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A Biographical Memoir by

LOUISE H. MARSHALL

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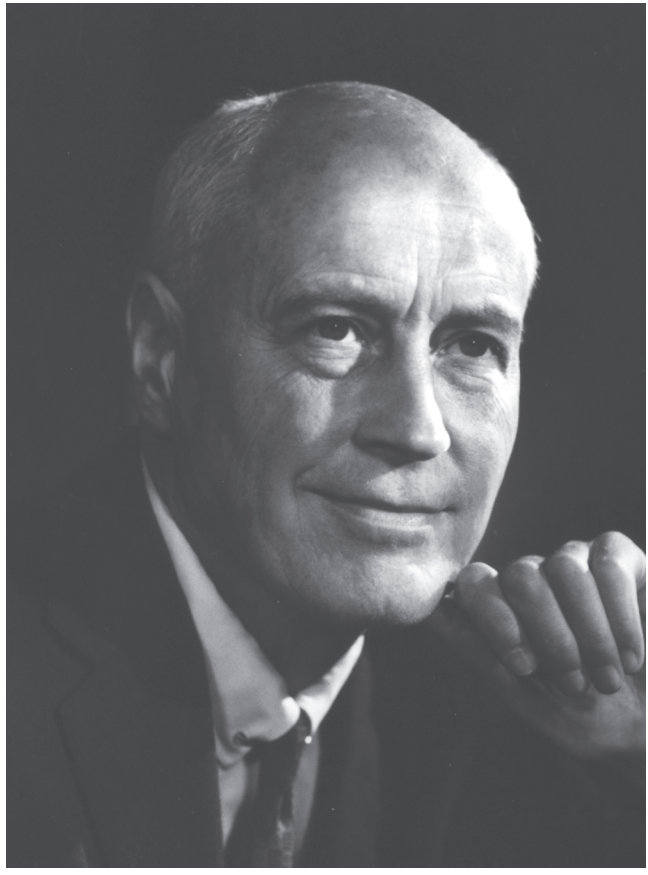

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HORACE WINCHELL MAGOUN

June 23, 1907–March 6, 1991

BY LOUISE H. MARSHALL

HORACE WINCHELL MAGOUN was an emigrant from chilly New England to the warm clime of Southern California. Between his residencies on the North American coasts, a 20-year Midwestern interlude intervened, a period during which he developed a conceptual synthesis of one of the major integrating elements of the animal nervous system. With clear, direct evidence and bolstered by supporting clues, the idea of the brain stem reticular formation as an arousal system interposed between incoming (afferent) channels and outflow to motor, endocrine, and autonomic effectors, satisfied the test of time and became accepted knowledge of some mechanisms related to cerebral and behavioral integration. Continuing studies by Magoun and other neuroscientists revealed the function of the nonspecific systems of the central core of the brain stem in modulating the excitability of the central nervous system in response to internal and external environmental stimulations. The diffuse influence of reticular core activity on the cerebral hemispheres was suggested experimentally in the maintenance of subjective conscious wakefulness and attention to novel stimuli, phenomena that implied a philosophic relationship to higher nervous activity.

Born in Philadelphia, the middle of three children, Magoun had become a thorough New Englander by the time he left the East Coast. His baby sister called him "Tid," a nickname he much preferred to his given name. Their father, Roy Winchell Magoun, bore the surname derived from the Scottish, meaning son of a blacksmith. Roy was ordained in the Episcopalian ministry, and so the early years of the young family were peripatetic, with successive, short assignments to parishes throughout New England. During that period Tid spent several summers with his mother's two sisters living in their Coe homestead in West Newton. They were retired teachers from the Boston public schools, and they perhaps instilled a sensitivity to the English language in their bright nephew. Roy Magoun's final ministry was to Newport, Rhode Island, as founding superintendent of the Seaman's Church Institute. This charitable establishment—still serving its ministry today—was the gift of a few concerned citizens to provide a home away from home, where seafarers could rest in clean, inspirational quarters between voyages, an enterprise that reflected the progressive era of extending a helping hand to the downtrodden. An affable man and adept at socializing with Newport's summer colony, Roy was active in the city's civic life and related well to the summer "cottagers."

