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LEONARD CARMICHAEL

1898—1973

A Biographical Memoir by

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Biographical Memoir

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BY CARL PFAFFMANN

LEONARD CARMICHAEL was born in the Germantown section of Philadelphia, Pennsylvania. He was the only child of Thomas Harrison Carmichael, a successful physician, and Emily Henrietta Leonard Carmichael, an active volunteer worker on many charitable boards. At the time of her death, she was chief of the Bureau of Recreation of Philadelphia. His maternal grandfather, Charles Hall Leonard, D.D., LL.D., was Dean of the Crane Theological School of Tufts University for many years.

Leonard attended the Germantown Friends School, although his parents were not Quakers. He further cemented the family traditions with Tufts when he entered the University in 1917. Not only was his grandfather a dean at Tufts, but his uncles attended college there. Leonard was elected to Phi Beta Kappa in his junior year, and received a B.S. degree *summa cum laude* in 1921. He was much influenced by his senior research project on the embryology of the eye muscles of the shark, which aroused his interest in the sense organs as directors of animal behavior. His interest in sensory psychology and physiology became a dominant theme in his later scientific career. As an undergraduate, he was much influenced by the books of Jacques Loeb, the biologist ultramechanist, and C. Lloyd Morgan, the proponent of emergent

evolution. After reading Howard C. Warren's *Human Psychology,* however, Leonard decided that psychology (rather than anatomy or physiology) was the discipline in which he could best study the senses with a view to their functional, as well as biological, setting.

He entered Harvard as a graduate student on a fellowship provided by the educational psychologist, Professor Walter F. Dearborn, with whom he developed an especially close association. He was assigned a fine office and adjoining laboratory, and was able to work in the Harvard shop, rebuilding an improved model of the famous Dodge-Dearborn eye movement recording camera. Carmichael was encouraged to satisfy his interest in biology, as well as psychology, and he did so with a number of zoology courses. His first piece of graduate laboratory research was a quantitative study of the reaction of the meal worm (*Tenebrio molitor*) to light, under the direction of G. H. Parker, professor of zoology. Carmichael regarded Parker's lectures on the nervous system and the sense organs as models of clarity and scholarship. Among his psychology professors were E. G. Boring, L. T. Troland, and William McDougall.

Carmichael's continuing interest in the sensory control of, or release of, inborn patterns of behavior led Dearborn to recommend a theoretical and historical Ph.D. dissertation on the psychology and biology of human and animal instincts. A summary of the conclusions was published in an article entitled "Heredity and Environment: Are They Antithetical?" William Preyer's studies of signs of life in the fetus before birth pointed the way for Carmichael to investigate morphological growth of receptors and the nervous system in relation to behavior released at various stages of early ontogenetic development in mammals before learning begins, or is important. After receiving his Ph.D. degree, he was awarded a Sheldon Fellowship, which permitted travel and

study abroad. "Report of a Sheldon Fellow," published in the *Harvard Alumni Bulletin* (1925), describes his visits to the University of Berlin and other German universities.

In 1924 he joined the faculty of Princeton to teach physiological psychology and the history and systems of psychology. There he began his research on the development of behavior with larval amblystoma and frog tadpoles. It had previously been shown that their physical development proceeded normally in laboratory Petri dishes when immobilized with a mild concentration of the anesthetic, chloretone. Carmichael focussed upon behavioral development when presumably all sensory input was reduced, and clearly all motor movement inhibited, so that no practice was possible. In the strongly antihereditarian point of view that dominated American behavioral psychology at that time, the outcome of this experiment aroused widespread interest. Carmichael found that when the anesthetic was removed, the experimentally treated organisms swam with vigor and coordination equal to that of the undrugged controls, who were allowed to move throughout development. As he stated in his autobiography:

> These studies supported a hereditary rather than an environmentalistic theory of the determination of the growth of organized behavior. At the time, the results of these experiments surprised me and almost shocked me. They did not support my then strongly held belief in the determining influence of the environment at every stage in the growth of behavior.*

Carmichael's reports of these experiments in *Psychological Review* (1926, 1927, and 1928) seemed to dodge the obvious conclusion. He continued to speak of the intimate interrelation of heredity and environment and the difficulties of disentangling their interaction.

