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THE SCIENCE-VALUES RELATION: IMPACT OF THE CONSCIOUSNESS REVOLUTION

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DISCUSSION

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*Dr. Roger W. Sperry**

As a scientist, my world outlook and beliefs about both human and nonhuman nature underwent a major conversion during the mid-1960s. Long-trusted principles had proclaimed a complete scientific explanation of brain function and behavior—and all human nature—to be possible in strictly physiological or physicochemical terms, with no reference to conscious subjective experience. These principles, which had always seemed to be logically airtight and irrefutable, were discovered to be based, in fact, on a logical flaw or shortcoming. A loophole was found.

As a result, I renounced my earlier views in favor of a new mentalist paradigm in which the traditionally rejected subjective mental and spiritual qualities of the conscious mind were interpreted to play an active, functional, causal role in brain processing. In this new "mentalist" scheme, subjective conscious states, as emergents of brain action, became ineliminable causal constructs in scientific explanation. This meant that my outlook in science must be reversed to include conscious experience among the legitimate causes of behavior.

The new reasoning was introduced to the National Academy of Sciences and to psychology in the late 1960s. And, by the mid-1970s, psychology too had reversed its position on consciousness and switched from behaviorism to a new mentalist or cognitivist paradigm. In what follows, I shall be speaking from the standpoint of this paradigm shift in behavioral science in general, not from my personal philosophy—though I take the two to be identical in terms of underlying principles. For our present purposes, however, it is important to emphasize the basis in mainstream psychology, not in personal opinion. What is involved essentially is a shift to a new form of causal determinism a shift that I hold to be a move toward

*Most of this paper was read for Dr. Sperry by his wife, Norma, because his speech is slowed by an advancing neuromotor condition.

a more valid conceptual foundation for all science, not just psychology.

The answer to the question, "Is there convergence between science and religion?" seems from the standpoint of psychology to be a definite and emphatic "Yes!" Over the past fifteen years, these changed foundational concepts have brought radical revisions in our scientific descriptions of the nature of human nature and the psyche. The resultant views today are much more palatable and compatible for theology than were those of the behaviorist-materialist era. Where religious belief and scientific belief formerly stood in direct conflict, even to the point of being mutually exclusive, one now sees promise for a new compatibility, perhaps even harmony.

At the risk of being repetitive, it will help to say a little more about these developments on which the convergence in question directly depends. The developments I refer to are not something vague, abstract, or obscure; nor are they a matter of wishful thinking. The swing in psychology from behaviorism to mentalism (or cognitivism) during the 1970s is a widely recognized and well-documented shift of majority opinion and practice—a true paradigm shift to a new conceptual framework for the science of behavior. In the early 1970s, the objective radical behaviorism that had dominated psychology for over half a century gave way rather abruptly to a new, more subjective explanatory framework called mentalism or cognitivism. In short, this change can be seen to provide science and all of us with a new philosophy, a new outlook, a new way of understanding and explaining ourselves and the world.

The contents of conscious experience, long banned from scientific explanation by rigorous objective behaviorist and materialist principles, have now made a strong comeback. Subjective mental states and events such as mental images, feelings, thoughts, memories, and other introspective phenomena, formerly renounced as nonvalid and useless for objective scientific explanation, have become widely accepted today as explanatory causal constructs. Described by some psychologists as a "deep conceptual conversion," this turnabout in doctrine is commonly referred to as the *consciousness* or *cognitive* or *mentalist* revolution and has also been called the *humanist* or *third* revolution (the first two having been associated with John Watson and Sigmund Freud). In effect, the conception of conscious experience in brain function and behavior was turned around from that of a nonfunctional, noncausal epiphenomenon,

or parallel aspect or byproduct of brain function, to that of an integral, ineliminable directive working force.

A new solution to the age-old mind-brain problem is involved, as well as a revised form of causal determinism. Also, our concepts in neuroscience of the working of the physical brain and of the kinds of governing forces that are in control undergo substantial revision. Where previously science had relied exclusively on objective neuronal activity, biophysics, biochemistry, and, eventually, quantum mechanics, the scientific account now includes subjective qualities as explanatory constructs. The full range of the contents and qualities of the world of inner experience have not only been reinstated but are now given primacy over the more basic physicochemical forces. As emergents of brain activity, the higher-level mental states are conceived to interact causally at their own level and, concomitantly, to exert control from above downward over their constituent neuronal events at the same time that they are being determined by them.