Magoun's mother, Lucy Coe Perkins, came from an exotic background. Her just-wed parents had embarked for Yokohama in the wake of the opening of Japan to foreigners and Grandfather Perkins had set up a successful dental clinic that undoubtedly fostered the Japanese proclivity for a gleaming smile. Subsequently they moved to Shanghai, where Lucy was educated in a French convent. Dentist Perkins eventually returned to practice in Boston, and his grandson remembered formal visits as a child to ensure his own gleaming smile. Another memory was of shopping trips with his mother

to the local French purveyor of cheeses and the ensuing animated conversation. She eventually was known in Newport as "the cat lady" in recognition of her compassion for stray felines, an attitude shared by her son, who became adept at handling cats in the laboratory.

When the Magoun family arrived in Newport in 1919, Horace Magoun was an impressionable 12-year-old. During summer vacations he reveled in lazy days with his peers at their special beaches and evenings hanging around the theater crowd. Later he learned to drive and became part-time chauffeur to his high-school history teacher. That association instilled an appreciation of history, a lifelong motivating interest of the future scientist. Four years at Rhode Island State College, plugging along with his major sequence in biology and washing dishes in exchange for meals, were enlivened by registering three times for a course in nineteenth-century French theater and the vicarious idyll of "la vie Bohême." On graduation from "Little Rhody," as Magoun called his college, in 1929, coincident with the Great Depression, he gratefully accepted a half-time teaching assistantship in zoology at Syracuse University in western New York.

For his part-time research at Syracuse, Magoun concentrated on the embryogenesis of two giant equilibrium-controlling neurons situated on each side of the brain of Petromyzon, a predator invading New York's fishing waters. After receiving, in 1931, his master's degree and marrying a companion graduate student, Jeannette Alice Jackson, he continued his westward migration to take up an appointment to the newly organized Institute of Neurology at Northwestern University Medical School situated beside Lake Michigan in Chicago. There he commenced full-time studies toward the doctorate under Stephen Walter Ranson (1880-1942), a leading neuroanatomist-physiologist. Ranson's closely orchestrated research program initially concerned the neural

aspects of posture and locomotion and later focused on the hypothalamus and nearby subcortical structures in the integration of somatic and visceral processes in homeostasis and emotional behavior.

By his acceptance into Ranson's graduate program, Magoun had the good luck to participate prominently in one of the early outstanding world centers of research on the nervous system. All work in the institute was centered on a novel instrument, the Horsley-Clarke stereotaxic apparatus, whose role in furthering progress in neuroscience cannot be overestimated.[1] After two dormant decades in England, use of the instrument was revived and its vast utility revealed by Ranson's commissioning a clever machinist to replicate the specifications published in 1908 (*Brain* 31:45-124). Paired with an atlas of the cat brain prepared by Ranson's associate, Walter ("Rex") Ingram, the stereotaxic instrument opened the uncharted realms of subcortical brain tissue to experimental discovery and manipulation by providing a tool for accurate and replicable localization of clusters of neuronal cells. Biomedical research in the neurologic sciences at that time was largely centered on the peripheral nervous system and analysis of the nerve action potential, culminating in the Nobel award to Gasser and Erlanger in 1944. There were still many unsolved problems, the most contentious of which was the nature of the action potential—electrical or chemical. The "axonologists" were in full stride, sharpening the contrast between the "new" subcortical investigations with behavioral components and the search for attributes of the nerve action potential.