*Leonard Carmichael, "Leonard Carmichael," in *A History of Psychology in Autobiography,* ed. E. G. Boring and Gardner Lindzey, vol. 5 (N.Y.: Appleton-Century Crofts, 1967), p. 37.

It was also at Princeton that he became interested in the history of research on reflex action, and published two papers, one on Robert Whytt and the second on Sir Charles Bell. Carmichael made frequent mention of Bell as an early contributor to physiological psychology. Indeed, Carmichael and his graduate students and colleagues formed the Sir Charles Bell Society and met together for dinner and general reports of one's doings during the Annual Meetings of the American Psychological Association.

Carmichael's paper on Bell (*Psychological Review*, 1926) was a careful review of Bell's contributions, such as his recognition in 1811 of many of the facts that Johann Müller later included in his 1838 *Handbook* under the doctrine of specific nerve energies. Bell clearly understood that the same stimulus will give two different sensations, depending upon the nerves affected. He noted that a sharp steel point applied to one type of papilla on the tongue would cause a feeling of sharpness by way of the sense of touch. When a taste papilla was touched, he perceived a metallic taste but no touch. Bell also gave a treatment of the five senses, reciprocal innervation of antagonistic muscles, and wrote on the expression of the emotions. On Bell's controversial priority for the demonstration of the separate functions of the dorsal and ventral roots of the spinal cord, Carmichael supported Bell's priority on the law that bears his name. Carmichael noted: "Magendie perhaps independently gave the principle a more exact formulation and a clear physiological proof."* More recent historical documentary evidence has become available and is interpreted by Cranefield (1974) to give the priority to Magendie.†

* Leonard Carmichael, "Sir Charles Bell: A Contribution to the History of Physiological Psychology," *Psychological Review*, 33: 196.

† Paul Frederic Cranefield, *The Way In and the Way Out, Francois Magendie, Charles Bell and the Roots of the Spinal Nerve* (Mount Kisco, N.Y.: Futura, 1974).

Carmichael moved to Brown University in 1927 as one of the youngest full professors on the Brown faculty, still in his twenties at the time of his appointment. He had been recruited to build a new laboratory and graduate department and to strengthen the undergraduate program in psychology. Carmichael was an excellent and popular lecturer. His elementary psychology lecture sections filled the largest lecture hall on campus. He personally gave all the lectures in the three successive sections every Monday and Friday morning. He enlivened his lectures with dramatic, but clear, demonstrative material, slides, and film strips. Junior faculty and graduate student teaching assistants conducted the quiz sections during the week. Leonard was voted the most popular teacher at the University a number of times by the students.

I was an undergraduate student at Brown when I first met Leonard. He was then a young bachelor, whose dashing campus image was reinforced by a bright red Buick roadster. The riddle of his numerous trips to Cambridge was solved by his marriage to Pearl L. Kidston of Hudson, Massachusetts, on June 30, 1932. After graduation from college, she worked at Harvard's Graduate School of Education. They had one child, Martha, born during Leonard's last year at Brown. Martha married S. Parker Oliphant, and their first child was named Leonard Carmichael Oliphant.

Although Carmichael was busily involved in organizing the new laboratory and department, equipping it for research and for graduate training in experimental and physiological psychology, and carrying out his own research, he personally taught undergraduate and graduate courses and guided the research of honor undergraduates and several graduate students. While I was an undergraduate at Brown, any doubts on my own career plans were settled after completion of Carmichael's elementary psychology course. In-

deed, Carmichael was my first and most important mentor and guided my honors and master's research in physiological sensory psychology. He urged me to apply for a Rhodes Scholarship to study physiology at Oxford. The Rhodes Scholarship was awarded to me, and following my studies at Oxford, I went on to Cambridge University. After two years of graduate work under the late Lord Adrian, I received my Ph.D. degree. Throughout the years, my strong personal ties with Leonard and Pearl Carmichael prospered.

