

## An Influence in Psychobiology

### Brain Circuits and Functions of the Mind.

Essays in Honor of Roger W. Sperry. COLWYN TREVARTHEN, Ed. Cambridge University Press, New York, 1990. xxviii, 410 pp., illus. \$69.50; paper, \$37.50.

In the last century no one has contributed more to our understanding of the development and cognitive functions of the brain than Roger W. Sperry (emeritus professor of psychobiology at the California Institute of Technology). Beyond science, the impact of Sperry's work on popular culture today seems more widespread than that of any other psychologist since Freud and any other biologist since Darwin.

Sperry has been concerned with three major issues about the brain and behavior. The first of these is how, during development, the sense organs make specific connections with the brain and the brain makes specific connections with muscles. The second is how movements are centrally controlled and how the processing of sensory information is adjusted for the organism's own movements. The third issue is the role of the connections between the cerebral hemispheres and what cutting them can reveal about the functions of each hemisphere. These "split-brain" studies provided powerful tools for studying cognitive functions of the brain, captured the popular imagination, and were the basis for Sperry's being awarded the Nobel Prize in 1981. Many would argue that the earlier work on the development of neural connections deserved a Nobel as well. For Sperry these three interests are closely integrated and have led to his current major concern, the interaction between consciousness and brain matter.

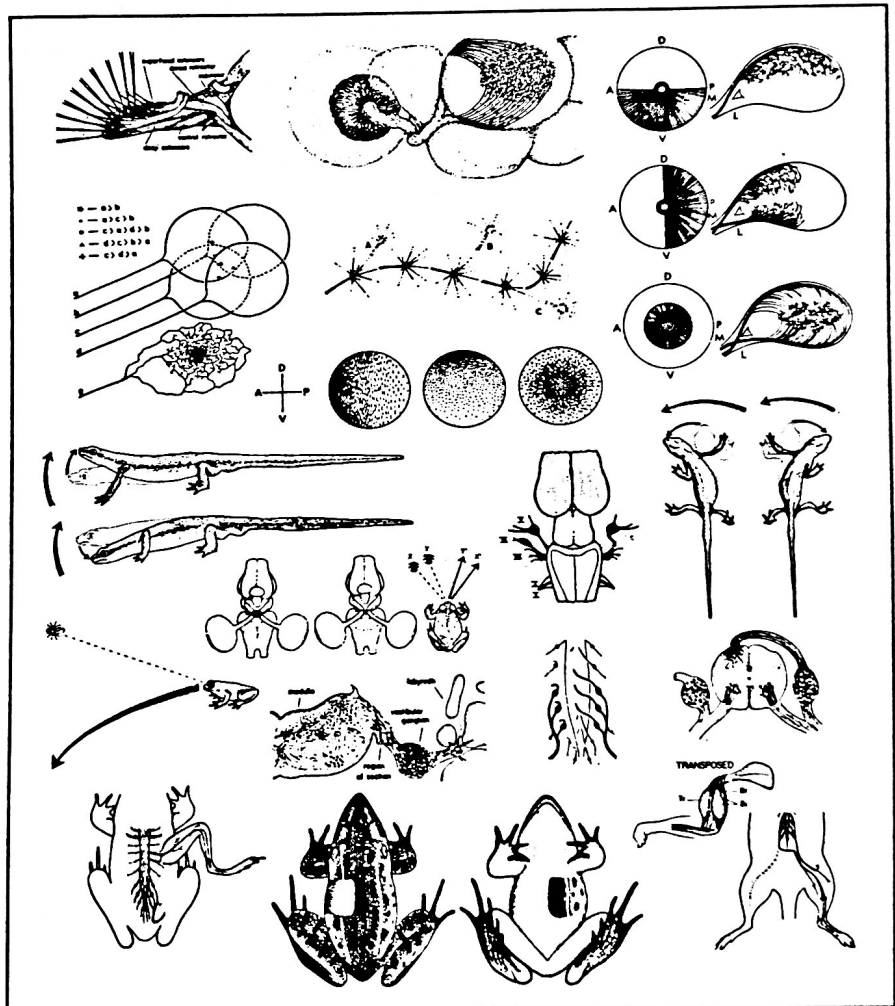
Many of Sperry's experiments have all the hallmarks of truly great science. Before they were carried out the rationale behind them often seemed unclear. For example, on hearing of the plans for a now classic experiment, a colleague asked, "Why are you cutting the optic nerve of that newt and twisting its eye in the socket?" Afterward, the far-reaching implications of Sperry's experiments usually became obvious. The results of this 1943 eye of newt experiment overturned the em-

