Journal of Criminal Law and Criminology

Volume 50
Issue 4 *November-December*

Article 15

Winter 1959

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Edwin C. Conrad, Electroencephalograph (EEG) as Evidence of Criminal Responsitility, 50 J. Crim. L. & Criminology 405 (1959-1960)

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POLICE SCIENCE

THE ELECTROENCEPHALOGRAPH (EEG) AS EVIDENCE OF CRIMINAL RESPONSIBILITY

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CRIMINAL RESPONSIBILITY

The *Durham* case[1] has revived the controversial issue of criminal responsibility. The proponents of M'Naghten's rule, the right and wrong test, still maintain that it is scientifically adequate, founded upon necessity, and dictated by the experience of mankind.[2] Inherent in this position is the concept that criminal responsibility is a legal and not a medical problem and that wholesale acquittals under *Durham* will endanger society. On the other hand, *Durham*, the so called "product of mental disease" test, to which has been added in some cases the idea of "irresistible impulse," maintains that insanity is basically a medical, not a legal problem, that the M'Naghten rule ignores medical developments of the past century, and that the "right and wrong" test should be discarded in favor of the "product of mental disease" criterion.[3]

This article will concern itself with proof of criminal responsibility under any of the prevailing tests by the use of electroencephalographic studies.

[1] Durham v. United States, 214 F. 2d. 862 (C.A., D.C. 1954).

[2] See People v. Ricks, 327 P. 2d. 209 (Cal. Apps. 1958); State v. Goza, 317 S.W. 2d. 609 (Mo. 1958).

A very searching analysis of the adequacy of M'Naghten is contained in the recent case of Sollars v. State, 316 P. 2d. 917 (Nev. 1957), motion for rehearing denied 319 P. 2d. 139 (Nev. 1957).

[3] Durham v. United States, 214 F. 2d. 862 (C.A.D.C. 1954); Commonwealth v. Chester, 150 N.E. 2d. 914 (Mass., 1958); State v. Pike, 49 N.H. 399, & Amer. Rep. 533 (1869).

New Hampshire was the first state to be influenced by the teaching of Dr. Isaac Ray, the eminent English psychiatrist, that insanity is a medical problem. As early as 1869 New Hampshire abandoned the M'Naghten rule and in its stead introduced the concept that an accused is not to be held criminally responsible if his unlawful act was the result of mental disease or defect. Under the New Hampshire rule, insanity is not defined as a matter of law but in effect is made a question of fact to be determined by the jury as any other fact would be determined.

HISTORICAL ORIGINS OF THE ELECTROENCEPHALOGRAPH

The electroencephalograph, hereinafter referred to as EEG, is a modern scientific, medical instrument which records the brain wave patterns of individuals.

While the EEG was developed after 1929, Galvani, the Italian scientist, as early as 1790, demonstrated that: (1) contraction of muscles will occur on electrical stimulation; (2) during a contraction of a muscle by use of external force, an electric current is generated.[4] Later in 1875, Caton in England was able to show that the exposed brain of a rabbit produced electrical disturbances, which could be graphed and recorded.[5] However, while there was some work along these lines, it was not until 1924 that Hans Berger, a German psychiatrist, visualized the process of recording brain waves and using the records obtained to analyze specific psychiatric problems. Berger's publications on the subject, beginning in 1929 and ending in 1939, have earned for him the title of father of electroencephalography.[6]

[4] GALVANI, L.: De Viribus Electricitatis in Moto Musculari Commentarius. MEMOIRS OF THE INSTITUTE OF SCIENCES. Vol. 7, p. 1791, Bologna, Italy.

[5] CATON, R.: The Electric Currents of the Brain. BRIT. MED. J., Vol. 2., p. 278, 1875. CATON, R.: Researches on Electrical Phenomena of Cerebral Gray Matter. TR. INTERN. MED. CONGRESS, 9th Session, Section VIII. (Physiology), Washington, D. C., Vol. III, pp. 246–249.

[6] See BERGER, H.: Über das Elektrenkephalogramm des Menschen. ARCH. F. PSYCHIAT. Vol. 87, pp. 527–570, 1929.

See also SCHWAB, ROBERT S., ELECTROENCEPHALOGRAPHY, pp. 1–7. (W. B. Saunders Co., Philadelphia, 1951.)