At Brown University, Carmichael achieved his long-cherished goal of studying the development of behavior in fetal mammals. His study began with the fetal cat, and he developed an especially designed cradle in which the pregnant cat could be supported, so that after Cesarean section, the fetus, with fetal circulation intact, floated in a bath of warmed saline solution. A high cervical section of the maternal spinal cord permitted discontinuance of anesthetic, and thus the fetus could be studied in a normal physiological state, free of anesthetic.

James Coronius and Harold Schlosberg participated with Carmichael in the first study of the fetal cat. Verbal records of descriptions of the behavior were dictated, and motion pictures were taken. Interest was focussed on the responses to well-controlled sensory stimulation. In addition to fetal cats, Carmichael and his students subsequently made a prolonged series of studies on the development of behavior of the fetal guinea pig. More than 100 cutaneous pressure reflexogenous zones were studied throughout the entire active prenatal life of sixty-eight days. Carmichael noted in *The Experimental Embryology of Mind* (1941):

> Thus it is not the physical character of the stimulus, but rather that it shall be above the threshold of some of the complex of skin receptors and in a specific locus, that determines the response. Such typical patterns of behavior remain amazingly constant in an organism that is rapidly grow-

ing, and, conversely but similarly, growth may suddenly alter such responses, and such alterations of behavior may easily be confused with learned responses, especially in postnatal life.

I have never seen any responses in the late fetus which, in their elements, have not appeared as a typical patterned reaction to isolated stimuli many times before. In the late guinea pig fetus the hair coat is well grown, the teeth are erupted, eyes and ears are functional, and adaptive integrated behavior is well established. At this time such an animal will, to use the language of teleology, attempt in a most effective and even ingenious way to deal with a tactual stimulus applied to its lip. First, it may be, it will attempt to remove the stimulus by curling the lip; then, if the stimulus remains, it is brushed by the forepaw on the stimulated side. If the stimulus still persists, the head is turned sharply. Finally, a general struggle is resorted to which involves movements of all four limbs and all trunk muscles. In a late fetus this final maneuver is sometimes so quick and effective that the experimenter is often thwarted and the offending stimulus is removed—by a guinea pig fetus that is having its own willful and annoying way in spite of anything the experimenter can do. Each of these special responses, however, may be seen as an old one to the person who has watched the growth of fetal behavior.

Complex patterns of behavior emerge as a result of maturation. Such behavior is possibly as truly end-seeking and purposeful as is any behavior in the world which does not involve the use of language. I see no reason to believe that this emergent purposeful behavior is not as natural a result of the processes of growth as is the length of the fetal whiskers, and quite as independent of learning.

The growing animal functions in a way that is in general adaptive at every stage. When I wrote my first papers in this field, dealing with the development of drugged amblystoma, I was so under the domination of a universal conditioned reflex theory of the development of adaptive responses that I denied categorically the truth of the statement just made. But every experiment that I have done in the field of the early growth of behavior has forced me to retreat from this environmentalist hypothesis. Now, literally almost nothing seems to me to be left of this hypothesis so far as the *very early* development of behavior is concerned.

The classical work of Preyer and Coghill on the sequence of motility in the developing amphibian larvae showed the first movement to be a C shaped or reversed C curvature. This was followed by an S or sigmoid form of reaction. The

S movement was fundamental to swimming, which consisted of a succession of sigmoid movements before the limbs developed. When they did appear, both sets of limbs moved only as part of the larger trunk movement. Independent limb action gradually began to individuate out of the dominant trunk movements. Movement of the trunk in walking was regarded as nothing more nor less than swimming movements at a generally reduced speed. Development, from the very beginning, was a progressive expansion of a perfectly integrated total pattern from which partial patterns individuated with various degrees of discreteness.