The invoked principle of causal control from above downward in organizational hierarchies—later dubbed *downward causation* by Donald Campbell, Sir Karl Popper, and others—can be applied at all levels throughout science. The new outlook says that we and our world are more than just swarms of atoms, electrons, and protons. The higher holistic properties and qualities of nature to which the brain responds—the colors, the forms, the weights, the sounds, along with things such as purpose, intentionality, and caring in human and social activity—all become just as real and causal for science as are the atoms and molecules on which they depend—and they cannot be reduced to quantum mechanics. The outcome is a renunciation of the quantum mechanics philosophy that has dominated science for over half a century (but not, of course, of quantum physics *per se*). Among other consequences, much of our traditional reasoning regarding the polarization of science and religion, freedom and determinism, fact and value, "is" and "ought," becomes obsolete, with new possibilities opened for a convergence of theological and scientific thought.

It seems fair to say that, prior to this mentalist revolution, that is, up through the 1960s, mainstream science and religion actually had stood to one another as archenemies. All through the behaviorist-materialist era, science had been upholding an impersonal, value-devoid, physically driven cosmos governed by chance and quantum mechanics. This strictly physically determined cosmos was con-

ceived to be ultimately lacking in purpose, caring, higher meaning, morality, and other attributes that are essential and, indeed, vital to the concerns of religion. Things such as subjective value, purpose, and meaning—if they existed at all—were supposed to be only epiphenomena of brain activity, best ignored in scientific explanation since they, supposedly, in no way changed the course of events in the real world, either in the brain or in the universe at large.

The foregoing characterization of pre-1970s science and religion as "archenemies" may appear a bit harsh in view of seeming exceptions such as, for example, Ralph Burhoe's Institute of Religion in an Age of Science (IRAS) and the associated *Zygon Journal of Religion and Science*. It is presupposed, however, that we are here discussing mainstream science and religion. It has long been a stated policy for IRAS and *Zygon* that the attempt to join science and religion must be based on solid mainstream science, not on fringe activities and minority opinions that might try to pass as science. For this reason, the Burhoe project was constrained to try to merge religion with the prevailing materialist, reductionist doctrines of mainstream science. This, of course, meant trying to merge religion with radical behaviorism, the selfish gene concept, quantum mechanics philosophy, and all the other reductive, mechanistic, deterministic views upheld in traditional materialist philosophy. Despite good intentions and valiant attempts in this direction over several decades, this project never really succeeded from the standpoint of religion. As one theologian jocularly summarized the effort recently: "With friends like these, who needs enemies!"

The actual relation of religion to mainstream materialist science seems to have been more realistically assessed by the council of the National Academy of Sciences when, in 1981, they issued the following resolution, quoted in the Academy's booklet *Science and Creationism*: "Religion and science are separate and mutually exclusive realms of human thought, presentation of which in the same context leads to misunderstanding of both scientific theory and religious belief." In other words, acceptance of the reductive physicalist beliefs traditionally upheld in scientific materialism logically destroys the kinds of beliefs upheld in religion and vice versa.

As already stressed, this mutually exclusive "archenemy" status is, today, a thing of the past—at least in behavioral science—thanks to the consciousness revolution. We used to be faced, in the last analysis, with a choice between two mutually exclusive conceptions

of ultimate reality: the spiritual-religious and the physical-scientific frameworks for belief. The new mentalist paradigm introduces a third choice. Described as a midway compromise, this new outlook on reality combines formerly antithetical features from both sides of the old spiritual-physical dichotomy into a new world-view synthesis. The new outlook integrates the physical with the metaphysical (what Dr. Wilson has referred to as materialism vs. transcendentalism), positivistic thought with phenomenology. It accepts subjectively experienced mental and spiritual qualities as autonomous causal realities. At the same time, however, it denies that these mental-spiritual phenomena can exist separately in an unembodied form apart from the functioning brain.

To better understand the new outlook, it will help to view it in relation to the changes called for in our concepts of causation. The traditional assumption in behaviorist psychology, like that in neuroscience, physics, biology, chemistry, and all the natural sciences, supposed everything to be determined from below upward, following the course of evolution. In this "microdeterminist" view, all brain function is determined by, and can be explained in terms of, brain physiology or neuronal activity. In turn, the neuronal activity can be explained in terms of biophysics and biochemistry and so on, everything being determined and accounted for eventually in terms of subatomic physics and quantum mechanics—or some even more elemental "theory of everything."

