

1947

EEG--Electroencephalography

Harold S. Hulbert

Follow this and additional works at: <https://scholarlycommons.law.northwestern.edu/jclc>

 Part of the [Criminal Law Commons](#), [Criminology Commons](#), and the [Criminology and Criminal Justice Commons](#)

Recommended Citation

Harold S. Hulbert, EEG--Electroencephalography, 37 J. Crim. L. & Criminology 491 (1946-1947)

This Article is brought to you for free and open access by Northwestern University School of Law Scholarly Commons. It has been accepted for inclusion in Journal of Criminal Law and Criminology by an authorized editor of Northwestern University School of Law Scholarly Commons.

EEG—ELECTROENCEPHALOGRAPHY

Harold S. Hulbert, M.D.

The author is a Fellow of the American Psychiatric Association and of the American Medical Association. He has been a member of the Editorial Board of this Journal during many years. A practicing psychiatrist, he is accustomed to placing great emphasis on tangible data of disturbed mental states and their recovery. It is ten years since the neurologists and psychiatrists have been using electro-encephalography; in those years enough data have been developed and checked with clinical diagnoses and programs of medical therapy for the EEG to be generally accepted by the trial courts, penologists and parole boards and parole officers. Hence this simplified presentation in The Journal.—EDITOR.

The world of criminology should be prepared for Electro-encephalography.

Living cells of the body, in their functioning, create chemical and thermal, mechanical and faint electrical energy. The electrical energy from the functioning of the cells of the heart can be magnified by amplifying tubes (just as broadcast radio electrical waves are amplified by a radio receiving set to make them audible) and these heart waves can be recorded by an EKG (electro-cardio-graph; K for the German *Kardia*) and the record of waves can be made a visible permanent record called EKG or electro-cardio-gram. "Graph" and "Gram" we use as in the phrases "I shall telegraph a telegram." Graph for instrument and Gram for its recorded message.

As a tree is covered with a bark or cortex, so the white matter of the bulk of the brain is covered with a finger-thick layer of gray matter called the cortex of the brain. These cortical cells act in clusters. Just as other acts, like thinking and perceiving and inaugurating voluntary movements, they create faint electrical energy by their actions. The electrical energy of clusters of brain cortex cells, like electrical energy that arises from heart action, can be magnified by amplifying tubes and recorded by an EEG (electro-encephalo-graph) and an EEG (electro-encephalo-gram) record of *brain* (or brain cortex) waves made into a visible permanent record. Cephalum is brain, and is not to be confused with a similarly sounding word, *sypphilis*; jurors should be so told explicitly!

EEG tests are made over four or six areas of the scalp by applying tiny electrodes to the scalp. The wires from these electrodes go to the recording device. The energy is recorded in waves on a movable tape.

Two points of possible misunderstanding must now, at once and for all, be cleared up: 1) This is not another lie detector test, and 2) it is not a shock apparatus for no electricity is passed *into* the patient or his brain. EEG does not record

either ideas or emotions. Also, as one is listening to a radio, one's radio receiver does not send any electrical energy back to the radio broadcasting station; the receiving set only amplifies faint electrical energy which its antennae pick up from the air and which originated at the broadcasting station. Therefore an EEG is totally imperceptible and harmless.

A test takes about an hour and costs about \$15.00 to \$20.00. It uses about \$2.50 worth of materials. To "read" or interpret an EEG takes considerable time; writing up its meaning takes further time. Technicians' and doctors' salary or fee, plus overhead, account for the cost. The apparatus is expensive, about \$700.00 to \$1,000.00 per channel. There are one to three or six to eight channels per instrument. Supplemental equipment, grounds, transformers if needed, compressed air for drying, shielding against static and nearby electrical equipment and instruments, add to the initial expense. EEG's are portable one-channel, which can be carried into a home or jail or office; movable three-channels which can be wheeled to any room in a hospital; six- or eight-channels which are built in in a hospital or penitentiary. Some are used for clinical tests and others for research. The instruments made now are more reliable than those first in general use in the 1930's. About 1936 they became practical.

