laws – is possible even in principle. Had Sperry asserted without qualification that this sort of explanation is feasible in theory, I would not have claimed that Bunge's account of reduction is consistent with Sperry's position. But the presence of the qualifying 'probably' shows some doubt about this matter. Moreover, the passage just quoted occurs in one of Sperry's earliest papers on consciousness; to the best of my knowledge he has said nothing further about the possibility of such an explanation. Hence this is not to be numbered among Sperry's theoretical convictions. But since only a materialist could entertain such a possibility, this passage is further evidence that Sperry's position is, indeed, a form of materialism. It is important to stress this, since opinions to the contrary linger on. In a recent (1983) interview, published in *Omni*, the interviewer remarks 'I've seen occasional statements that equate your views with animism or dualism', and asks, 'Is this a misinterpretation?' Sperry, of course, replies that it is, and goes on to assert, 'Everything indicates that the human mind and consciousness are inseparable attributes of an evolving, self-creating cerebral system'.⁷⁴

I hope that it is now clear what Sperry means by 'emergence' and what are the dynamics of the form of determination I have called 'structural causation' and which plays a major role in his view of mind. It remains to be shown that Sperry holds this position invariably and consistently. This must be done because Sperry is frequently misinterpreted, largely because

of his cavalier attitude to philosophical language. He does not define his terms with the care that a philosopher demands, nor does he appreciate the importance of doing so. For instance, despite his thesis that consciousness is an emergent property of cerebral functioning, he occasionally speaks of interaction between the mental and the cerebral, or between the mental and the material. Readers of such passages, not surprisingly, take their author to be a dualist. Puccetti, for instance, accuses Sperry of inconsistency in his treatment of the mind-body problem: 'It is Sperry's constant see-sawing between monistic materialism on the one hand and dualistic interactionism on the other that makes it so difficult for others to see exactly what is his position.'⁷⁵ In responding to this criticism, Sperry provides no clarification of his position; he merely remarks, 'Puccetti's quarrels with the proposed causal view of consciousness seem in general to fall largely in the area of terminology and semantics rather than being directed at the basic concept as such . . .'.⁷⁶ Evidently Sperry thinks that his 'basic concept' is clear – that Puccetti's concern with 'terminology and semantics' is otiose pedantry. I will argue that although Sperry holds a consistent position, appropriately called monistic materialism, his lack of care about the meaning of words results in turns of phrase that, taken literally, amount to dualistic assertions. I will show that in the most striking cases of this, the thrust of Sperry's argument is monistic, so that any appearance of dualism is due to terminological aberrations. I must stress that this critical scrutiny of his phraseology is undertaken to prevent or repair misunderstandings of a theory that I think to be extremely important. I have no natural love of picking nits!

In support of my interpretation of Sperry's position, I begin by citing passages that show it to be an emergentist materialism. As we have seen he says that 'conscious phenomena are built of neural events as elements and perhaps also of glial and other cerebral events'.⁷⁷ In a different context, having said that '[i]ndividual nerve impulses and other excitatory components of a cerebral activity pattern are simply carried along or shunted this way and that by the prevailing overall dynamics', in a manner analogous to drops of water in a stream or the component atoms and molecules of a rolling wheel, he goes on to say, '[o]bviously, it also works the other way around, that is, the conscious properties of cerebral patterns are directly dependent on the action of the component neural elements'. He tells us that there is a 'mutual interdependence' between 'the sustaining physiochemical process' and 'the enveloping conscious qualities'. In other words, says Sperry,

[t]he neurophysiology . . . controls the mental effects, and the mental properties in turn control the neurophysiology. One should remember in this connection, however,

that the conscious phenomena are in a position of higher command, as it were, located at the top of the organizational hierarchy.⁷⁸

We note that in the first sentence of the last quotation, 'control' is used equivocally. The neurophysiology controls the mental effects in the sense that the system characterized by consciousness is composed of neurophysiological elements; the mental properties control the neurophysiology in the sense of structural causation. We have seen that Bunge equivocates, in a similar way, on 'determine'.