The new mentalism rejects this exclusive, reductive microdeterminist reasoning and replaces it with another. The new outlook accepts the control from below upward but claims this is not the whole story, that a full explanation requires that one also takes into account controls exerted from above downward by the higher level properties of a system. This control is referred to as "macro," "molar," or "emergent" determinism. It is the failure to recognize this downward control, along with dualist explanations in theology, that have made religious and scientific belief seem mutually exclusive. With reductionist fallacies now corrected in the new macrodeterminism, there seems no logical reason why scientific belief cannot be fused with religious belief, so long as dualist views are avoided (which, I am told, is no great problem in contemporary theology).

Psychology's new mentalist paradigm resolves the old free-will issue by retaining determinism—both "micro" and "macro"—in such a way that the antecedent causes determining one's willed

actions include subjective wants, values, and other mental aspects that make up the cognitive self. Thus, from the standpoint of mentalist doctrine, as from that of common experience, one does what one subjectively chooses or *wants* to do.

Mentalism also erases much of the old antithesis between scientific fact and values. Subjective values become objective causes of behavior, not excluded any longer from scientific explanation. In addition, the cosmology and world view of science are reformed in ways that no longer destroy values. Further, our current concepts of cognitive processing make it logically and theoretically possible to go from *is* to *ought*, rendering the "naturalistic fallacy" itself fallacious. The combined result is a new era in the science-values relation.

REMAINING ISSUES

We turn now to other areas of agreement and disagreement between science and religion. I hope most of us will agree at the start on at least one general presupposition: namely, that human belief systems, along with their attendant values and moral priorities, have tremendous power in shaping social policy and the course of world events and (especially with the explosive increase in the human impact) that human beliefs will be a major, if not the key, factor in determining the future for all life on our planet. From the standpoint of brain processing, the central importance of the belief system as a determinant of behavior and decision making at all levels can hardly be overrated. Religious, philosophic, and ideologic beliefs, in particular, incorporate or imply a world view or life-goal framework that then ultimately determines the public judgment of how things ought to be in the world—the cultural sense of value and conceptions of right and wrong.

A crucial remaining issue that is brought into new focus by the mentalist paradigm can be stated as follows: In forming ideologic or religious belief, is it any longer necessary and/or desirable to go beyond the limits of present knowledge and empirical verification? In other words, do we put our faith in the kind of truth limited by reason and the domains within which scientific and religious belief are in accord? Or, do we reach beyond into other realms? The answer, of course, is critical to the treatment of many other issues.

Until the 1970s, there was little choice; theology could hardly depend on scientific doctrine that, in the final analysis, was mutually exclusive and incompatible with its own aims. In addition, it has often been said that science, at its best, does not go far enough to satisfy the ultimate concerns of religion.

In our changed situation today, however, new reasons can be seen for basing our belief systems—at least at the social level and for purposes of legislation—firmly within the bounds of empirical verification where science can lend support. Publication trends of the past dozen years show increasingly that, with the new paradigm and other advances, one can arrive at a very workable theology or value-belief system that is sound and consistent and has competitive appeal and credibility—all staying within bounds acceptable to science.

The principal argument, however, relates to the power of belief systems in determining social values and the future. It says, in effect, that if we risk mistakes in this critical area or even fail to correct past errors, it could easily mean our finish. If we do not succeed soon in finding a theology that will protect the biosphere, and if we do not find a neutral "common denominator" belief system and ethic on which most nations and most cultures and faiths can agree, then very shortly we may not have any nations or theologies or sciences to worry about—or even any biosphere. In today's scenario, the issue of survival (or better, of quality survival) logically takes overwhelming precedence over all other moral imperatives.

Current efforts, based mainly in science and technology, to cope with mounting global ills represent a losing battle. Only a major overhaul in the existing social and moral order can be expected to provide a sustainable civilization. The key, I believe, lies in the kinds of values and moral priorities that would result from a merger of religion with the new science. The beliefs and values that would logically result are in tune with world reality. Expressed through social policy and legislation, these values would preserve and enhance the biosphere instead of destroying it. Building on the neutral universality and credibility of scientific truth, they would also provide a basic, common-core global ethic for world government or, at least, for a world security system to control nuclear and other metanational global threats.