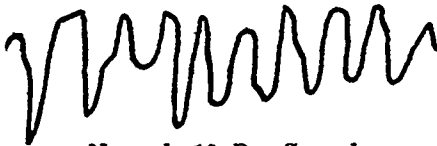
Judges, prosecutors, defense lawyers, penologists, experts in court, probation and parole officers, and those concerned with the prevention of delinquency, need to have a useful knowledge of EEG, but not a working knowledge. This is especially so in dealing with impulsive and periodic delinquents and pre-delinquents. It is also of medical-legal value in head injury cases, in will contests, etc.

The EEG record is a strip of special paper with one or several long irregular wavy lines on it. These have certain marks, letters and measured straight lines. The letters and their meanings are L F or No. 1, R F or No. 2, meaning Left Frontal and Right Frontal and are always in 1-2 order; L P or Left Parietal and R P or Right Parietal, 3 and 4; L O and R O, Left and Right Occipital, 5 and 6; and L T and R T, Left and Right Temporal; and the neutral or ground lead (pronounced lead) which is usually the lobe of the ear or ears. That is because the electrodes are placed above those specified areas of the scalp and pick up the faint electrical energy of the underlying lobes of the brain. The electrode is the top of a truncated cone; it is small, about one-fourth of an inch in diameter; it can pick up the electrical energy of a zone of the white matter of the brain beneath it about two inches in diameter.

There are three systems of nomenclature describing or entitling the waves: the European, the Canadian, and the Amer-

ican (meaning here that used in the United States). Terms like Alpha waves, Beta, Gamma, etc., are not popular in the United States. Here we describe the record of the brain waves using descriptive terms:

Brain waves of EEG can be and are described by their frequency per second: 10 per second (normal; actually normal is $8\frac{1}{2}$ to 12 per second), Fast (15 to 40 per second), Slow (three per second), Very Slow (two per second). Others are described just by frequency, one or less per second, or four to six per second, or just by the word "Fast." Frequency is the greatest of the half-dozen or so characteristics. 10, 15-40, 3, 4 to 6, 2 or slower are the most significant frequencies and are typical of certain conditions which modify or impair thinking and conduct. Related to frequency of waves there may be an estimate of the duration of a certain wave, say one-fifteenth of a second.



Normal—10 Per Second.



Fast—28 Per Second.



Slow—4 Per Second.



Wave and Spike, Slow.
Petit Mal.



Grand Mal Epilepsy.



Slow, Saw-Toothed
Psychomotor Ep.

EXAMPLES OF ELECTROENCEPHALOGRAMS

Next in significance is the amplitude of the waves, or distance from crest to trough. The amplitude is a measure or correlation of the voltage. The voltage is expressed in micro volts or one-millionth of a volt. The average waves are from 10 to 100 m.v., the mean about 30 m.v. So the report may speak of high voltage 25 per second, etc., or low voltage meaning low amplitude.

The third characteristic is the *shape* of the brain waves as recorded by an EEG. The wave may be a spike (or a series of spikes), or it may be rounded, or flat top, or round-flat top which is notched and called "saw tooth," or alternate wave and spike. The technician and/or interpreter will make a notation on the record about artificial waves which are not brain waves such as from muscular activity, blinking the eyes,

or from interference from electrical sources, such as an electric fan near by, or other artifacts.

Finally each recording of an EEG has one horizontal line showing how fast the paper moved in one second — which usually is three centimeters long or the diameter of a silver U.S. half dollar, and a vertical line |, like a printed capital I, showing and marking 50 or 100 or whatever micro-volts, so anyone can estimate from it the amplitude of the waves or their voltage on any specific EEG record.

EEG is mostly used clinically to make or confirm the diagnosis of some one of the many forms of the epilepsies, to localize brain tumors, and to verify the presence or absence of brain injury or focal or local brain disease.

As yet there are no books published on EEG and conduct or conduct deviations, but in the scientific journals there are numerous articles on, or touching on, abnormal EEG records. The *Journal of the American Psychiatric Association* has been publishing many articles on EEG for the past six years. Several references are appended at the end of this article.