By the time Magoun joined the flourishing program at Northwestern, exploration of the hypothalamus was underway. He immediately took part in studies in cat of the effects of stimulation of the gland on respiration and other motor functions and in June 1934 submitted a dissertation titled

"The Central Path of the Pupilloconstrictor Reflex in Response to Light." Curiously the previous year an article of that title was published bearing Ranson's name as first author[2] and presenting most of the dissertation data. The jarring experience of having his work appropriated may help explain Magoun's later insistence on placing his name last. Five additional collaborative papers on the oculopupillary constrictor reflex appeared in 1935, but it was not until nine years later that Magoun delineated the corresponding dilator pathways.[3] Magoun's role in establishing this new direction in neuroscience research was fundamentally significant. He not only imparted his skill in the use of the instrument but also had major responsibility in carrying out studies on visceral integration, emotional expression, the regulation of feeding, fighting, mating, and other vital behaviors that constitute the responses to the internal and external environments and preserve the individual and the species. During the 11 years of his association with Ranson and institute personnel, 38 collaborative papers were published; the ubiquity of Ranson's name on studies in which he did not touch the apparatus (attested by at least two students) was a sensitive point with the younger scientists.

Ranson's death in 1942 and the incipient dismantling of his institute thrust Magoun into an unaccustomed independence. He moved into basement space of the department of anatomy, commenced teaching medical students, and successfully applied to the National Foundation for Infantile Paralysis (March of Dimes) for support of a study of the neuropathology and neurophysiology of the bulbar type of polio. He found the injury was to the reticular core of the brain stem, and in experimental animals stimulation of that region either facilitated or inhibited ongoing motor activity, depending on site of stimulus and suggesting extrapyramidal tract involvement, in addition to the usual pyramidal motor

innervation. Another series of experiments, in collaboration with Ruth Rhines, an M.D. seeking her Ph.D., extended the work to skeletal muscle physiology and was summarized in a slim monograph in 1948.

In contrast with the formal and reserved atmosphere that had permeated Ranson's institute, Magoun took great delight and inspiration from association with a group recruited by Percival Bailey to the neurophysiology research laboratory of the Illinois Neuropsychiatric Institute in Chicago. There the high spirits and relaxed camaraderie with Bailey, Warren McCulloch, Gerhardt von Bonin, and John French brought him within the circle of the second of three neuroscience centers of excellence in Chicago in that era.[4] During his last four years in Chicago, when the INI association bloomed, Magoun was a coauthor on six papers; they dealt with descending modulating pathways to the reticular formation and with tremor.

The Magoun research program was enhanced in 1947 when he offered space to Donald B. Lindsley, a new appointee to the department of psychology of Northwestern University. Its Evanston campus had no animal facilities, and Lindsley brought expertise in the field of electroencephalography. An additional extension occurred in the fall of 1948, when Giuseppe Moruzzi from the University of Pisa, Italy, arrived as a Rockefeller fellow. Finding the Institute of Neurology bereft of space, he was glad to accept Magoun's invitation to take part in studies on the cerebellum. Their collaboration yielded the famous paper of 1949, which became a citation index classic.[5] As the senior author later wrote, in lightly anesthetized animals stimulation of the brain stem seemed to abolish the cortical EEG waves, however "[w]hen amplification of the cortical record [was] by chance turned up . . . [t]hen we saw the large slow waves give way, during reticular stimulation, to a record of low-voltage fast activity,

called 'EEG arousal,' a pattern which was characteristic of alert attention in the human EEG" ("Autobiographical Material," unpublished manuscript, n.d., p. 12). After Moruzzi returned to Italy, Magoun showed with Lindsley and several students, including Thomas E. Starzl, that reticular formation impulses projected forward diffusely and across sensory modalities, that they were conducted through medial core pathways, and that they persisted after cessation of the initiating stimulus. This ascending reticular system was shown to be associated with alert wakefulness as a background for sensory perception, higher intellectual activity, for voluntary movements and behaviors, and to provide insights about brain and mind. Those findings have become a piece of accepted wisdom of how brain and behavior are coordinated.

In 1950, boxed in by lack of space and an uninterested administration just when his breakthrough program was underway, Magoun made a final migration, to Los Angeles, to become founding chair of the department of anatomy at the "southern branch" of the University of California. With construction incomplete and the need to accommodate newly recruited scientists, contact was renewed with John Douglas French (1911-88), then head of neurosurgery at the Long Beach Veterans Administration Hospital. French's recommendation through administrative channels resulted in conversion of unused dependent wards into laboratories for basic neuroscience. During that decade teams of investigators were in place at Long Beach, 30 driving miles and 118 traffic lights from Westwood, and at other, closer VA and California state facilities.