Carmichael saw something different in fetal mammals. He gave more importance to the early individuation of quite specific responses, which later became parts of integrated behaviors. Rather than debate the pros and cons of a wholistic versus specific development, Carmichael cautioned that the researcher would do better to record as unambiguously as possible the responses made by a fetus at any stage—rather than to fit all developmental changes into one formula. He agreed with William James's statement that: "Psychology must be writ both in synthetic and analytic terms."*

Carmichael's work began at a time when the advances in ethology documenting the release of species-specific behavior by patterned stimuli were not well known to the American biological and psychological communities. The regular occurrence of these species-specific behaviors, and their occurrence in vacuo, that is, where animals were reared in isolation so that postnatal experience did not occur, led Konrad Lorenz and Nikko Tinbergen to argue for the instinctive basis of much of animal behavior that occurred under natural circumstances. Such "releaser stimuli" were

*William James, *Principles of Psychology*, vol. 1 (N.Y.: Dover, 1890), p. 487.

often perceptually complex, for example, a sequence of movements by another animal, coloring and size of an egg, or particular location and size of a red bill spot.

Psychologists as a group even now tend to be cautious in attributing behavior patterns to genetically determined processes or propensities. Still, increasing interaction among students of animal behavior and psychology is leading to a sounder appreciation of the role of genetic determinants in behavior, both in their own right and as setting the stage upon which experience and learning can interact. Carmichael's influence on thought regarding the development of behavior and its sensory control was, in a sense, premonitory of such changing views on the heredity-environment issue. His two editions of the *Manual of Child Psychology* (1st ed., 1946; 2nd ed., 1954), and a more recent third edition (1970) of *Carmichael's Manual of Child Psychology,* under Paul Mussen's editorship, are witness to his never flagging interest in behavioral development.

Carmichael left Brown University in 1936 to become Dean of the Faculty of Arts and Sciences and professor of psychology at the University of Rochester. Two years later, he accepted the presidency of Tufts University with the understanding that he be allowed to continue his scientific work. However, he was less able to devote his energies to his past scientific interests, since World War II efforts overlapped with his Tufts years. The Laboratory of Sensory Physiology and Psychology at Tufts turned to war-related projects which included the improvement and application of new techniques to the study of eye movements and visual fatigue. Electronic, rather than ocular photography proved more suitable for long time reading fatigue studies, an old interest from his days with Dearborn.

To this method of registration could be added the simultaneous registration of brain waves, the electrical signs of

oscillatory neural activity in different brain regions throughout the reading and other visual tasks. A book, *Reading and Visual Fatigue* (co-authored with Dearborn), appeared in 1947. He had pioneered with H. H. Jasper at Brown and the Bradley House some of the first EEG (electroencephalographic) registration of brain waves in humans and animals (1935).

He contributed in many other ways to the war effort. He was particularly proud of his role as director of the National Roster of Scientific and Specialized Personnel, which did invaluable work in the recruitment and assignment of scientists for the atomic energy and radar projects, among others. In the period from 1939 to 1945, he commuted between Tufts and Washington once or twice weekly, as he mentioned in his autobiography, "spending more than a year of nights on a sleeping car between Boston and Washington."* He also served on a number of advisory committees and boards at the national level. In 1947 and 1948, he was chairman of the American Council on Education.

Carmichael was elected to the American Academy of Arts and Sciences in 1932 and to the American Philosophical Society in 1942. He was elected to the National Academy of Sciences in 1943 and served as the chairman of its Section on Psychology from 1950 to 1953. He was president of the American Philosophical Society from 1970 to 1973. For almost a quarter of a century, he was a member, and for much of the time chairman, of the Board of Scientific Directors of the Yerkes Laboratories of Primate Biology. Later he served on a similar board for the Delta Regional Primate Research Center and for many years was on the

* Leonard Carmichael, "Leonard Carmichael," in *A History of Psychology in Autobiography*, ed. E. G. Boring and Gardner Lindzey, vol. 5 (N.Y.: Appleton-Century Crofts, 1967), p. 48.

Board of Scientific Overseers of the Jackson Memorial Laboratory at Bar Harbor.