bryological wisdom of the day (that experience plays a major role in the development of neural connections), set the central question for the next 50 years of developmental neuroscience (how do growing neurons find their targets?), provided the most widely used preparation for answering it (the connections between the retina and optic tectum), and offered what is still the best answer (chemoaffinity, the idea that biochemical specification of growing axons is

crucial in leading them to their specific targets). V27  
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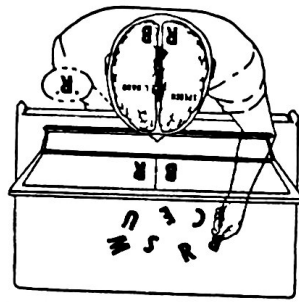
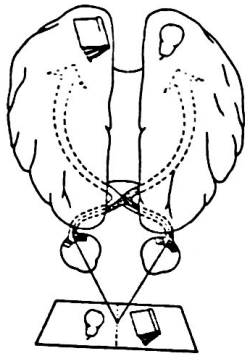
*Brain Circuits and the Functions of the Mind*, edited by Colwyn Trevarthen, a former student and long-time collaborator, is a festschrift for Sperry. It is an unusually fine job in several ways. First, each of the 23 contributions is closely related to Sperry's own work rather than simply describing the author's latest research. This reflects both the persisting influence of Sperry and the desire of the editor and authors to celebrate this influence. Second, the volume is enriched by several contributions from eminent neuroscientists who were not Sperry's actual collaborators. A third and unusual touch is starting each section with a composite of figures from Sperry's papers, many of which also grace introductory psychology and biology textbooks and form part of the iconography of modern neuroscience.

Trevarthen's preface provides an overview of Sperry's career and contributions. Evarts's



Composite figure made from illustrations in Roger W. Sperry's papers on specification of nerve connections. [From *Brain Circuits and Functions of the Mind*]

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Illustrations from Roger W. Sperry's papers on split-brain patients. [From *Brain Circuits and Functions of the Mind*]

foreword shows the intimate connections among the different strands of Sperry's work. The chapters by Levi-Montalcini (a Nobel laureate herself), by Hunt and Cowan, and by Zangwill and Wyke place Sperry's achievements in their historical context. Berlucchi and Antonini review how the corpus callosum, which connects the two hemispheres, brings a representation of both visual fields to each hemisphere as Sperry had predicted it should. Glickstein shows how the cerebellum may provide for the bimanual coordination that Sperry and his students found to survive section of the corpus callosum in their early split-brain studies on monkeys. The papers by Mishkin and Phillips and by Milner, Taylor, and Jones-Gotman each demonstrate the power of Sperry's methodology in revealing brain mechanisms of attention, imagery, and memory. Levy argues for the role of unilateral activation in the functional specialization of the hemispheres. Trevarthen draws on many aspects of Sperry's work, as well as work described by several of the other authors, in his discussion of the development of language and communication in the human infant. The final chapter is a 1977 article by Sperry himself that provides an account of his human split-brain work from its beginning and how it led to his current interest in the reciprocal interactions of mind and matter.

Although most of the papers by Sperry's former collaborators begin or end with hagiographic incantations of how much the authors were taught, inspired, and influenced by Sperry, there is a paucity of description or even anecdotes about how he accomplished this—about what actually went on in Sperry's lab.

Another curious lacuna is the reluctance of any contributor to comment on the tremendous impact that Sperry's split-brain research has had on the contents of popular magazines, talk shows, New Age bookstores, and even how we talk about one another as being "right- or left-brained." Although much of this pop spin-off has little

support in the research of Sperry or others in the field, it would seem valuable to look into the contemporary Manichaeism of right and left that this work has spawned, however illegitimately. Why is science put in the left hemisphere along with such supposedly "bad" things as logic, linearity, and "Western thinking," whereas the right hemisphere is associated with "good" things such as creativity, intuition, and art? Now that we have this superb account of Sperry's science, it would be valuable to examine the sociology of its popular impact.