Given statements such as this, in conjunction with Sperry's depiction of the brain or nervous system as a hierarchy of systems, we are left in no doubt that his view of the mental is a materialist one. But alas, his use of terms often obscures this fact. We have seen that he speaks of 'interaction' in characterizing his position. In a different context, he claims to accept 'the holistic form of psychophysical interaction'.⁷⁹ His major paper of 1977 includes a section headed, 'Formula for Psychophysical Interaction'.⁸⁰ Now the word 'interaction' is clearly out of place in Sperry's position as I have described it. This term is used with propriety only in relation to two distinct things or events or states of affairs that affect one another in the mode of efficient causation. We would not speak of interaction between a body of water and its component molecules; for this would be a category mistake. The same must be said of Sperry's use of the term in relation to the mental and the material.

Careful reading of the above-mentioned section of the 1977 paper shows that Sperry does not believe in interaction in the usual sense of the word. For one thing, in this section occurs the statement, quoted earlier, that 'conscious phenomena are built of neural events as elements . . .'. Secondly, what he means by the claim that emergent conscious properties cause neural events is spelled out in the passage, quoted above, which begins, 'The causal power attributed to the subjective properties is nothing mystical'.⁸¹ Finally Sperry confesses that 'interaction' might not be the best term for his view of the mind-body relation: 'The term "interaction" for the psychophysical relation is perhaps not the best descriptively but is used for its historical connotations which still apply in the sense that mental phenomena are conceived to exert causal control influence on neural events.'⁸²

Another unfortunate use of terms is Sperry's description of his position as 'a midway compromise between the older extremes of mentalism on the one hand and materialism on the other'.⁸³ Bindra takes issue with this claim on the ground that these two positions, being logically incompatible, do not admit of compromise. 'There can be little doubt', says Bindra, 'that the tone and vagueness of Sperry's statement could lead some to identify

him as a dualist.⁸⁴ In his reply to Bindra, Sperry asserts that his position is 'mentalistic in accepting the existence of potent mental forces that transcend the material elements in cerebral function', and 'materialistic in denying that these mental forces can exist apart from the brain process of which they are a direct property'.⁸⁵ He is saying that his position is mentalistic, not in the traditional dualistic sense, but in that the domain of the mental is pre-eminent. In this lies the similarity to traditional mentalism. But, he continues, his view is materialistic in regarding mental forces as properties of the brain process. His meaning would be clear, I think, were it not for the antithesis, 'mental-material', in the first sentence. On the accepted sense of the word 'material', Sperry's view entails that mental forces *are* material; to describe them as transcending the material elements is to invite misunderstanding.

We have not come to the end of this particular story of non-communication. In the paper written in response to Bindra's criticisms, Sperry approaches the present point by giving a clear statement of his view. He asserts that his theory 'gives consciousness a functional role and requires that the subjective phenomena be included in the causal sequence for a complete explanation'.⁸⁶ This, he says, 'represents a return towards mentalism except that the mental forces are not viewed in any metaphysical, preternatural, nonmaterial, epiphenomenal, or other dualistic sense'.⁸⁷ So far, so good. But in the next paragraph he reaffirms the claim that his position is a compromise and goes on to reject Bindra's claim that dualism, like pregnancy, is an all-or-nothing affair.

I can only disagree with Bindra regarding his pronouncement that such a compromise is impossible – even in the form in which he reinterprets it to imply degrees of dualism. Dualistic mentalism has been expressed in different forms with different implications by different schools and the same can be said for materialism. It is not a simple all-this or all-that alternative. Within the context of the present scheme, it may be seen that as systems get more complex, the phenomena and properties of the whole system tend to become increasingly remote in quality from those of its elementary parts. A wide spectrum of qualitative differences is evident that approaches an extreme in the case of the brain and could be taken as degrees of dualism.⁸⁸

Here 'degrees of dualism' is used in the sense of 'degrees of qualitative difference between micro properties and macro properties'. Since 'dualism', in the received sense of the word, does not admit of degrees, and since Sperry has just said that he does not view the mental forces in any dualistic sense, this stipulation is an unfortunate one that cannot but becloud his meaning.