Upon his call in 1953 to the Smithsonian Institution Secretaryship, Carmichael turned his considerable administrative talents to improving that Institution, to which was added, among other things, the new Museum of Sciences and Technology—the Smithsonian's first major new building in fifty years. Two wings were added to the Museum of Natural History, and the old Patent Office Building was acquired to serve as a home for the National Collections of Arts and the National Portrait Gallery. During his eleven years of tenure, the annual congressional appropriation rose from $2.5 million to over $13 million.

He found the opportunity to indulge, to some degree, his interest in behavioral development. He gave notice to the superintendent of the Washington Zoological Park that he wished to be called, no matter what the hour, when a birth was imminent among any of its numerous animal species. I remember his recounting how the newly born giraffe would struggle to its feet, and in relatively short order begin to display coordinated, though awkward, motor patterns. He became much interested in the developmental studies of primates, and indeed served as first president of the International Primatological Society.

Upon his retirement from the Smithsonian in 1964, he was elected Vice President for Research and Exploration of the National Geographic Society. He had been a trustee of the Society for many years and served for a time as chairman of its Committee for Research and Exploration. He was able to further his long-time interest in primate research, taking the opportunity to observe troops of wild temperate-zone monkeys in Japan, and to watch for some days over thirty wild chimpanzees deep in the forests of East Africa. He was proud of the Geographic's support of the original and epoch-

making field studies of Jane Goodall on chimpanzees in their natural habitat. The frontispiece in this article was one of his favorite photographs.

Throughout his busy career, he continued active work as editor of psychology books for Houghton Mifflin. At the request of Random House in 1957, he wrote *Basic Psychology,* which gave his general point of view about psychology for the educated reader. He was delightfully surprised by its wide and continuing acceptance over the years. In 1964 he wrote a chapter on "The Early Growth of Language Capacity in the Individual" in a book entitled *New Directions in the Study of Language,* edited by E. H. Lenneberg.

The photographically beautiful book, *The Marvels of Animal Behavior,* published in 1972 by the National Geographic Society, began with his introductory chapter, "Man and Animal, a New Understanding." In this, he covered a broad canvas of man's interest in animals, as manifested in the art of ancient and vastly different cultures, totemism, biblical and classical antiquity, and modern science, especially ethology. The book depicts not only behavior in the wild, much of it social behavior, but gives good accounts of field work and experimental studies. Peter Marler of The Rockefeller University worked with Carmichael as editorial consultant, aided by a distinguished group of animal behaviorists. Marler's own work provided subtle examples of how experience in bird song learning interacted with innate predispositions and provided another kind of documentation in support of Carmichael's view that learning itself always depended upon maturation or growth. Such recent work added to Carmichael's convictions that many psychologists during the last half century had given far too little weight to the role of inheritance in behavior change during individual development. It was a source of satisfaction to him that his lifetime study of receptor-initiated behavior had given him over the

years a better and better understanding of the mechanisms of adaptive response and of mental life.

Leonard Carmichael as a person was formidable. He was taller than average and had an unusually resonant voice. For over half of his career, he was extremely formal in personal relations. He never called his graduate students by first names until some several years after their doctorate. He was similarly formal with his working associates. With years, however, he mellowed, as do most. Gatherings of his former students at meetings of the Sir Charles Bell Society became more relaxed, but still formal. Those meetings, hosted by Leonard and Pearl at their Georgetown home, with a superb buffet and ample libation, were a cordial exchange of academic reminiscences and family doings, and less the inquisitions on research done or not done that had characterized earlier meetings. The mood was one of affectionate loyalty to the "good doctor."

Much more could be said of Leonard Carmichael, his activities in national affairs and in the scientific and educational domains. His memberships, officerships, awards, and distinctions, too numerous to recount, include twenty-three honorary degrees, the Presidential Citation of Merit, the Public Service Medal of the National Academy of Sciences, orders of merit from four foreign countries, fellowships, trusteeships, and a legion of responsibilities and duties of distinction. His honorary degree citation from Harvard best sums it up: "A psychologist who combines distinction in his science and success in administration."

I WISH TO EXPRESS my appreciation to Mrs. Leonard Carmichael for the wealth of bibliographic and other material provided and to Leonard Mead for information on the Tufts years.

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