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Hunt and Cowan acknowledge that Sperry's work on hemispheric specialization and the implications for consciousness will probably remain as his major contribution to science. However, they want to assure that his fundamental contributions to developmental biology and neuroembryology in particular are not obscured. They show how Sperry's ingenious experiments on regeneration of nerve connections and bold conceptual advance provided by his chemoaffinity hypothesis completely revolutionized neuroembryology. Their lengthy but scholarly chapter goes back to the emergence of neuroscience as a cellular discipline in the 1880's and progresses to encompass Sperry's thoughts and experimental forays into the mechanical development of nerve fibers and to chemoaffinity which revealed the "marvelous power which enables nerve fibers from very distant cells to make contact directly with certain other nerve cells .... without going astray or taking a roundabout course". Hunt and Cowan have indeed provided a monograph on the history of neuroscience with current concepts and theories in neuroembryology which should be read by every student of neuroscience.

Other high-points of this volume include the chapter by Trevarthen, who spent much time with Sperry. Trevarthen presents data on the growth and education of the hemispheres based on more than 20 years of study of the communications of infants and toddlers, defining the stages of human biology. In evaluating this work, Trevarthen incorporates his findings from "split-brain" animals and humans. He feels that hemispheric asymmetry begins in utero and that with the ability to psychologically adapt, infants and children can learn language and other skills of culture by communicating with parents, peers, and teachers. He affords us his vision of a new approach to the transmission of culture through brain growth. Complementing Trevarthen's chapter is that by Nebes on the effects of aging on hemispheric specialization. Nebes' explorations of the decline of selective spatial disability and lateral asymmetry in the aging brain have raised new questions about long-held notions of the deterioration in the aging brain.

The final paper of the series is the one by Sperry, previously published in 1977, which presents his ideas on the nature of consciousness and its regulatory role in brain function. By including this paper, Trevarthen felt it to serve as "an elegant bridge" from the laboratory tests of divided consciousness to the more philosophical arguments that draw on a wider stream of evidence. It is included in the hope of satisfying any skeptics of the scientific soundness of the basis for Sperry's bold and original interpretations of the nature of human cognition.

As I reviewed this series of papers and its documentation of the development of neuroscience two omissions became evident. First, I wonder why the work of Gazzaniga was not included here. Gazzaniga, as particularly noted by Trevarthen, was the first of Sperry's graduate students to carry out experiments with human commissurotomy patients. The process by which research techniques used with monkeys and cats were extended to human subjects as well as the results of the "first" of such classic findings would have been of considerable importance and interest in this volume.

The second omission concerns the early history of the split-brain preparation which may have helped to stimulate Sperry's ideas. During 1917-1926, studies were reported from Pavlov's laboratory on interhemispheric "irradiation" in normal and in callosal-sectioned dogs. Krasnagorski (cited by Anrep, 1917) and Rozental (1923) conditioned responses in dogs to tactile stimulation of a point on one side of the body. Contralateral transfer ("irradiation") of the somesthetic CR was obtained by stimulation of the corresponding point on the opposite side of the body. The notion of splitting the brain through midsagittal section of the corpus callosum in order to restrict unilateral somesthetic input to one hemisphere appeared to offer a unique approach to investigate interhemispheric transfer ("irradiation"). In additional experiments in dogs (Bykov and Speranski, 1924), callosal section abolished transfer of the conditioned somesthetic response from one side of the body to the same point on the opposite side. Two symmetrical skin areas in dogs could be easily differentiated after callosal section in contrast to normal dogs (Bykov, 1924; Pavlov, 1926). These findings appear to be the first reported observations of interhemispheric transfer and its abolition by callosal section as well as to demonstrate a critical role for the corpus callosum. Inclusion of these early findings would have helped to complete the history of the "split-brain" preparation.

This distinguished collection of essays will serve as important documentation of the history of the development of neuroscience. It will be of interest and concern to teachers and researchers of neuroscience and to students of neuroscience. It will also receive the attention of historians and philosophers of science for this volume is also a story of the progress of science through the practice of science by one of the foremost scientists of our genre across a span of some 50 years.