The point about qualitative difference between micro properties and macro properties is an important one. Consciousness differs so radically, in its intrinsic characteristics, from any physical entity of our acquaintance

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that it seems plausible to think that the mental and the physical must be entirely disparate forms of being. This qualitative difference was long regarded as strong evidence for dualism. It is to Sperry's credit that he sees no force in this line of argument; the passage just quoted is as close as he comes to mentioning it. The weakness of a dualistic appeal to qualitative difference has been ably shown by Richard Taylor.⁸⁹

Curiously enough, when Sperry considers the likelihood of claims on behalf of paranormal phenomena, he fails to see the implications of his point that there can be striking qualitative differences between molar and molecular phenomena. The position he takes is what one would expect from a reductionist. Thus, in the *Omni* interview, he says,

Some people have used the new mentalist concepts to bolster mystical and supernatural beliefs, including those of parapsychology. Actually, under the new model, mental telepathy, psychokinesis, precognition, and the other so-called psi phenomena become even less likely than they were before.⁹⁰

Sperry's view is 'the new model'; presumably the old one is reductive materialism. Now there is nothing in Sperry's position that will 'bolster' views such as he mentions; but it is surely the case that a theory that allows for emergent properties provides room for unexpected or surprising properties of mind. Just as systemic properties cannot be explained solely on the basis of the properties of the individual components, in the absence of information about the structure of the system, so also systemic properties cannot be predicted on this basis. Given a detailed and well-confirmed theory of a system, emergent properties can be both explained and predicted. In such a context, it might be possible to show, on the basis of the theory, that the system *cannot* have certain properties which someone has attributed to it. If the theory forbids them, then either they are not present or the theory must be revised. In the absence of such a theory, however, nothing of this sort is possible. We have seen that there is, at present, a conspicuous lack of theory of the structure of the cerebral system that has mental properties. Hence there is no basis on which to decide whether 'psi phenomena' are likely or unlikely. Whether or not they exist is an empirical question altogether. The real consequence of Sperry's emergentist theory is a more liberal attitude to the paranormal than that of reductive materialism. Sperry's view clearly does not make psi phenomena less likely than before. It makes them less unlikely. *Why?*

I hope to have shown that Sperry's position is consistently materialist, and that all appearances to the contrary are to be explained in terms of his use of language. Now it must not be thought that Sperry's linguistic infelicities are entirely due to carelessness. As I have said above, the terms commonly used in discussions of mind and body frequently have dualistic


connotations. That something is material, for instance, suggests that it is not mental; and if it is mental it is not material. How, then, can clear and unambiguous expression be given to the view that the mental is an emergent property of a material organ, the brain? I have said that Sperry's locution, 'mental forces that transcend the material elements in cerebral function', is misleading; but what words ought he to have used? 'Neural' would be less misleading than 'material'; but what is really needed is a careful and explicit redefinition of terms in the context of Sperry's theory. It could be stipulated, for instance, that mental events and physical events are two different kinds of material event. Then Sperry could speak with clarity and propriety of mental forces transcending the *physical* elements in cerebral function. His confusing phraseology is, in large part, due to his failure to recognize the need to redefine terms carefully in order to give a clear presentation of a radically novel theory.

For Sperry the most important consequence of his theory of consciousness is that in principle it brings about a *rapprochement* between science and the humanities; for the guiding principles of the latter have their origin in consciousness which, as a property and part of cerebral processing, lies within the domain of science. In Sperry's view the realm of the humanities thus becomes part of the province of science. As he puts it,

In effect, this change means that the whole value-rich qualitative world of inner-conscious, subjective experience, the world of the humanities, that has long been excluded from the domain of science on materialist [*sic*] grounds, is now reinstated.⁹¹

These words were written in 1977, in Sperry's last published paper on either the split brain or consciousness. Since then his attention has been focused on issues to do with values. In the *Omni* interview he states that 'according to our new views of consciousness, ethical and moral values become a very legitimate part of brain science', and that values will have a more important role in shaping our future than will anything else that a scientist might study. Hence his decision to concentrate upon values which, he says, 'are universal determinants in all human decision making, and . . . actually the most powerful causal control forces now shaping world events'.⁹² Sperry regards 'the human-value implications' of his research as having an overriding significance compared to any other avenues that it opens.