There is no doubt that Horace Magoun arrived in Los Angeles with visions of an interdisciplinary institute that would bring together collaborative studies and report directly to the chancellor. As he later wrote, "Those eleven years [at Ranson's institute] of essentially full-time research . . . thoroughly

oriented [me] to an institute way of life, and throughout the balance of [my] investigative career all [my] research was pursued collaboratively." (1984). And again, his experience at Northwestern and the INI "had imprinted a high regard for collaborative and interdisciplinary research. . . ."[6] Coincident with settling his new faculty recruited from various neuroscience subdisciplines, he confronted the local academic traditionalists, many of whom were wary of losing turf to the novel idea of a multidisciplinary research unit. With legendary persistence and regental backing, the neuroscientist prevailed and in the political atmosphere of Vannevar Bush's "endless frontier," the availability of funds for construction and training programs was no problem. By means of federal and state dollars a 10-story building of research laboratories, offices, and animal quarters was completed in 1961 at the corner bridging the medical school with the Neuropsychiatric Institute. The Brain Research Institute (BRI) was one of the earliest interdisciplinary and multidisciplinary American organizations committed to the production of knowledge on brain and behavior and represented the outcome of Magoun's persuasive powers to surmount departmental barriers. Unfortunately, territorial animosities were not entirely resolved and while Magoun was on sabbatical at the National Institutes of Health, the freestanding aspect of the proposal was rewritten and the BRI became a subsidiary of the medical school. The BRI's prime mover took a pragmatic view of the damage and flew home to ensure the best possible preparation for the site visit. Instrumental in the success of the BRI in attracting a steady flow of students and guest investigators was the award of one of the innovative training programs in the biological basis of mental health, activated by the National Institute of Mental Health in 1957, and its continued renewal to the present.

Magoun's plans for the nascent BRI benefited from his

ranging participation in advisory positions at the national level, notably at the National Institutes of Health. An effective committee member, he rotated among appointed terms at the five institutes that had stakes in the nervous system, and thus was aware of their interest in receiving novel proposals. Among the adjunct facilities established as support systems for the emerging discipline at UCLA, the Brain Information Service (BIS) was the most successful, and is a survivor today. The Data Processing Laboratory was a pioneer in computer analysis of the EEG. The Biosphere program served its short usefulness in the federal space program. And finally the Neuroscience History Archives, with an oral history project and digital photographic collection, was established in 1980 and continues to promote the preservation and knowledge of neuroscience history.

His gradual preoccupation with neuroscience infrastructure was further manifested by Magoun's involvement in securing funds to organize two conference series sponsored by the Josiah Macy, Jr., Foundation. Three conferences each were held on *The Central Nervous System and Behavior* (1958-60), and on *Brain and Behavior* (1961-63), distinctive for their inclusion of scientists from the Soviet bloc. That gesture earned Magoun's designation as the leader of the U.S. delegation in 1958 to the so-called Moscow Colloquium on Higher Nervous Activity. The ebullient success of the colloquium led to the formation of the International Brain Research Organization (IBRO), and Magoun had a seat on its central council. He was editor of the three-volume nervous system section of the first *Handbook of Physiology* published by the American Physiological Society (1959-60). That period also saw the first edition of *The Waking Brain* (1958), an acclaimed delineation of the ascending reticular system and its ramifications, with multiple reprints and an expanded second edition (1963). A solid reputation for effective writing

is attested also by two invited chapters in the *Annual Review of Physiology* (1943, 1949) and again in *Physiological Review* (1950).