Finally, in closing, it may be emphasized that, today, to opt for putting our faith in the kind of truth supported by science does not at all diminish the need for theology. Most scientists, caught

up in the minute details of specific problems, couldn't care less about the value implications or ultimate bearing of their discoveries. Even when they do, the value-belief implications involve a highly complex discipline, one that needs specialists of its own—not to mention all the implementation aspects in practical application.

Initially, science and theology started out together in search of answers. Now, the way seems to be opened again for a reunion in the search for a more intimate understanding of the forces that made and move the universe and created humanity and for ultimate guideline beliefs to live and govern by.

ADDENDUM

In attempting to go further into some of the more specific issues on which religion and science might still differ, despite the new "macro" paradigm, I found I did not know enough about the tenets of the different mainline religions—nor even enough about the different contemporary interpretations of Christianity—to define effectively the possible remaining areas of conflict. It seemed better merely to try to list briefly a few of the relevant implications of the new paradigm, leaving it for others more competent in these areas to determine to what extent there may be agreement or conflict.

In general, the new outlook supports a system in which the most sacred things in life are neither reduced to quantum mechanics nor set off apart in another world of existence. Resultant moral priorities are this-worldly and, more important, of a kind that will act to preserve and enhance the long-range quality of our biosphere, as well as to provide a common neutral basis for international, intercultural, and interfaith compromise on ethical issues and how things ought to be in the world.

In the eyes of science, humanity's creator becomes the vast creative force system in "evolving nature," which includes human nature. Nature is qualified in this context as "evolving" or "emergent" or "creative" because there are destructive forces in nature as well as creative ones.

Evolving nature in macrodeterminist terms involves gradual emergence of increased direction and purpose among the forces that move and govern living things at both collective and individual levels, including an emergent awareness and spirituality in higher brains. Current conceptions of causation rule out the separation of

creation and creator. In the perspectives of science, the two are intricately and inextricably interfused and evolve together. The creative force system is, thus, not a static but a dynamic entity that grows and evolves as evolution progresses.

From the standpoint of brain processing, values—including ethical and moral values—are relative to this world's reality. Only the highest good, expressed in the abstract as "implementing God's will" or "enhancing the quality of existence," remains constant. Concrete moral directives for achieving the highest good logically change as reality and world conditions change. Even the sanctity of human life is relative to reality, not absolute.

As human numbers grow, and as human interests and welfare increasingly overwhelm or come into competition and conflict with those of other species, questions arise as to the extent to which humankind should take or be given precedence. This becomes one of the great moral issues of our age. Is this planet primarily or exclusively for humanity, as many claim, or do other species also have "rights"?

It seems ironic that humanity's aspirations for immortality, if maladaptively implemented, could result indirectly in destroying not only our immortality but also our mortal existence, as well as that of numerous other species.

Rev. Joseph A. Bracken, SJ

Given the enormity of the problems facing human beings today, not only to live well but simply to survive on planet Earth, Dr. Roger Sperry's appeal for a new world view that brings together the facts established by the natural and social sciences and the value-laden beliefs traditionally upheld by the great world religions certainly deserves careful consideration. Since I myself have been for some years at work on basically the same project, namely, the creation of a new world view more in line with contemporary self-understanding, I am very pleased to have this opportunity formally to respond to Dr. Sperry.

He suggests, quite properly in my judgment, that such a merger between science and religion will not take place unless proponents of both science and religion rethink the assumptions that have classically held them apart. That is, religion must give up "dependence on dualistic concepts," while science must renounce "much of its traditional materialistic legacy, including decades-old behavioristic, reductionistic, probabilistic, mechanistic, and deterministic principles."[1] As proof that science, for its part, is already moving in that direction, Dr. Sperry cites his own research into the mind/brain relation. Increasingly, the empirical results coming out of that line of work have led him to the conclusion that the reductionist approach of Newtonian science, whereby the existence and activity of entities are exclusively to be explained in terms of the laws governing the existence and activity of their component parts, must be set aside in favor of a new operational premise that he calls "downward causation." Dr. Sperry explains the latter as "the idea that, in the reciprocal interaction of lower and higher levels [within a given organism], the higher laws and forces (once evolved) exert downward causal control over the lower forces. The lower level forces in any entity are enveloped, overwhelmed, and overpowered

[1]Roger Sperry, "Changed Concepts of Brain and Consciousness: Some Value Implications," *Zygon Journal of Religion and Science* (March 1985): 44.