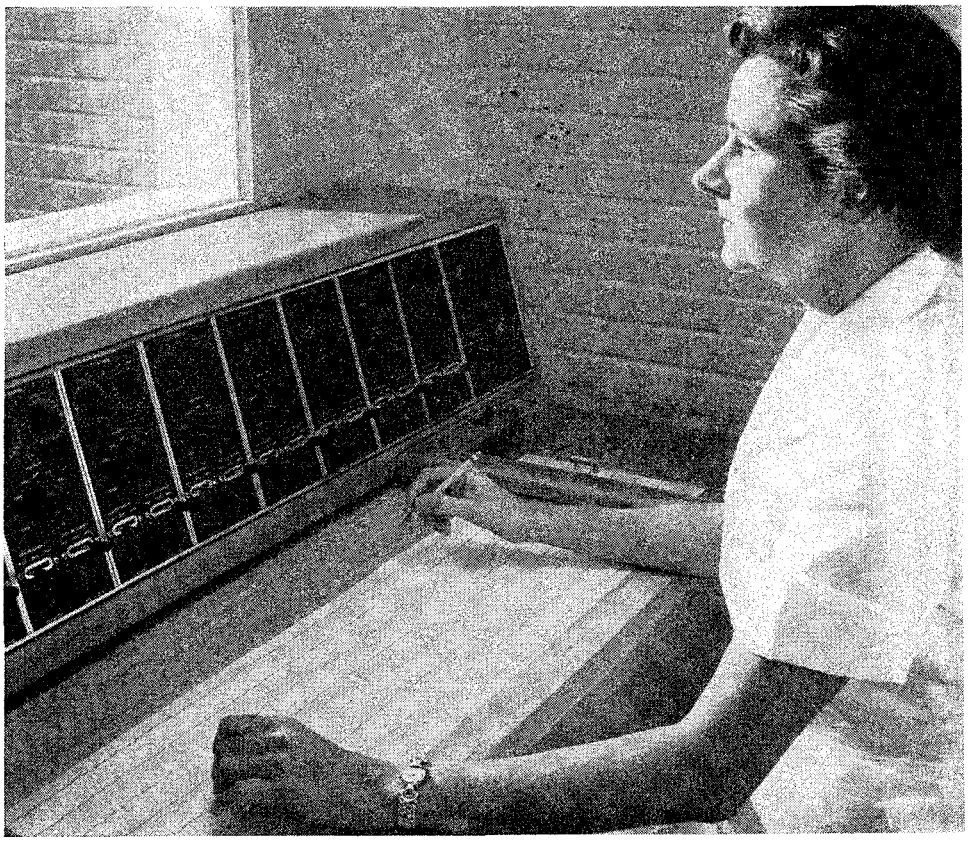

Figure 1.
Electroencephalograph in operation. The 8 brain wave patterns are visible on the graph. (Courtesy, Edin, Worcester, Mass.)

The Brain Wave Recorder

The EEG is an apparatus for making graphic records of the actual electric potentials of the human cerebrum. Two or more electrodes connected to the instrument are placed on different parts of the skull or scalp. The difference in potential brought about by electrical action within the brain is traced by styluses writing with ink on a continuous paper strip. The EEG is a rather complex electronic instrument, an integral part of which is a powerful amplification system necessary to record the small voltages occurring across the electrodes placed on the skull. (See figure 1). In essence the EEG records both the *cyclical* activity and *amplitude* of brain wave patterns of the human being. In other words, the EEG records permanently and in readable form the electrical oscillations of the brain due to the electrical activity of the cortical cells.

A study such as this can only skim the surface with respect to the subject of brain wave patterns and their significance. Medical men, however, will agree that in general a normal brain wave pattern in human beings is discernible and that all other patterns are considered abnormal. By way of illustration, Gibbs teaches us that the rhythmic activity of the cortex of the brain ranges from below 1 cycle per second to above 100 cycles per second, and the voltage range is from 1 microvolt (one millionth of a volt) to 1000 microvolts. Adult normal persons will show a frequency range of 8½ to 12 cycles per second and a voltage range from 5 to 50 microvolts; also many types of injury to the brain, such as trauma and infection, will slow or speed up the electrical activity of the cortex.[7] According to the Gibbs classification, an EEG with a dominant 8½ to 12 cycles per second