It is well known generally that there may be a dreamy state of consciousness preceding and/or following a major convulsion with unconsciousness in an epileptic, and it is somewhat generally realized that the irritability of an epileptic is pathological in degree. Some epileptics because of their epilepsy, become mortally enraged over trifles or over wrongs that non-epileptics bear without sudden assault. Epileptics are the most touchy and explosive of our citizens. Yet between attacks they may be "sticky sweet," proudly wearing a lapel pin of their Sunday School. I tell my students and nurses, "Never handle an epileptic, for their resentment is over-resentment; no one likes to be handled. Also, never give an epileptic a direct order for no one likes an abrupt order and epileptics *hate* orders. Say, "Please do this," or, "I wish you would put on your slippers, or whatever." I quote the incident of two men leaving a barber shop; each rubbed his jowls to see if he had had a smooth shave. The non-epileptic man silently bewailed that he had given the barber a dime tip. He was provoked, to be sure, but did nothing about it. The other man, a nocturnal epileptic, we later found out, went back into the barber shop and tried to kill the barber with a razor because he had been provoked just by having a poor shave!

EEG tests, if repeated, will or may show brain waves of epilepsy in one who has convulsions which have never been observed because they occur only at night and he sleeps alone. Here EEG points the way to therapy and points away from

penal confinement without therapy and with inevitable mismanagement.

Petit Mal, or little malady epilepsy, is a brief clouding of consciousness with brief nodding of the head or blinking of the eyes or jerking of the hands. The nodding of the head or other movements occur at the rate of three per second. The EEG shows three per second slow brain waves of alternate wave and spike at these times, or after two or three minutes of deep over-breathing.

Among the other forms of general epilepsy — in contradistinction to focal or local epilepsy such as from a brain tumor — is the one of greatest significance to criminologists. It is called Psycho-Motor Epilepsy, and it too has its characteristic EEG brain waves: slow waves, four to six per second, of average amplitude or voltage, of distinctive shape viz., flat top or saw-toothed curved top. These waves come in brief bursts or runs lasting four to six seconds. Following such a seizure the waves become mixed.

Psychomotor is more psychic than motor (muscular). That is, there usually is no convulsion nor twitching. In speaking during a psychomotor attack or episode or seizure, a word may be incoherent or there may be mumbling or rubbing the face or neck with the hands. The phrase "Psychomotor seizure" is in general use but is not as well chosen as is a *grand mal* major convulsion seizure where the victim shakes as though seized and shaken by invisible evil spirits as a terrier shakes a rag he has seized. "Attack" is also an ancient term, as though the invisible attacked the patient. Psychomotor "discharge" is the electroencephalographer's term. For non-medical and non-EEG personnel the term "Psychomotor *episode*" is to be preferred.

Dr. Frederick A. Gibbs, formerly of Harvard, now of Illinois, an American pioneer and authority on EEG, lists the following as symptoms of Psychomotor Epilepsy, formerly called Psychomotor Equivalents: amnesic states, somnambulism, fugues, attacks of abnormal rage, behavior disorders, irrational but apparently purposeful movements, impairment of consciousness, usually some evidence of emotion (rage, anxiety, discomfort, fear); negativism and destructiveness are often manifested; tendency to injure themselves or others as by attacking with a knife or lighting a fire; states akin to negativism or to fright expressed by the phrase: "I can't stand it." There are feelings of horror; hallucinations, rarely elaborate, and/or delusions associated with the attack. After recovery the patient may try to justify, or at least to explain his behavior during the attack. Memory may be absent even for com-

plicated and apparently purposeful behavior or memory may be fairly clear for some stages of the episode.

A person may come out of a psychomotor episode abruptly or may clear up gradually with variations in judgment and in memory, his judgment may be better in the latter part as he clears up but his memory may be poorer and contradictory because his brain wearied in the latter part of the attack. In a psychomotor episode the victim may show impaired, perhaps primitive or immature judgment. He may lack his mature selective inhibitions and be un-social; his behavior may be contrary to his best interests or to the rights or interests of others.