Discussion

BISHOP MELCZEK: Do any of our discussion groups have comments to volunteer?

FR. WILLIAM LORI: Our group reached a sort of consensus regarding Dr. Sperry's statement that survival takes precedence over everything else as a value. We agree that the survival of the biosphere is a critical, overarching question and an urgent moral imperative. Having said that, however, we began to talk about the place of individual moral questions and imperatives in the context of this overall, universal problem. We noted that the Church tries to maintain two bodies of moral teaching: a social one, concerned with great issues like preventing nuclear war and preserving the biosphere; and an individual one, emphasizing personal decision making. We sense that there is some common matrix between those two kinds of moral teaching, even if this matrix is not well understood.

DR. ROBERT RUSSELL: We would first like to express our appreciation for the courage Dr. Sperry has shown in critiquing and adjusting the world view that dominated his earlier work. We were moved by his "conversion" and recognize our own responsibility to be very clear about what we are committed to in our traditions and what we need to examine.

Dr. Sperry said: "With reductionistic fallacies now corrected in the new macrodeterminism, there seems no logical reason why scientific belief cannot be fused with religious belief, so long as dualist views are avoided. . . ." We would be inclined to agree with this statement if we are permitted to change a few words; for example, we would substitute *ideas* for *beliefs*. "Scientific belief" strikes us as a curious and, perhaps, unfair term, and "religious belief" may be too general to be useful. If you compare scientific ideas, concepts, or hypotheses to religious ones, on the other hand, there could be a great deal of overlap and mutual elimination and critique.

We were also uneasy with the word *fusion*. We weren't sure what you would get if you fused science and religion; you might only succeed in losing both. However, if some sort of interactive overlap could be constructed, as St. Thomas did with Aristotle, it could trigger a new age as far as critiquing the metaphysics that underlies our theology is concerned. Thomas himself, after all, used Aristotle to critique earlier theologians. It isn't just a matter of selecting and rejecting, but a process of honestly wrestling with the best science, the best philosophy, of our time. A critical examination of theology as it embraces the issues science raises is essential.

We agree with Dr. Sperry that survival is the most urgent issue of our day. Those of us in the fields of moral and philosophical reflection have a special call to embrace the challenge of technology and to examine world crisis. We should also question the focus of survival. Is it individual? Is it the species? Is it the species plus the ecology on which species depends? Is it planet Earth? There is ambiguity in the question of who survives and how survival is defined, and this ambiguity generates some of the misunderstandings and problems in the moral critique of technology.

Our group talked briefly about a way of combining two speakers' ideas. Dr. Dyson eloquently discussed three levels of consciousness: quantum mechanical, human, and cosmic. Dr. Sperry talked about downward causation as a new concept in the analysis of mind/body relations. Is there any sense, we wonder, in which the Cosmic Mind might be the source of downward causation? If so, what would be the locus of that causation? Would it be the universe in the sense that Cosmic Mind could change the future? Or, would downward causation be more local, affecting individual humans? Can mystical experience be interpreted in this light? All very speculative, of course, but interesting.

SR. ROSEMARY DONLEY, SC: Our group raised a number of issues, which I will mention briefly. We also feel moved to issue a caution. While the dialogue between science and religion is certainly important, we must avoid parochialism. This applies not just to the Catholic tradition but to all traditions.

We strongly agree that survival is a most important moral imperative. We discussed the role of charity as a theological concept and noted that ultimate survival for us is the gaining of eternal life. We share a concern with world order, a concern that has to be international. We agree with Dr. Sperry that God is in the universe. But, as Catholics, we have another belief that we do not see as

competitive, namely, that God also transcends the universe. In discussing this point, we recognized the importance of not losing sight of our differences. These differences and diversities do not prevent our working together. At the same time, they are very significant when it comes to treatment of final goals such as survival.

We had an interesting discussion on what we mean today by "natural law." Clearly, it is essential that people in our tradition examine the concept of natural law in the light of the findings of modern science. Traditionally, Catholics believe that grace builds upon nature, that grace is not limited by nature. Thus, science must not be allowed to co-opt religion, just as religion is not called to "convert" science.

BISHOP MELCZEK: Any comments on these group reflections?