[7] Gibbs, F. A. and Erna, L., Atlas of Electroencephalography, Vol. 1, pp. 70, 106, Ch. 10, What is Normal, p. 106, (2nd. ed., Addison-Wesley Press, Cambridge, Mass. 1950).

activity and no abnormal slow or fast activity is classified as normal for adults, all others being abnormal. At the other extreme, organic damage to the brain will slow cortical activity, and a slow or very fast EEG suggests an epileptic diathesis or an organic brain disorder.[8] The dart or spike and dome configurations of the brain wave pattern with increased activity in cycles per second is quite characteristic of certain types of epilepsy.[9] (For characteristic brain wave patterns, see figure 2).

Obviously, what is a normal EEG depends on a great number of factors, beyond the reach of this article. That many variables will affect the results as recorded by the EEG is obvious. The observations of Gibbs on brain wave patterns are illuminating:

1. A normal EEG is presumptive but not positive evidence of normality.
2. A slight abnormally slow or fast EEG is by itself not significant but adds support to other evidence of an epileptic diathesis or an organic brain disorder.
3. A very slow or exceedingly slow EEG as well as a very fast or exceedingly fast EEG suggests an epileptic diathesis or an organic brain disorder.[10]

Brain wave patterns will be influenced by the following EEG parameters or factors:

1. Age.
2. Level of consciousness (whether asleep, awake, relaxed, attentive).
3. Brain metabolism.
4. The clinical symptomatology of epilepsy and related brain disorder (trauma, encephalitis, vascular disease).
5. Pharmacological action of stimulants, sedatives and anti-epileptic substances.[11]

These variables do suggest certain limitations which must be considered in interpreting any EEG studies.

In passing it should be noted that the American Medical Association and the American Electroencephalographic Society have adopted minimum standards and specifications for acceptable EEG instruments.[12] These are set forth in the Gibb's book and should be thoroughly studied before considering the presentation of EEG evidence.

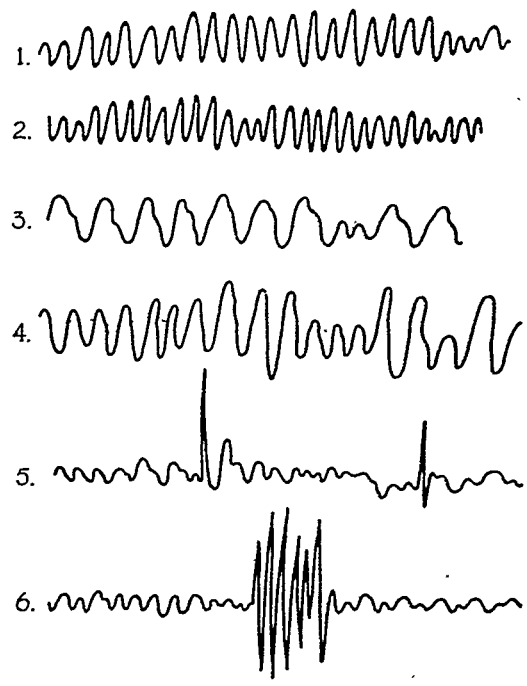

Figure 2.
Brain Wave Patterns.
A diagrammatic illustration of various types of brain waves as recorded on EEG tracings, the x or horizontal axis being the time base and the y or vertical axis the amplitude of the wave. (1) and (2) represent normal alpha 9–11 c/s rhythm. (3) and (4) demonstrate various types of "slow waves" from 3 c/s to 6 c/s, the type of cerebral dysrhythmia seen after cerebral concussion. (5) represents the isolated "spike" found as a sign of focal irritation of the underlying cortex. (6) represents a seizure discharge. Source: GORDY, DR. LOUISE, Concussion of the Brain, AMERICAN BAR ASSN., 1955 PROCEEDINGS, Section of Insurance Law, pp. 437, 463.