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**BRAIN CIRCUITS AND FUNCTIONS OF THE MIND: Essays in Honor of Roger W. Sperry.** (Edited by Colwyn Trevarthen). ISBN: 0-521-26102-3, (hardcover, \$84.95); 0-521 37874-5 (paperback, \$42.95); Cambridge University Press, New York. 1990.

While a graduate student at the University of Pennsylvania, I was fascinated by Myers and Sperry's "split-brain" studies and consequently chose an aspect of interhemispheric transfer in "split-brain" cats as my dissertation topic. At that time, I was fortunate enough to meet with Roger Sperry and discuss some concepts of interhemispheric interaction. I was to spend the next ten years working with "split-brain" cats, eventually directing my activities toward early development of hemispheric function. I shall always be grateful to Professor Sperry for providing such an important impetus for so much of my work as well as for many of my convictions in neuroscience. So, I am especially pleased to have been asked to review this collection of essays honoring a scientist who had such a profound influence on my early research career.

Editor Colwyn Trevarthen has assembled an elegant series of papers. The collection consists of twenty one chapters, a Forward by the late Edward Evarts, a Preface by Colwyn Trevarthen, a list of every student and associate who worked with Sperry and a complete bibliography of Sperry's research from 1939-1988. The volume closes reprinting Sperry's 1977 paper, "Forebrain Commissurotomy and Conscious Awareness". This collection goes far beyond Sperry's renowned "split-brain" studies. It is the story of the beginning of neuroscience - from invertebrate cells and chemoaffinity to brain circuits and cognition and then to consciousness and philosophy.

Most of the essayists had some association with Sperry commonly actually working in his laboratory at California Institute of Technology. They are affectionately referred to as "Caltechers". Showing the influence by Sperry, usually at the beginning of their careers, the essays are a statement of the evolution of their research interests founded on that early association. All the papers are research oriented. The authors have either summarized their past scientific findings or give experimental details, results, and implications of their ongoing research. In addition to describing research resulting from their association with Sperry, these authors also furnish details of the "person" of Sperry as he guided their scientific thinking and judgement and established a basis for their life work.

The volume is divided into three chronological sections. Section I. is on Specification of Behavioral Nerve Networks in Invertebrates. The theme of these first five chapters represents Sperry's early work in developing his chemoaffinity hypothesis. In the first chapter Rita Levi-Montalcini describes her recollections of a young Sperry when she first met him at a meeting organized by Paul Weiss in 1949. The chapter by Hunt and Cowan provides the antecedents of neuroscience that led to Sperry's experiments in chemoaffinity. Remaining chapters in this section include details of neurobiological research on retinotectal connections all based on Sperry's chemoaffinity hypothesis.

Section II, Split-Brain Studies of Perception, Motor Coordination, and Learning in Cats and Monkeys, and Comparisons to Humans, starts with the now historic report of the failure of interhemispheric transfer of learning in "split-brain" cats by Myers and Sperry in 1953. The papers in this section review and detail the vigorous research and broad range of questions that Sperry, his students, and his associates explored about perception, learning, and motor coordination in the disconnected mammalian brain. These papers range from that of Berlucchi and Antonini on the mechanism by which the two halves of information are brought together in the cortical visual system with techniques learned in Sperry's laboratory to that of Preilowski's studies of handedness in commissurotomy monkeys and man which suggest that evolutionary pressures can influence cerebral asymmetry in different species.

Section III, Cerebral Hemispheres and Human Consciousness, reviews experiments carried out with human commissurotomy patients to define the level of consciousness and language and other types of expression (e.g., emotion) of the right hemisphere. These studies also address the issue of divided consciousness and self-awareness, and the basis of coordination of action on the whole body. Individual papers describe experimental procedures designed to explore right hemisphere function as well as to define hemispheric independence, perception and memory, and the neurobiological basis of hemisphericity. Zangwill and Wyke review Hughlings Jackson's historical concepts of hemispheric function. The paper by Milner, Taylor, and Jones-Gotman describes case studies conducted with commissurotomy patients to answer specific questions about human temporal lobe function. Finally, Trevarthen addresses growth and education in the hemispheres and Nebes details his findings on hemispheric specialization in the aging brain. The volume concludes with Sperry's 1977 paper.