The acceptance of the ascending reticular formation as an important integrating concept in the knowledge of brain and behavior was acknowledged by many awards and invitations to lecture. A non-award, however, was a source of deep embarrassment in 1957, when the Nobel selection committee's designation of Magoun was broadcast by the media, then superseded by the Karolinska Institute Assembly with "one of our own." Magoun internalized the disappointment, mentioning only once during a long friendship that "Ragnar Granit beat me out of the Nobel."

The next phase of Magoun's career took him officially out of the laboratory and into the upper halls of academe. Installation of the research programs of members of the BRI in the new building offering advanced laboratory facilities under the directorship of John French had lessened the pressure, and Magoun had stepped down from the chairmanship of the department of anatomy in 1955. By that time the department was one of the largest and most productive in the country, and it was characteristic of its founder to move to more challenging endeavors when old ones were doing well. He served two terms as dean of the graduate division and in that capacity, 1962 to 1972, he promoted the participation of minorities in higher education and spoke and published on educational topics. The new challenge seemed to be to promote the ranking of his university in the context of the older established schools. The rivalry had a sense that the West Coast had overtaken the eastern axis in many of the subdisciplines of neuroscience.

In view of his mother's upbringing it is not surprising that Magoun relished visits to Japan. In Yokohama in the springtime he imagined his mother as a little girl playing

beneath the cherry blossoms. His presentation to the Japan Medical Society at Osaka in 1963 was titled "Plasticity and Memory Process in the Nervous System." Four years later and as a member of the medical sciences panel of the United States-Japan Committee on Scientific Cooperation, he addressed the medical society in Tokyo on "The Role of Organized Research Units in the Development of the Neurosciences," a quasi-historical paper. The crowning fulfillment came in 1971 with the award of the Second Class of the Order of the Sacred Treasure by the Japanese government in recognition of Magoun's role in training the country's neuroscientists. Some Japanese researchers who had spent time at the BRI banded together in an alumni association, the Japanese Reticular Society, but it did not survive the passage of time. In 1980 the Japanese scientific monthly, *Kagaku Asahi*, published an interview with Magoun, asking the mind and brain question. The translation, by Masako Isokawa, provides a fortuitous coda to Magoun's scientific contributions: "Mind is a melting pot of all experiences."

The final phase of Magoun's career commenced when he returned to the Los Angeles campus in 1974. The two previous years he had been in Washington as director of the Fellowship Office of the National Research Council. There, characteristically, he had fostered the appointment of minority personnel to the numerous selection panels of the large NRC associates program administered for the National Science Foundation. At home in the BRI, Magoun assisted in the development of a division of behavioral sciences in the department of psychiatry. That relatively undemanding responsibility afforded time to renew his serious interest in brain history, the grounds for which had been set much earlier, in 1958, at a CIBA Foundation symposium; Magoun's topic was the development of ideas relating mind and brain. In 1959 he inserted a panel on brain history into the scientific

panels of IBRO. Magoun was thus an ideal prospect when the Josiah Macy, Jr., Foundation asked him to contribute an essay on neuroscience for its two-volume publication *Advances in American Medicine: Essays at the Bicentennial* (1976), in collaboration with the National Library of Medicine; he completed the assignment several weeks ahead of the deadline with minor collaborative help. The next project was a set of 40 posters accompanied by a 27-page brochure on the history of the human brain, prepared for the annual meeting of the American Neurological Association in 1979. The twenty-fifth anniversary of the BRI occasioned the publication of its history, a 325-page monograph written by the institute's prime mover (1984). Meanwhile, in direct result of his essay for the bicentennial volume, Magoun embarked on what he considered would be his magnum opus, a history of American neuroscience in the twentieth century; it was published posthumously in 2003.

Formally attired and groomed, at 6 feet and reflecting his college training as a long-distance runner, Magoun was an impressive figure in any gathering. With his supportive wife, Jean, a mutual attraction to achieving women was manifested by both scientific and historical collaborative projects. Having shared with Tid Magoun the Neuroscience History Archives office for many years, I could bask in the warmth of his enthusiastic welcome of visitors. These included both old and new friends: William Windle, who had Parkinson's disease, Jack French with Alzheimer's, and particularly students. He retold jokes on himself, such as the time at Long Beach when he rhetorically asked, "Now what stupid idiot would do a thing like that?" and a lab assistant spoke up, "I'm that stupid idiot. You want to make something of it?"