CARDINAL BERNARD LAW: Let me pick up on what Sr. Donley said just now about natural law, in reference to the quotation from Dr. Sperry's paper regarding the fusion of religious and scientific belief. It seems to me that Dr. Sperry's statement can be understood in terms of natural law, in our classical terminology. This understanding, in turn, offers a basis for a more humane system in dealing with questions of survival.

Science is uniquely qualified to illumine that natural law that develops in terms of human experience. I wonder if the fusion or point of contact Dr. Sperry hopes for is not already present in the Catholic tradition: the concept of natural law may provide a basis for more creative interaction with the scientific community. It may also lay the groundwork for interaction with other world religions, since discussion of natural law does not threaten beliefs that flow out of revelation, out of the teachings of individual religious leaders.

DR. JAMES BLACHOWICZ: Our group spent considerable time discussing reductionism, the effort to treat phenomena at one level as explainable in terms of a lower level. We wondered if there are cases where reductionism does not apply that would be helpful in establishing the autonomy of religion and science. After all, there is no point in discussing the compatibility of religion and science if the two are not autonomous to begin with. Civil engineering is autonomous in that a bridge builder can do the job without knowing atomic physics. Some biologists assert most emphatically that biology is not reducible to chemistry. Is this sort of autonomy helpful in regard to the religion/science question? Granted that a phenotype may depend on a genotype, the genotype is also influenced by the phenotype. That is, genes are what they are because human beings

struggle in particular ways in particular environments. There is a kind of downward causation here as well. Are these reflections helpful for our discussion?

It would be helpful to get Dr. Dyson's and Dr. Wilson's reactions to reductionist thought. Is there any legitimate sense in which the data of their respective disciplines cannot be explained in terms of anything else? Can an ethical system's survival be explained by Darwinian principles and, yet, retain an autonomy that a Darwinian would recognize?

BISHOP MELCZEK: Let's hear first from Dr. Sperry, and then from Dr. Dyson and Dr. Wilson.

DR. SPERRY: Most biologists I know teach that biology is molecular and chemical, and they practice what they teach. I'm not sure from your statement whether you are agreeing or disagreeing with that.

DR. BLACHOWICZ: I would support a *de facto* autonomy on the part of biology, without getting into the theoretical question. A biologist can do all sorts of investigations in his or her discipline without having to know chemistry. The chemists in our group took a stronger stance, suggesting that biology is not even theoretically deducible from chemistry. There are emergent laws and principles, they say, that can't be deduced from chemical ones.

DR. SPERRY: Well, good for them. I doubt, though, that this is standard thinking, in general, among chemists. When it comes to relating chemistry to biology, I think we must all agree that to know the chemistry of something biological usually helps enormously for our understanding, prediction, and control. What is at issue are the kinds of conclusions to be drawn therefrom regarding the nature of the forces that control biology. Is the biosphere therefore controlled by the elemental forces of chemistry, or do the vital forces of life, society, and the human spirit have also to be recognized as causal realities in their own form, at their own level?

The situation in modern physics is more complicated, with the old mechanistic views of Newtonian physics being renounced on the basis of seemingly reductionist reasoning in which subatomic properties are extrapolated to "macro" Newtonian realms. I am not sure what physicists would say.

DR. DYSON: Physics contains a variety of diverse disciplines. For example, sciences such as geophysics and astrophysics examine things that are available to observation and that don't change a great deal over time. They deal with the past, especially geophysics. On

the other hand, there are sciences such as quantum mechanics that essentially deal with the future. When you discuss a quantum mechanical situation, you are always making probabilistic statements about the future. That is all quantum mechanics can do; you can't talk about the past in quantum mechanical language.

So, yes, there is a great deal of autonomy among the different branches of physics. And it is certainly not useful or fruitful to reduce geophysics to quantum mechanics even if it were possible, which I doubt. Reductionism isn't really an issue for the physicists. We moved beyond that a long time ago.

DR. WILSON: To coin a phrase, "Reductionism is the opiate of the scientist." The triumph of science has come largely through the reductionist enterprise. It has always been accompanied by resynthesis. The ideal of much scientific research has been to take a complex process, to crack it apart into its component units (not always the ultimate units of subatomic particles, but those at the next level of organization down), to characterize those units as real units in such a way that they can be recombined according to certain algorithms, and hence to explain more fully the level at which you started. Reductionism works extremely well as a methodology, especially if combined with a resynthesis that takes into account position effects.