Several papers highlight this excellent collection. In the chapter on the chemoaffinity hypothesis,



Hunt and Cowan acknowledge that Sperry's work on hemispheric specialization and the implications for consciousness will probably remain as his major contribution to science. However, they want to assure that his fundamental contributions to developmental biology and neuroembryology in particular are not obscured. They show how Sperry's ingenious experiments on regeneration of nerve connections and bold conceptual advance provided by his chemoaffinity hypothesis completely revolutionized neuroembryology. Their lengthy but scholarly chapter goes back to the emergence of neuroscience as a cellular discipline in the 1880's and progresses to encompass Sperry's thoughts and experimental forays into the mechanical development of nerve fibers and to chemoaffinity which revealed the "marvelous power which enables nerve fibers from very distant cells to make contact directly with certain other nerve cells .... without going astray or taking a roundabout course". Hunt and Cowan have indeed provided a monograph on the history of neuroscience with current concepts and theories in neuroembryology which should be read by every student of neuroscience.

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and Behavioral Research. Splicing Life: The Social and Ethical Issues of Genetic Engineering with Human Beings. Washington: President's Commission, 1982 [Superintendent of Documents, USGPO, Washington, DC 20402]. \$5.00; Stock No. 040-000-00464-5.

The social and ethical matters discussed by the Commission include concern about monsters like Frankenstein's, "playing God," the impact of rapidly developing technology, the potential for the relief of human suffering, and laboratory safety. The Commission recommends that research in gene splicing be independent of federal funding and be monitored by a widely diverse oversight body.

**Public Responsibility in Medicine and Research.** Privacy and Confidentiality: Can They Be Protected? Boston: PRIM&R, 1982 [PRIM&R, 15 Court Square, Suite 340, Boston, MA 02108]. \$17.00.

PRIM&R's seventh volume is a report of an October 1981 conference in Boston on issues in privacy and confidentiality. Topics include privacy in research; special problems of minors and the mentally ill; privacy for institutions, for individuals, and for patients' records; and methods or technologies for guaranteeing confidentiality. The appendix contains material on the Freedom of Information Act, NIH Guide to requirements of the Privacy Act of 1974, and further commentaries on ways to insure privacy.

**Rhoden, Nancy K.** "The Limits of Liberty: Deinstitutionalization, Homelessness, and Libertarian Theory." *Emory Law Journal* 31(2) (Spring 1982), 375-440 [N. Rhoden, Assistant Professor, Ohio State University School of Law, Columbus, OH 43210].

Rhoden examines the beliefs that lead to deinstitutionalization, and its consequences upon released patients. She attributes some of the failures of deinstitutionalization to the "theoretical biases" of its advocates who have overlooked or underestimated the role of community facilities in accommodating released patients.

**Robitscher, Jonas; and Haynes, Andrew Ky.** "In Defense of the Insanity Defense." *Emory Law Journal* 31(1) (Winter 1982), 9-60 [A. K. Haynes, Emory University School of Law, Atlanta, GA 30322].

The authors argue that there is a constitutional right to plead insanity, and that the judicial system must be reformed to better accommodate the insanity defense. Misuse of the insanity defense could be curbed, they argue, if the courts "combine a broader use of the doctrine of diminished responsibility with a more circumspect use of the traditional concepts of criminal responsibility."

**Sen, Amartya; and Williams, Bernard, editors.** *Utilitarianism and Beyond.* New York: Cambridge University Press, 1982. \$37.50.

This volume consists of seven original essays and two reprints, which address utilitarianism both as a theory of moral and political philosophy

Reprints of articles cited in "In the Literature" are not available from the *Hastings Center Report*. Reprints are frequently available from the author or journal. When known, the address of the author is given in brackets at the end of article citations. Journal addresses are marked with an (\*). Prices of books are given whenever possible.

phy and as a theory of social choice. Contributors include Amy Gutmann, R.M. Hare, John Rawls, and T.M. Scanlon.

**Shapiro, Robyn.** "Medical Treatment of Defective Newborns: An Answer to the 'Baby Doe' Dilemma." *Harvard Journal of Legislation* 20(137) (1983), 137-52 [R. Shapiro, Assistant Adjunct Professor, Marquette University Law School, Milwaukee, WI 53233].