It is arguable that Sperry is correct in holding that a *rapprochement* between science and the humanities is a consequence of his theory; but the further consequences that he envisions are questionable in the extreme. I shall not discuss the claim that the world of the humanities has been reinstated as part of the domain of science, for it is insufficiently clear just what this means. Let us focus upon the more specific assertion that 'accord-



ing to our new views of consciousness, ethical and moral values become a very legitimate part of brain science'.⁹³ On Sperry's own principles this is simply not so. He holds that the values in question characterize consciousness, which is an emergent property of cerebral systems. The structure of these systems is at present unknown; but they are assumed to be composed of entities that lie within the brain scientist's area of expertise. But that these entities lie within the domain of brain science does not entail that an emergent property of systems composed of these entities also lies within this domain – let alone properties or modifications of this emergent property. Thus the physicist is not an expert on the functioning of the brain, even though all cerebral systems are composed of entities of which he has expert knowledge. As we have seen in the discussion of emergence, knowledge of component entities is not sufficient for understanding the molar behaviour of complex systems composed of these entities. Thus, on grounds independent of the fact–value dichotomy, we can see the groundlessness of Sperry's claim that values are part of brain science. This claim represents a lapse into a reductionism that he elsewhere rejects; for instance, in his 1977 paper, he asserts that 'psychology and psychiatry are best interpreted as disciplines in their own right, not reducible or identical to neuroscience or behavioral biology'.⁹⁴ What is true of psychology is surely also true of value theory.

The *Omni* interview with Sperry appeared as this paper of mine was in the final stage of preparation. His views, as presented in the interview, are in agreement with those of his earlier writings. Additional light is shed on the origin of his view of consciousness: he says that his split brain studies led him to see 'the normal bilateral consciousness' as 'a higher emergent entity that's more than just the sum of its right and left awareness and supersedes this as a directive force in our thoughts and actions'.⁹⁵ His sense of 'mentalism' is defined more clearly as, 'a doctrine holding that mental events, as consciously experienced in the mind, determine and explain behavior'.⁹⁶ But he also says that mentalism stands in contrast to 'behaviorism and materialism'. He still uses the latter term to refer to reductive materialism and does not call his own theory 'materialistic'. He also accuses reductive materialist philosophy of 'a failure to adequately credit the nonmaterial elements in reality'.⁹⁷ Thus Sperry still uses misleading terminology. This, although unfortunate, is a superficial matter. His position is consistent and of revolutionary import.

Earlier in this paper, Sperry's concepts of emergence and of 'the causal power attributed to the subjective properties', which I have called 'structural causation', were clarified by reference to Bunge's concepts of emergence and structural determination. It should be added that Bunge has a

theory of the mental, an 'emergentist materialism',⁹⁸ which has affinities with Sperry's theory. To compare these two views in the detail that would be needed is beyond the scope of the present paper. I shall only note that they are not opposed in the way that Bunge thinks them to be. In discussing the conscious control of behaviour, he writes, '[t]o account for such phenomena there is no need to invoke an immaterial consciousness (as Sperry, 1969, . . . and so many others have done)'.⁹⁹ We have seen that Sperry does not invoke an immaterial consciousness. To think that he does is to misunderstand him in a manner invited by his occasionally infelicitous use of terms.

NOTES

- 1 The most thorough account of these studies and their results is R. W. Sperry, 'Forebrain Commissurotomy and Conscious Awareness', *Journal of Medicine and Philosophy*, Vol. 2 (1977) (hereafter 1977), pp. 101-15. See also his 'Perception in the Absence of the Neocortical Commissures', *Association for Research in Nervous and Mental Diseases*, Vol. 48 (1970), pp. 123-38 (hereafter 1970a); 'Lateral Specialization in the Surgically Separated Hemispheres', in F. O. Schmitt and F. G. Worden (Eds.), *The Neurosciences: Third Study Program*, M.I.T. Press, Cambridge, Mass. 1974, pp. 5-19 (hereafter 1974).
- 2 1970a, p. 135.
- 3 1977, p. 122.
- 4 1974, p. 7.
- 5 *Ibid.*, p. 11.
- 6 See 1977, p. 109.
- 7 See 1977, pp. 110-12.
- 8 *American Scientist*, Vol. 40 (1952), pp. 291-312 (hereafter 1952).
- 9 1952, p. 292.
- 10 1952, p. 291.
- 11 1952, p. 292.
- 12 1952, p. 293.
- 13 *Ibid.*
- 14 *Ibid.*
- 15 1952, pp. 303-4.
- 16 1952, p. 296.
- 17 1952, pp. 297-8.
- 18 1952, p. 298.
- 19 1952, p. 299.
- 20 1952, p. 309.
- 21 1952, p. 299.
- 22 1952, p. 297.
- 23 *Ibid.*
- 24 *Ibid.*
- 25 See 1952, pp. 303 f.
- 26 1952, p. 297.
- 27 1952, p. 299.
- 28 *Ibid.*
- 29 1952, p. 300.
- 30 See R. W. Sperry, 'Mind, Brain and Humanist Values', in J. R. Platt (Ed.), *New Views on the Nature of Man*, University of Chicago Press, Chicago 1965 (hereafter 1965); pp.