Magoun claimed to detest large social events, yet as a connoisseur of sherry he invariably took the opportunity to

discourse on a current research project, a kind of rehearsal for the clean composition that he would later hand to a typist. Associates were often urged to undertake projects that Magoun had conceived, a gesture of friendly encouragement from the "900-pound gorilla" whose stature needed no boost. This was in the pattern of abandoning a project when it became viable and moving to a greater challenge. The gesture was easily misinterpreted, however, as an attempt to unload boring details and could arouse resentment. There was also a perception of arrogance generated by Magoun's overcompensation for shyness behind his cool facade. When Magoun berated staff or friends (librarians dubbed him "Earthquake Magoun" and rushed to help him) he was quick to apologize.

The ability to conceptualize with a broad brush a synthesis of the evidence discovered in the laboratory was sustained by Magoun's compartmentalization of his daily life. Events at home (especially after Jean's cerebrovascular accident in 1962) did not seem to impinge on the demands of his official commitments. He was decisively in command until a succession of small strokes preceded his death in Santa Monica, California. A pioneering career of major contributions to the knowledge of how the brain functions was coupled with a drive to promote the discipline that fosters the production of that knowledge.

Preparation of this memoir was possible only through many channels of assistance. I am grateful for cooperation of the BRI (Allan J. Tobin, Director) from all levels, and also thank Carmine D. Clemente, Charles H. Sawyer, and Arnold B. Scheibel for comments and the Magoun family for help with details. Direct access to the Horace Winchell Magoun Papers, in the Louise M. Darling Biomedical Library, University of California, Los Angeles, and the bibliography and finding aid prepared by archivist Russell A. Johnson

(copies available on request) were essential to bring this memoir to fruition.

SELECTED AWARDS, LECTURESHIPS, AND HONORS

1952 Harvey Lecture, New York Academy of Medicine
1953 Max Weinstein Award, United Cerebral Palsy Association
1954 James Arthur Lecture, American Museum of Natural History, New York
1955 Member, National Academy of Sciences
1956 George W. Jacoby Award, American Neurological Association
Israel S. Wechsler Lecture, Mount Sinai Hospital, New York
Menas S. Gregory Lecture, New York University College of Medicine
Thomas William Salmon Lecture, New York Academy of Medicine
1958 Honorary D.Sc., Université Aix Marseilles
1959 Honorary D.Sc., Northwestern University Medical School
1960 Honorary D.Sc., University of Rhode Island
Fellow, American Academy of Arts and Sciences, Boston
1961 City of Hope Award, City of Hope Hospital, Los Angeles
Borden Award, Association of American Medical Colleges
1963 Passano Award, Passano Foundation
1965 Honorary L.H.D., Wayne State University
1970 Karl Spencer Lashley Award, American Philosophical Society
1971 Order of the Sacred Treasure Second Class, Japanese Government
1974 Distinguished Alumni Lecture, Northwestern University Medical School
1988 Co-recipient, Ralph W. Gerard Prize, Society for Neuroscience

NOTES

1. H. E. Hoff. John Fulton's contribution to neurophysiology. *J. Hist. Med. Allied Sci.* 17(1962):16-71.

2. S. W. Ranson and H. W. Magoun. The central path of the pupilloconstrictor reflex in response to light. *Arch. Neurol. Psychiatr.* 30(1933):1193-202.

3. A. J. Harris, R. Hodes, and H. W. Magoun. The afferent path of the pupillodilator reflex in the cat. *J. Neurophysiol.* 7(1944):231-44.

4. The third active center was at the University of Chicago headed by Ralph Gerard in the department of physiology of the medical school.

5. G. Moruzzi and H. W. Magoun. [This Week's Citation Classic]. *Curr. Cont. Life Sci.* 24(1981):21.

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