The author discusses judicial decisions that bear upon the right of competent and incompetent adults to refuse medical treatment. She contrasts this situation with the withholding of treatment from handicapped newborns, and proposes model legislation that would help physicians and parents make more informed decisions regarding the care of such children.

**Sider, Roger C.; and Clements, Colleen.** "Psychiatry's Contribution to Medical Ethics Education." *American Journal of Psychiatry* 139 (April 1982), 498-501 [R.C. Sider, Department of Psychiatry, University of Rochester School of Medicine and Dentistry, 300 Crittenden Blvd., Rochester, NY 14642].

According to Sider and Clements, though psychiatry has traditionally been excluded from the teaching of medical ethics, it has a unique potential to enlighten and inform due to its biopsychosocial awareness of (1) the place of affective components; (2) the dynamics of moral development; and (3) the impact of the socialization process experienced by medical students.

*Soviet Studies in Philosophy* 21 (2) (Fall 1982) [M.E. Sharpe, Inc., 80 Business Park Drive, Armonk, NY 10504].

This volume is titled *Ethics and Morality Studies: A Soviet Discussion*. It includes a lead essay by V.T. Efimov called "Polemical Notes on Ethics and Morality Studies," and five commentaries.

✓ **Sperry, Roger.** *Science and Moral Priority.* New York: Columbia University Press, 1983. \$16.95.

Sperry, a psychobiologist and Nobel laureate, argues that a union of science and moral values is supported by developments in brain research and is humanistically required. The essays in this volume were written over a period of sixteen years.

**Stinson, Robert; and Stinson, Peggy.** *The Long Dying of Baby Andrew.* Boston: Little, Brown and Company, 1983. \$16.50.

This is a personal account in journal form of the birth and death of a highly premature infant. A short version of the story, which raises questions about quality of life, truth-telling, consent, medical bureaucracy, responsibility for decision making, health care costs, aggressive intervention, and prolongation of dying, appeared in a 1979 article in *Atlantic Monthly*.

**Suber, Daniel G.; and Tabor, William J.** "Withholding of Life-Sustaining Treatment From the Terminally Ill, Incompetent Patient: Who Decides?" Parts I and II. *Journal of the American Medical Association* 248 (November 12 and 19, 1982) 2250-51, 2431-32 [Office of the General Counsel, American Medical Association, 535 N. Dearborn St., Chicago, IL 60610].

The authors discuss the *Quinlan*, *Saikewicz*, *Eichner*, and *Spring* cases, among others, and describe the various ways a decision to withhold treatment was supported. They conclude that physicians must be guided in their decisions to withhold treatment by hospital policies, criteria developed by the courts, and (when they exist) hospital committee review procedures.

**Thompson, Dennis.** "Ascribing Responsibility to Advisers in Government." *Ethics* 93(3) (April 1983) 546-60 [D. Thompson, Department of Politics, Princeton University, Princeton, NJ 08540].

Thompson focuses upon the moral responsibility of government advisers in order to enrich the general debate over the moral responsibility of public officials. He extracts criteria that could adequately be used to ascribe responsibility to advisers from three traditional ways of analyzing this problem—causality, intention, and requirements of the official role.

**Vatz, Richard E., and Weinberg, Lee S., editors.** *Thomas Szasz: Primary Values and Major Contentions.* Buffalo: Prometheus Books, 1983. \$18.95; \$9.95 paper.

This handbook, which includes a complete bibliography of Szasz's works, provides for the student Szasz's views, values, and arguments plus both sides of the debate generated by his position that mental illness is a myth.

**Walzer, Michael.** *Spheres of Justice: A Defense of Pluralism and Equality.* New York: Basic Books, 1983. \$19.95.

Walzer's purpose is "to describe a society where no social good serves or can serve as a means of domination." By examining the "materials" that our society creates and distributes, such as education, free time, political power, security and welfare, money, and love, he attempts to articulate an account of distributive justice that would lead to a society that is equal, diverse, and free from domination.