The automatic actions during a psychomotor episode may not attract the attention of others, and the patient may "come to himself" in a strange or even distant place without knowledge of how he got there, a condition called amnesia. He may spend money or contract debts or make and sign instruments — which he would not do in a lucid interval — of which he is later amnesic. If a victim of psychomotor epilepsy (which can be objectively shown without resort to opinion evidence) is by statute not responsible for *contracts* made when he was not lucid, why should he be held responsible for his other *conduct* when not lucid but in a psychomotor epileptic episode whether or not there are as yet pertinent statutes or decisions?

Running Epilepsy or Epilepsy Procoursans is a form of Psychomotor Epilepsy, the symptoms of which are running, climbing, hiding absurdly. It may terminate with a set phrase, e.g., "I'm all right now." EEG recordings are, of course, not possible in a "running" attack. The number of episodes, not their severity, have a poor prognostic omen.

EEG studies show that epilepsy is usually of mixed form. A person with epilepsy may usually have *petit mal* attacks and may have some psychomotor episodes and, under great stress or bodily upset, may have some *grand mal* seizures.

Treatment for Epileptic Adults and Problem Children

These studies, when repeated, are indicators of what medications, of what diets, and activities are most suitable for treatment. Even within the limitations of a jail or prison EEG studies ought to be made, before and after sentence. For those unable to have private care, an institution for epileptics is better than any other kind of institution for those with epilepsy that has gone without treatment probably because the condition had not been diagnosed clinically or by EEG. But if they have been found to have epilepsy and conduct disorders and if the condition is not amenable to medical or surgical treatment, then a custodial institution is to be considered.

Problem children who have unprovoked and inexplicable *periodic* deviations of conduct and who do not develop normally in personality even under general good domestic and pediatric care frequently show abnormal EEG brain waves. It is interesting food for thought that in the parents and near relatives of such children (although *they* may never have shown clinical signs of epilepsy) there is a high incidence of abnormal EEGs. Less than 40% of epilepsy is the inherited type.

School physicians and child guidance clinics and Juvenile Courts are beginning to have EEGs on periodic problem children. It opens a new vista. Penitentiaries and Juvenile Court Clinics will soon be expected to report on the EEGs of delinquents and prisoners. Parolability can be made a bit more predictable when there is EEG proof of how periodic brain upsets can be controlled by modern medication.

Electroencephalograms in Court

This author is ignorant of any cases in which Electro-Encephalograms have been presented in court and admitted or rejected and of any rulings of the higher courts on their admissibility. Such rulings are bound to occur.

RECENT LITERATURE ON EEG

Readers of this *Journal* should be especially interested in the last two chapters of *Injuries to the Skull, Brain and Spinal Cord*, edited by Samuel Brock, M.D. of New York University. It is published by Williams and Wilkins, Baltimore, 1943 (\$7.00).

The two chapters mentioned are by Moses Keschner, M.D., LL.D. of Columbia University on "Medico-Legal Aspects of the Electro-Encephalo-Gram" and by Paul F. A. Hoefler, M.D. of Columbia University on "The Electro-Encephalo-Gram."

Jasper, H. H., Solomon, P., and Bradley, C.: Electroencephalographic Analyses of Behavior Problem Children. *Am. J. Psychia.*, 95: 641-658, 1938.

Brill, N. Q., Seidemann, H., Montague, H., and Balsler, B. H.: Electroencephalographic Studies in Delinquent Behavior Problem Children. *Am. J. Psychia.* 98: 494-498, 1942.

Brown, W. T., and Solomon, C. I.: Delinquency and the Electroencephalograph. *Am. J. Psychia.*, 98: 499-503, 1942.

Solomon, C. I., Brown, W. T., and Deutscher, M.: Electroencephalography in Behavior Problem Children. *Am. J. Psychia.*, 101: 51-61, 1944.

Gibbs, F. A., Bagchi, B.K., and Bloomberg, W.: Electroencephalographic Study of Criminals. *Am. J. Psychia.*, 294-298 with bibliography, Nov. 1945.