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- 77–78; 'A Modified Concept of Consciousness', *Psychological Review*, Vol. 76 (1969) (hereafter 1969), p. 532; 'An Objective Approach to Subjective Experience', *Psychological Review*, Vol. 77 (1970) (hereafter 1970b), p. 589; 1970a, pp. 135–7; 1974, p. 117.
- 31 1977, p. 117.
- 32 M. Bunge, *Treatise on Basic Philosophy*, Vol. 3, Reidel, Dordrecht 1977, p. 97.
- 33 Op. cit., Vol. 4, 1979, p. 41.
- 34 Ibid., pp. 41–42.
- 35 See P. Oppenheim and H. Putnam, 'Unity of Science as a Working Hypothesis', in H. Feigl, M. Scriven and G. Maxwell (Eds.), *Minnesota Studies in the Philosophy of Science*, Vol. II, University of Minnesota Press, Minneapolis 1958, pp. 5–6.
- 36 Op. cit., 1979, p. 42.
- 37 M. Bunge, *Causality*, Meridian Books, Cleveland 1963, pp. 17–18.
- 38 Ibid., p. 18.
- 39 Ibid., p. 19.
- 40 Ibid.
- 41 Op. cit., 1979, pp. 42–43.
- 42 See J. R. Searle, 'The Intentionality of Intention and Action', *Inquiry*, Vol. 22 (1979), pp. 274–5; *Intentionality*, Cambridge University Press, Cambridge 1983, p. 94.
- 43 *Intentionality*, p. 135.
- 44 Ibid., pp. 112–40.
- 45 1970b, pp. 588–9.
- 46 1969, p. 534.
- 47 1970b, p. 589.
- 48 See R. W. Sperry, 'Mental Phenomena as Causal Determinants in Brain Function', in G. Globus, G. Maxwell, and I. Savodnik (Eds.), *Consciousness and the Brain*, Plenum Publishing Co., New York 1976 (hereafter 1976), pp. 167–8. See also 1965, pp. 79–80; 1969, pp. 533–4; 1970b, p. 589.
- 49 E.g. see 1965, p. 80.
- 50 1970b, p. 589.
- 51 K. R. Popper and J. C. Eccles, *The Self and Its Brain*, Springer International, Berlin 1977, p. 19; see also D. T. Campbell, "Downward Causation" in Hierarchically Organized Biological Systems', in F. Ayala and T. Dobzhansky (Eds.), *Studies in the Philosophy of Biology*, University of California Press, Berkeley 1974, pp. 179–86.
- 52 1977, p. 120.
- 53 1969, p. 533.
- 54 E.g. see C. Sherrington, *The Integrative Action of the Nervous System*, Cambridge University Press, Cambridge 1947; pp. xx–xxi.
- 55 See Barbara B. Brown, *New Mind, New Body*, Harper & Row, New York 1974, pp. 155–74.
- 56 1976, pp. 167–8.
- 57 1969, p. 534.
- 58 Ibid., p. 535.
- 59 1970b, p. 587.
- 60 Ibid., p. 589.
- 61 1977, p. 122.
- 62 1969, p. 535.
- 63 See R. M. Chisholm, 'Freedom and Action', in K. Lehrer (Ed.), *Freedom and Determinism*, Random House, New York 1966, p. 17; 'On the Logic of Intentional Action', in R. Binkley, R. Bronaugh, and A. Marras (Eds.), *Agent, Action and Reason*, Blackwell, Oxford 1971, pp. 38–39.
- 64 'On the Logic of Intentional Action', p. 44.
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- 66 1977, p. 122.

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- 68 1970b, p. 587.
- 69 1977, p. 120.
- 70 1969, p. 535.
- 71 Ibid.
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