Marna Howarth  
and Eric Feldman

# Kunskap om hjärnan

## tvingar fram nya värdesystem

Om en värld från yttre fysik skulle bestå av en enda enhet, skulle den höligen rätt snart kunna sä-

la finger på den punkt som är den grundläggande orsaken till alla våra konflikter och svårigheter. Mänskans värderingar, Samtidigt som den moderna människan tillgripit sig gudalika krafter för att kontrollera naturen - eller upphäva den - är hon försedd med värderingar som har sina rötter i ständigt flytande och förändringsbara värderingar. Med dessa värderingar försöker vi att skapa en värld som grunder sig på inbillningar, fantasier, önskelöskande och intuition. Rymdsvaret skulle - uppenbarligen - rekommendera oss att ändra vårt värdesystem så att det bättre överensstämmer med de krafter och de problem som präglar dagens värld.

Med denna bild av människans situation inleder hjärnforskaren Roger Sperry (Nobelpris 1981) sin bok Science and Moral Priority, Merging Mind, Brain and Human Values. Han menar att hjärnforskningen kommer att tvinga fram en omprövning av de värderingar, filosofier, religiösa doktriner, världsmoder och värdesystem som människans åttioåriga historia har utvecklat.

De senaste tolv åren har hjärnforskningen ledd till en ny syn på människan och hennes värderingar, hävdar Sperry. Kyftan mellan vetenskap och moral, som varit så framträdande under de senaste årtionden, kan enligt honom försvinnat. Vetenskapen kan nu formulera en värdeorientering som kan ligga, grunden till en bättre värld.

De två inom hjärnforskningen som Sperry återkommer till i boken är hjärnans fysikaliska och hjärnans psykiska funktioner. Sperry hävdar att hjärnans fysikaliska funktioner är de som styr våra värderingar, medan hjärnans psykiska funktioner är de som styr våra handlingar.

Sperry är alltså inte materialist, utan han är en dualist. Han tror på två olika världar: en fysikalisk värld och en psykisk värld. Han tror att hjärnans fysikaliska funktioner är de som styr våra värderingar, medan hjärnans psykiska funktioner är de som styr våra handlingar.

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en ny bok

Roger Sperry  
Science and Moral Priority,  
Merging Mind, Brain and  
Human Values  
Columbia University Press,  
New York

### Växelvärden mellan medvetande o. materia

Detta bokstycke och växelvärdet mellan medvetande och materia är ett av de mest intressanta i Sperrys bok. Han diskuterar här de olika sätt på vilka medvetande och materia påverkar varandra.

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### En ständigt växande tvivel mellan medvetande och materia

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### Hierarkiskt värdesystem

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Knowledge about the brain forces us toward a new system of values

If a being from outer space were to visit earth, it would probably be able to put its finger quite rapidly on the point that is the main cause of all our conflicts and weaknesses: man's (human) values. At the same time as modern man has acquired God-like powers to control nature - or destroy it - he is supplied with values that have their roots in the stone age: myths and acts of faith, interspersed with convenient ideologies that are based on imagination, fantasies, wishful thinking and intuition. The outer space visitor would obviously recommend that we change our system of values so as to better conform with the powers and problems that beset today's world.

Brain researcher  
(Roger Sperry (Nobel Prize 1981) begins his book "Science and Moral Priority, Merging Mind, Brain and Human Values" with this picture of man's situation. He believes that brain research should force a re-examination of the ideologies, philosophies, religious doctrines, world models and values systems that man has formulated up to now.

The most recent observations in brain research lead to a new outlook on man and his evaluations, Sperry asserts. The separation between science and morals, which has been so conspicuous during the last decade, can finally be bridged. Science can now formulate a hierarchy of values that can be the basis for a better world.

The experience in brain research that Sperry is citing is the following. Neuroscience has laid forth convincing evidence that man's mental consciousness is inseparably united with the living brain. The union takes place via a hierarchical control system. Neurons (brain cells) in connection with other neurons form a circuit where they mutually control each other. This circuit forms an entity on a level that is superior to the individual neurons. This circuit is joined to other circuits ? ? ?

This complicated system of circuits has holistic properties, that is to say, qualities that the individual parts do not have. These holistic properties are what we call mental, psychic processes.

Interaction between consciousness and matter.

The biophysical and electrochemical traffic between brain cells is governed by a superior mental system that decides which orbits shall be opened and closed to release a new thought, a new feeling, a new object of the attention.

