Leftness and Rightness

The Psychology of Left and Right. MICHAEL C. CORBALLIS and IVAN L. BEALE. Erlbaum, Hillsdale, N.J., 1976 (distributor, Halsted [Wiley] New York). xii, 228 pp., illus. $14.95.

Symmetry, especially bisymmetry, fascinates. There have been excellent books on the perception of symmetry, confusion of left and right, and symmetry in mathematics, physics, chemistry, and biochemistry, in animal and plant form, and in art. The subject has interested famous scientists and philosophers, including Descartes, Pascal, Goethe, Mach, and Pasteur (but excluding Leonardo, who was left-handed and who, in his meticulous mirror-writing notes, conspicuously fails to comment on symmetry).

Now, we possess entirely new data about relevant brain anatomy and about the genesis of human awareness of bilateral symmetry and its converse, consistent lateral asymmetry. Evidence on the complementary mentalities of left and right hemispheres of the human brain and proof that there are marked differences in them between individuals give new meaning to old questions: Why do symmetric left and right forms look alike, why do they form a pleasing array when combined side by side, and yet why is it so important for a child to gain the ability to tell one from the other consistently, in the same order? What is it that links handedness to the development of language or the ability to analyze shapes—is it experience, or could it be the maturation of an innate structural bias of the mind? In practical life, how should a parent or a teacher cope with left-handedness in a child who is expected to be schooled for a complex technological world designed by right-handers for right-handers? The questions lead to the heart of our ideas about the innateness and adaptability of human nature.

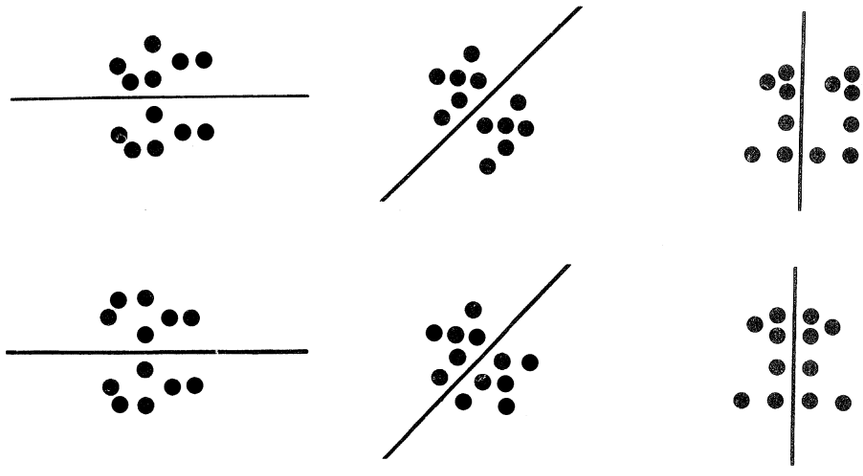
Corballis and Beale have written a review and synthesis of biological and psychological knowledge pertaining to these questions that is a pleasure to read. A highly informative, well-argued text is relieved with sometimes irreverent New Zealand wit. This is an excellent book for students because it is clear, accurate, and, except where the authors' expertise on experiments with animals leads them too deeply into technical complications, well simplified. It cannot fail to stimulate interest in the relation between functions of the mind and the form of the brain.

Leftness and rightness are in essence psychological. Left, like red, is a category of brain process. But, unlike red, left refers to the body of the subject, and especially to his possibilities of movement. The words "left" and "right" are learned labels for locations or directions that have symmetric relation to an axis of reference in an object or in a place. They refer back to the body of the observer and thus to some structural asymmetry in him, even when they are projected to signify a location outside the body.

The search for the evolutionary origins of mental asymmetry leads down a fascinating path. Life is founded on chemistry, in which the laws of parity prevail. Although an important event in the history of scientific thought, the discovery of nonconservation of parity by elementary particles would seem irrelevant to imparity in life; the final chapter on this topic, containing mistakes in physics, could well have been omitted. Symmetry is a natural result of equilibrium in force and motion. Some consistent bias in our imperishable "germ plasm" or some consistent outside influence, like gravity or the path of the sun, is needed to fix a sidedness in organisms. As it happens, the protein α-helix and the DNA helix have one direction of twist, like the Standard American Screw. Corballis and Beale seem not to have perceived this transmissible reservoir of one-sidedness in the stuff of life. The complex statistics on handedness and hemispherecity in families and large populations lead them to reject the Annett and Levy-Nagylaki gene theories for handedness and to champion the theory of Morgan, a neuroanatomist, that inheritance of left-brainedness (and so right-handedness) is due to a cytoplasmic factor, outside the genes, that creates a growth advantage for organs on the left. Genes or environmental factors merely prevent the expression of this factor in components of the brain, to cause mixed dominance and ambidextry or left-handedness. It makes a good lesson in epigenetics, but the evidence is thin.

Octopus, fish, rats, cats, and monkeys confuse two-dimensional shapes that are symmetric about an up-down axis. Reviewing the experiments, Corballis and Beale conclude that most animals have some "feel" for the difference between the two sides of their bodies and can differentiate left and right responses, but that most fail to discriminate between left and right mirror shapes or surfaces.

In seeking to explain this confusion in animals, Corballis and Beale decide that Cartesian feature-analyzing and passive-information-processing theories that disregard the active transformations of stimulation by movement of the subject are inadequate. They prefer a "cognitive" approach based on paradoxical judgments of humans, who, while they perceive the configuration of a stimulus in specific detail, also generalize to the distal object in independence of its direction, distance, and orientation on the occasion on which it is perceived.