On the other hand, reductionism fails as a philosophy, especially when defined strictly, as I suspect our chemist colleagues are doing. A strict reductionism holds that everything can be explained by simple reference to the constituent units studied on their own terms, without reference to the higher systems into which they can be assembled.

Dr. Sperry's presentation was on target, in my opinion, all the way through. But, I was somewhat puzzled by his use of words like *reductionism* and *materialism* and even *mentalism* in a fashion that evoked old wars and values. I would have benefitted from some concrete examples. If you will forgive me, Dr. Sperry, I will suggest one, just to show how the emergent explanation is beginning to take hold as part of cognitive science.

We have always thought of dreams as quite ethereal and intangible, yet, the physical equipment involved in producing one is incredibly complex. Let's glance at the phenomena that may be concatinated in the dream process to distinguish explanations that recognize higher organization and top-down control from mere reductionist explanations at the level of neurons. There are some-

where between ten and one hundred billion neurons in the brain, each of which has somewhere on the order of one to ten thousand neural connections. The brain is the most awesome concrete object of which we are aware in the whole universe. When you go to sleep, you shut down most of your sensory systems. You enter a REM period. At this point, long neurons in the brain stem fire upward into the cortical area, where are located immense numbers of neurons that form the seat of long-term memory.

Now, we are in a process that might be called "top-down organization." These long-term memory neurons are activated, and they feed imagery down into the short-term memory centers and the seats of consciousness. (Don't ask me to define this process precisely, but it is a mapping and scenario-making procedure that occurs with extreme rapidity.) The particular long-term memories involved, and hence the imagery they create, are affected by a number of things, including your emotional state, whether you had too much food the evening before, and so on. But, a large amount of random—or at least not easily explained—imagery appears in fragments. The mind has an extraordinary capacity to make stories. This is what consciousness is all about, a constant scenario building back and forth through time. The stories will make a certain amount of sense, and they will involve certain feelings. The mind flashes through a story, a reconstruction of reality.

The full biological meaning of the dream and its adaptive significance are not fully understood. Reductionist scientists feel, however, that we can explain the dream state, which has such an extraordinary importance for culture and human feeling, ultimately at the neuronal level. The reductionist hopes to discover reality by explicating the cell biology of the neurons. Dr. Sperry maintains, and I agree, that you cannot begin to understand something like dream imagery simply by cataloging and studying all the neurons. You have to understand the hierarchic control, this feed-down from a higher to a lower level.

Forgive this long-winded account. I may have scandalized Dr. Sperry and others who know neurobiology better than I do. I wanted to try to reconcile the validity of reductionist methodology with the new holistic, cognitive mode of assembling information and recreating patterns.

DR. SPERRY: Sociobiology seems also to have undergone a conversion. It is good news indeed to learn of this potential support for top-down control. Such views are still far outweighed in science

at large by traditional "micro" reasoning and much in need of any support that arises.

I think the issue of reductionism is very much alive, even in physics, at least in reference to quantum mechanics. When quantum mechanics came along and proved to be superior to classical physical theory for subatomic phenomena, there was a natural sweeping out of the old in favor of the new. The idea took hold that quantum theory subsumes, includes, and replaces classical theory, a conclusion that antireductionist thinking would oppose. Most physicists still make this argument very strongly, pointing to mathematical equations. I suspect, however, that these equations also reflect classical physics. They contain functions that, if reduced to zero, permit the equation to work for classical physics. But, this eliminates quantum theory. Both theories work, but at different levels.

FR. MCMULLIN: Reductionism has been at the center of philosophic discussion for quite a long time. Let me go back to the seventeenth century for a moment. Descartes proposed a physics where all action is the result of contact between bodies, push and pull. No other form of action is permitted. That is, obviously, a highly reductionist scheme; gravitational attraction over distance is eliminated, for example. Descartes rejected gravity because he thought direct contact could handle everything, even the movement of the planets. Newton had to oppose this simplistic physics in favor of a richer notion.

In the nineteenth century, there was a great deal of interest in how color reveals itself in terms of optical frequencies. It became clear that Newtonian mechanics was insufficient to explain a very basic feature of our world, namely, color. A long sequence of events between the 1860s and the 1920s led to a new mechanics that used quantum notions that did not appear in the older physics. To explain color, you need quantum mechanics.