Thus, consciousness arises (emerges) from material processes but can not be identified by material processes. A perpetual exchange (interaction) takes place between the consciousness and neural processes. Sperry calls this theory "emergent interactionism".

Consequently, Sperry is not a materialist and therefore not an adherent of the identity theory according to which every conscious process is identical with some physical process in the brain. Neither does he consider himself a dualist in the classical meaning - like Descartes, the dualist distinguishes between the bodily (material) and the psychic (soul) substances. Sperry distances himself from the theory of the modern dualist, John Eccles, that consciousness is an independent unit which is connected with modules in the brain. A module is an integrated collection of about ten thousand nerve cells. Sperry calls himself a mentalist.

Sperry's opinion is that this new holistic - mentalistic - paradigm implies a new view of man and should form the basis for a scientific construction of a value system. Since both materialism and dualism must ..... teachings that are based on these theories are thus rejected: communism with its materialistic view of history and its narrow perspective of class struggle, likewise the religious teachings that draw sharp separation between body and soul and in whose name bloody wars have been - and are still - fought.

According to Sperry we must use scientific methods to formulate value judgements, that is we must check that our inner "articles of faith" are in agreement with external reality. This excludes judgements based on conceptions of supranatural phenomena, mystical insights, revelations or undemonstrated hypotheses concerning economy and class-struggle, no matter how attractive they may look. These scientific standards obviously limit the judgements, but give it at the same time, a strength. Guidelines obtained in this way are more reliable since they are not based on subjective conceptions.

#### A hierarchic system of values.

Earlier value systems have been based either on man the measure of all things or on God-oriented myths. The conditions of today require more long-sighted biospherical perspectives, where the respect for the laws of nature includes the forces that govern the universe and that shaped man, and where special attention is given to protecting and fostering development in our own biosphere.

Sperry imagines a value system which, like the brain, is constructed in a hierarchical fashion. The highest good is everything that fits in and fosters the cosmic pattern (the Grand Design) that governs and controls everything from the subnuclear particles to the galaxies. Anything that damages and disturbs these shaping forces, that is to say the quality of life, ought to be considered as in error and evil.

All decisions imply a choice between evaluations. Each brain interprets and elaborates the same information in completely different ways, depending on the value system that molds the brain. What an individual or a society values determines in general its actions.

It should be possible, according to Sperry, to formulate a scale of values on scientific grounds, that could be accepted internationally. This value scale should be applied in practical worldly questions and therefore does not have to be in conflict with traditional metaphysical articles of faith to which people feel attached and which they desire to maintain.

In Sperry's view, his theory on emergent interactionism explains the development from inanimate matter to consciousness. But, one asks oneself, where is the border between subjective mental conditions and objective material processes? Or is this question based on the old dualistic conceptions and in reality irrelevant? In any case there are a number of obscure points in Sperry's mentalistic paradigm and thus the philosophical construction does not rest on completely solid ground.

#### Man free.

To get the international community to accept a value system based on scientific judgements should not in itself be impossible - already the United Nations charter contains a similar value system - but the difficulty obviously is to get the solemn formulations applied in practice. The war between Iran and Irak or the fighting in Beirut defies all common sense. Nevertheless, they can go on year after year fired by religious fanaticism and glowing passions which appear completely incomprehensible to the outsider. In a homogeneous country like Sweden, all the citizens share the same values to a high degree.

But every day, conflicts between different groups and individuals, even within a circle as narrow as the family, show how fast different interests and priorities can come out in the open and how difficult it is to agree on acceptable compromises.

Science may give a new point of view of man, but the question is whether man succeeds to look upon himself with science's objective clarity when his own close-lying interests are at risk. Which values he will give priority to depends on his degree of maturity and on the perspectives he is able to lay out - even here one finds therefore a hierarchic scale.

Sperry is conscious of this. His model allows man a high degree of freedom from exterior forces and gives him the possibility of determining in a rather free way what he will do. But freedom is relative, man cannot liberate himself from the higher forces of his own decision machinery. He cannot set himself free from the combined effects of his own thoughts, impulses, feelings, articles of faith, ideals and hopes, and neither from his own heredity and recollections. These factors, including subconscious desires, affect his decisions.