Symmetrical and repeated patterns used in an experiment by Corballis and Roldan. "In order to pursue the idea that the detection of symmetry may depend on analog rotations of the input, Corballis and Roldan . . . have investigated the time it takes to detect symmetry as a function both of the orientation of the pattern and the tilt of the subject's head. . . . Note that the axis [in the patterns used] is clearly marked with a line and the pattern is either mirrored about the line or repeated across it . . . the time taken to judge a pattern either symmetrical or not increases as the axis departs from the vertical. . . . This result is consistent with the idea that the subjects mentally rotated the patterns to the vertical before judging their symmetry, although it does not, of course, prove it." [Reproduced from M. C. Corballis and C. E. Roldan, *J. Exp. Psychol.* 1, 221 (1975), in *The Psychology of Left and Right*]

Human perception of orientation and symmetry depends on mental transformation analogous to actual motor exploration of different aspects of the thing perceived. We gain a stronger sense of bisymmetry or balance by centering and aligning the axis of symmetry of a pattern, motorically or mentally, with an internal mental axis of uprightness, one that represents the gravitational axis about which the body must normally be balanced.

Cerebral asymmetry has evolved in humans in relation to a unique development of cooperative intelligence and communication. The main factor at the outset seems to have been a bias to choose one hand for gestures of communication, and this has led to a one-sided control for speech and for sequencing in all signal movements. Subhumans seem not to have developed a consistent handedness. Asymmetries recently found in the anatomy and behavior of apes seem to fit the hypothesis that, in evolution, watching to see what another is doing or expressing created the need for a consistent or near-consistent sidedness.

When social factors favoring right-handedness are accounted for, 90 percent of humans, even as newborns, appear to be inherently right-handed. This correlates with unilateral anatomical features of the cerebrum that emerge in the fetus. Cortical organs are, in turn, directly involved in speech, understanding of speech sounds, and ability to read and write. But all these intelligent skills elaborate after birth, becoming deeply molded by experience, and all express discoveries and inventions of culture.

In this book, data from human clinical studies on the lateralization of functions in the brain and the spate of recent research on asymmetry of perceptions and movements with normal subjects are given disappointingly superficial treatment. The authors add little that is original on these matters.

They review well the development of a sense of left and right in children and the peculiar inherent failure of lateralization of mental functions as well as right-handedness in some 2.5 percent who do not learn to read or write at the normal rate. Children under 5 seem, in psychological tests, like animals, having at most a vague sense of left and right. Corballis and Beale propose that the development of a left-right sense is due to growth of an asymmetry in the brain. They present a not-fully-worked-out idea that homotopic nerve connections between the hemispheres cause left-right reflection of images at the level of memory, beyond the immediate "here and now" of the percept and remote from the primary sensory regions of the cortex. Unfortunately, the interhemispheric conduction theory for mirror confusion, though plausible if one accepts that the higher mental functions are laid down in somatotopic (body-shaped) arrays, has no direct evidence. We must wait on anatomical research to see if this form of the notion is correct.

Most children 5 to 10 years of age thrive under formal school instruction and gradually become irreversibly left-brained for skilled use of words. Before that, their right brains have a limited potentiality to take over the same skills, and afterward the adaptability is lost. The whole conventional plan of Western education comes into collision with many left-handers and is especially hard on the unlateralized dyslexics. Man's native brain is clearly not prepared for total regimentation by society.

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Personal Recollections

Reflections on Biochemistry. In Honour of Severo Ochoa. Papers from a symposium, Barcelona and Madrid, Sept. 1975. A. KORNBERG, B. L. HORECKER, L. CORNUDELLA, and J. ORÓ, Eds. Pergamon, New York, 1976. x, 466 pp., illus. Cloth, $25; paper, $9.50.

The incredibly fast advance in many areas of biochemistry makes for equally rapid obsolescence of previous findings. Even the basic observation on which a new advance is based is rapidly forgotten because it has become common knowledge. What may be irretrievably lost in this natural course of events is really something else. It is the passion, the art, the very flavor which characterizes a particular scientific period that quickly sinks into oblivion together with the men and women who were the participants.

So Carl Cori writes near the beginning of this volume, which is indeed an endeavor, by a group of notable biochemists, to recapture some of the personal aspects of past achievements and to pay tribute to one of the major biochemists of our time.

Severo Ochoa's career spans nearly half a century and continues actively today. As pupil, colleague, director of research, and friend, he has been closely associated with a large proportion of the major contributors to biochemistry in the era of its most rapid growth. The symposium from which this book arises was held in honor of his 70th birthday. The central themes concern enzymatic mechanisms in biosynthesis and cell function. The contributors were asked to prepare not papers of the sort commonly found in journals but reflections on the development of a subject, a concept, or an approach to biochemistry. Most of the authors consider the development of one or more of their own researches, tracing origins of the work, significant influences not yet recorded in print, as well as errors and misleading clues, and the working out of conclusions. The subjects include much of the most important biochemical research of the last 40 years. Styles naturally differ greatly from one biochemist to another, and some papers are concerned with more personal recollections or with reflections on science in our time. Personal characteristics of the authors and differences in approach to difficult problems emerge more clearly than they generally do in formal research reports. Thus there is much that will be valuable to the historian of science, who will, however, be watchful for distortions and omissions in recollections of past activities set down many years thereafter. I return to this point later.

Ochoa's career, outlined in the opening article by F. Grande and C. Asensio, has indeed covered an extraordinary portion of the range of biochemical research. Born in 1905 in the northern Spanish province of Asturias, he published his first paper from the physiology department of the University of Madrid in 1929. The head of the department was Juan Negrin, who was later to become president of the Spanish Republic at the height of the civil war. From 1929, for two years, Ochoa worked in Otto Meyerhof's Institute of Physiology in Heidelberg. As he said later: "Meyerhof was the teacher who most contributed toward my formation, and the most influential in directing my life's work." Meyerhof's concern as an experimentalist was with the biochem-