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## HUDSON HOAGLAND AS AN EEG PIONEER: RECALLED BY HALLOWELL DAVIS

Hudson Hoagland died at the age of 82 on 4 March 1982. He will be best remembered by most of us as the co-founder of the Worcester Foundation for Experimental Biology, an important inde• pendent institute for medical science, now devoted primarily to cancer research. Many will also remember him as a co-discoverer, with Gregory pincus and M-C. Chang, of "The Pill", the most widely used oral contraceptive. Others will recall that in 1961-64 he was President of the American Academy of Arts and Sciences. Others will remember him as a political and social liberal, the "Humanist of the Year" in 1965. Still others will recall him as the most out• spoken and enthusiastic scientist and fund-raiser they ever knew. But early electroencepha• lographers will remember him best as one of the first of the American pioneers in EEG, in the decade before World War II.

I knew Hudson well, both as a professional colleague and as a personal friend. I regarded him very much as a younger brother. Indeed our association in EEG was so close that an outline of the story of our parallel careers may be of some historic interest. I was three years Hudson's senior in age but I received my MD five years before Hudson received his Harvard PhD ( in - psychology) in 1927. Both of us had original training in chemistry. ( Hudson earned an MA degree (1924) at M.I.T. in chemical engineering.) Curiously, I was Hudson's teacher in a summer course in mammalian physiology given at Harvard Medical School in 1926. Hudson's most important mentor, however, was William J. Crozier, Professor of General Physiology in the Biology Department at Harvard.

Hudson like myself became fascinated soon after graduation by the nerve impulse, and a little later by the neural code for the transmission of information from sense organs to the brain. Adrian was the acknowledged leader in this area. and Hudson spent a year (1930-31) in Adrian's laboratory as a Parker Research Fellow from Harvard. (I had preceded Hudson in Adrian's laboratory by 8 years, as a Sheldon Traveling Fellow from Harvard.) Hudson worked on the cutaneous nerves of frog during his stay in England, but after he returned to the USA to become Professor of Biology at Clark 'miver-s t ty in Worcester MA he shifted to the lateral line organ of fish. He was apparently t:le first to describe continuing "spontaneous" activity in a sensory system.

In 1933 or 1934 Adrian informed Hudson by letter of Hans Berger's paper of 1929 and of his (Adrian's) confirmation of the reality of the 10/sec rhythm recordable from the human scalp. Hudson reconfirmed the observation, using a Matthews oscillograph, just a matter of months after Derbyshire, Simpson and I had done so with a cathode ray oscilloscope. It did not take long for Hudson and our group to share information and start parallel studies. Hudson's first real EEG machine was made in the Department of Physiology of the Harvard Medical School as a simultaneous duplicate of my own second-generation electroencephalograph. Thus Hudson was an original member of the group of EEG pioneers that centered on Boston in the 1930s, and he was probably the most enthusiastic and imaginative of us all.

An example was his demonstration that the frequency of the alpha rhythm has a temperature coefficient that can be described by the Arrhenius equation, and that the coefficients obtained correspond to those of chemical reactions controlled by identified enzymes. These studies were made possible by the use, at the Worcester State Hospital, of hyperthermia as a treatment for general paresis. Hudson collaborated with the psychiatrist, Dr. Ewen Cameron, in a broad study of the EEG in schizophrenics and other psychoses and the effects of insulin coma, Metrazol convulsions and other heroic procedures that were in vogue at the time. For the descriptive aspects Hudson devised a "delta index" to quantify in a relative way the delta activity induced by various maneuvers. With a simple map measurer he measured the length of the line of an EEG tracing on a meter of paper. The excess length over one meter was his delta index. But Hudson in Worcester, like my own group in Boston, could find no clear correlations between the EEG and the psychoses: only tantalizing suggestions.

Another imaginative venture was the "hippocampal electrode", placed high in the nasopharynx, as suggested by Roy Grinker. Hudson hoped to show that "emotional probes", verbal in nature, administered by the psychiatrist, would activate the hippocampus before any other part of the brain. The hippocampus was thought to be deeply involved with the subjective aspects and also the expression of emotion, but, although emotions were evoked, the EEG from the nasopharyngeal lead gave no indication of specifically correlated changes in pattern or earlier timing. (Hudson later expressed doubt that his nasopharyngeal lead really sampled hippocampal activity, and I recall my own skepticism at the time.)

In the summer of 1940 Hudson and I and Alexander Forbes were all members of a team of medical scientists recruited by Ross McFarland to work at the School of Aviation Medicine at the Naval Base at Pensacola. The team objective was to find screening procedures to improve the selection of aviation cadets. EEG was our particular tool. We thought we had a major clue when a high percentage of the cadets, under the stress of hyperventilation or on the tilt table, developed high delta indices. A control group of instructors showed very few such delta reactions. But a little detective work revealed that many cadets came hurriedly to the laboratory in the morning without stopping for breakfast, while the instructors, on a less demanding schedule, breakfasted regularly and plentifully. The difference was simply low blood sugar among the cadets.

Neither the EEG nor any other of the screening tests could improve the selection of the cadets. The volunteers were actually as fine a group of healthy young men as could be found anywhere, and many of them later proved their competence in the battle of Midway.

At the end of the summer Hudson and I, in a long evening discussion, shared our disappointment that EEG had not contributed to the Pensacola project, and also that neither of us had found any clearly positive relation of EEG to the neuroses, the psychoses or the emotions. Stability of individual patterns and clear individual differences were there, but nothing would correlate with them. EEG seemed to belong to the neurological conditions of epilepsy, tumors, and the like. Hudson strongly advised, in fact implored, me to leave EEG to our large group of friends who were already busy at it. "Any of them can do the job", he said. He insisted that I had a duty to return to auditory physiology. I listened and after the war I took his advice, and it proved to be excellent. But I was surprised when Hudson himself did almost the same thing! He shifted his whole interest from the electrophysiology of the nervous system to the other great integrating system, the endocrines. His next and successful effort was to establish relations among the adrenocorticosteroids, fatigue and the stress syndrome of Hans Selye. This was the rock on which he and Gregory Pincus built the Worcester Foundation for Experimental Biology.

Like Alfred Loomis, Hudson Hoagland entered EEG early, contributed brilliantly, and then moved on to other areas in which they made even greater contributions to science and mankind.