Dr. Wilson spoke of methodological reductionism. You can take a theory such as Descartes' "action by direct contact" or Newton's "gravitation" and you push it as far as it will go. Yet, there is a different, stronger kind of ontological reductionism that claims that only certain kinds of entity exist and that all things are theoretically explainable in terms of these entities.

This stronger reductionism, which is a form of faith, is relatively harmless as long as all it does is deceive the scientist into pushing his method too far. It is a very dangerous thing from a philosophic standpoint, however. It narrows the frame of reference. When a

reductionist scheme fails because it has failed to take into account phenomena such as gravitational effects or color, what characteristically happens is that some property is attributed to the fundamental or lower-level entities that would not have been known except by studying their aggregate effects. For example, the only way we recognize gravitation is by examining an entire system. You could look at a single object all your life and not know it gravitates. Likewise, you could look at an electron all your life and not know anything about color. We discover certain kinds of properties only when they are evoked in the context of an aggregate or larger system.

Dr. Wilson, those who have read your classic work on human nature could easily suppose that you propose a reductionist scheme. You seem to argue that sociobiology, in principle, can explain anything, even ethical and religious beliefs. One of the strongest points in your presentation had to do with incest taboos. You took a relatively universal behavior common to a variety of religions and cultures and offered a genetic explanation for it. Yet, if one considers the diversity of cultures or the diversity of religions such as Islam and Christianity, it seems quite impossible to reduce their different value systems to something genetic. Since Christians and Moslems are not genetically diverse, one cannot explain their religious diversity genetically.

It makes sense to me to push sociobiology as a methodology as hard as you can. You will get some very nice things out of it. At the same time, if you make a more substantive claim. . . . But, perhaps you have moved from the stance you took on this matter in the 1970s.

Dr. Sperry's approach to consciousness is reminiscent of Michael Polanyi's. In *Personal Knowledge* and other works in the 1950s and 1960s, Polanyi constructed a hierarchical account of the natural world in terms of levels of activity culminating in consciousness. Polanyi, a very distinguished physical chemist turned philosopher, developed the notion of downward as well as upward causation. His attempt to work it out is worthy of attention, though not altogether satisfactory.

As I read Dr. Sperry's paper, his contribution to the broader discussion of religion and science can be taken either in a weaker or a stronger sense. The weaker sense is the assertion that your work has broken down an older form of determinism and reductionism that seemed incompatible with religious views. But, there

is a stronger claim implicit in what Dr. Sperry is saying. If scientific and religious views are to be fused, and if the evidence of religion has got to be acceptable to the scientist, then God, insofar as he can appear in the natural system at all, is simply the upper state of that system. This is an entirely immanentist or pantheist view. Viewed from this perspective, your contribution to the cause of religion is that you have made that kind of God more plausible. You note in your paper that the separation of creation and creator must be ruled out. This is an important restriction from the theological standpoint. The notion of God that you are proposing is that of a higher level within nature itself.

DR. SPERRY: Let me begin with your last item, Fr. McMullin. I would think that in the eyes of science the creator or creative force system must exist at all levels. It is an evolving, hierarchic, multiform, multicomplex, multinested, much more sophisticated entity than the usual image would imply. But, the new outlook does give primacy to the higher over the lower level controls.

You are right that Polanyi expressed very similar ideas, as did Lloyd Morgan and Jan Smuts before him and W. E. Ritter before them. These emergent views go way back, but their status up through the early 1960s remained that of scattered, individual, occasional, minority philosophy. This is why I emphasized that I am speaking today not from the position of personal philosophy but from that of mainstream psychology. For the first time, a whole scientific discipline has espoused this sort of outlook. It is interesting to speculate what caused this change from relatively obscure minority philosophy to the dominant practicing paradigm of the behavioral sciences.

I believe that behavioral science, though as yet unaware of it, is leading the way toward a more valid paradigm for all science. I see in this no quarrel with microdeterminism as such, and, of course, everyone agrees that reductionism is still fine as methodology. When you come, however, to interpretations, to the building of world views, to deriving moral values, then the macrodeterminist principles have to be taken into account. They do not replace but supplement and/or complement microdeterminism and reductionism.

DR. WILSON: Fr. McMullin is right in saying that in the 1970s, when I was trying to develop a sense of where sociobiology would go, I was very optimistic in my writings about the possibility of a total reductionistic explanation of all phenomena. But, I never