LIMITATIONS ON THE USE OF THE EEG

The science of electroencephalography is still in its early stages of development, and therefore, it may take the medical man many years more to fathom the meaning of the various brain wave patterns. At the present time the EEG can only be regarded as a diagnostic aid to be used along with the history of the patient and other scientific tools. In itself it cannot replace adequate clinical examinations. In other words, can EEGs only be interpreted with the aid of case histories and clinical findings.[13] As Gray points out, aside from the dart and dome of epilepsy, the EEG serves in

[8] *Ibid.*, Vol. 1, pp. 70, 106.
[9] GRAY, ROSCOE N., ATTORNEY'S TEXTBOOK OF MEDICINE, Vol. 1, pp. 1033–1036, (M. Bender & Co., Albany, N.Y., 1951).
[10] Gibbs, *op. cit.*, Note 7, *supra*, Vol. 1, p. 110.
[11] Gibbs, *op. cit.*, Note 7, *supra*, Vol. 1, pp. 79–80.
[12] Gibbs, *op. cit.*, Note 7, *supra*, Vol. 1, pp. 126–136.
[13] Belgium Correspondent. Symposium, Belgium Society of Mental and Legal Medicine and Neurology, JOURN. AM. MED. ASS'N., Vol. 155, July 31, 1954, p. 1273.

confirmation of other studies, but will not in itself permit diagnostic conclusions; moreover, the EEG is not positively diagnostic of epilepsy.[14]

In a sense, every individual has a unique EEG of his own.[15] Thus, abnormal waves may be found in normal individuals, and normal waves may even be found in epileptics.[16] Many demented patients have a normal EEG.[17] Consequently, it is extremely difficult to define a normal EEG. Under present techniques two examiners investigating the same subject may come up with different conclusions. Of course, "the greatest care is necessary in the interpretation of tracings and the practical conclusions which can be derived from them".[18]

While legal medicine can profit presently from the use of the EEG, the following preliminary considerations affecting its use must still be resolved:

1. Standardization of the technique of recording.
2. A clear definition of the normal rhythm and its alterations.
3. Knowledge of the metabolic factors which control cerebral rhythm.
4. A consideration, on the basis of extensive statistics, of the percentage of normal and abnormal tracings in disorders pertaining to legal medicine.[19]

The lack of definite standards with respect to these four points is an important objection to the use of the EEG and has led to the charge that interpretation of such graphs is a matter of individual uncontrolled judgment rather than scientific certainty. As a matter of fact, the accuracy of measurements on the EEG depends largely on the recorder's skill, care, and knowledge of the various variables involved, including the particular position of the electrodes with respect to the lines of force in the electric field. Therefore, any *absolute* measurements of voltage on the EEG are nearly impossible.[20]

Medical authorities are in general agreement that the EEG serves a very useful function in determining *organic* brain damage and certain forms of epilepsy.[21] But there is a disagreement as to whether the EEG can detect *functional* disorders. One school of thought in the medical field has claimed some degree of correlation between the abnormal EEG and the *functional* disorder of the human being.[22] A review of the medical literature indicates that most medical authorities shy away from any conclusion that the EEG will reveal *functional*, as distinguished from *organic*, disorder in the individual. Rowntree has characterized this viewpoint in these words:

> "Electroencephalography is of value in the diagnosis and localization of space occupying brain lesions, in the diagnosis and classification of epilepsy, and in the localization and prognosis of head injuries. It is of some value in certain organic diseases of the nervous system, mainly as an index of cortical involvement, in the diagnosis of mental diseases with an organic basis, in medicolegal cases and in the diagnosis of barbiturate intoxication. It is of little value in differential diagnosis of *functional* nervous and mental disorders, does not indicate loss of brain tissue and is not a measure of intelligence. Electroencephalography is just another laboratory procedure and should be regarded as skeptically as any other test in which results depend on machine, technician, and interpreter."[23]

Hughes confirms this thinking:

> "While the usefulness of electroencephalog-

[14] Gray, *op. cit.*, Note 9, *supra*, Vol. 1, pp. 1031–1041.

[15] Gibbs, *op. cit.*, Note 7, *supra*, Vol. 1, p. 106.

[16] Gray, *op. cit.*, Note 9, *supra*, Vol. 1, pp. 1033–1035.

[17] HILL, DENIS, ELECTROENCEPHALOGRAPHY, p. 360 (McMillan Co., N.Y., 1950).

[18] Paris Correspondent, Application of Electroencephalograph in Legal Medicine, JOURN. AM. MED. ASS'N., Vol. 129, Dec. 27, 1945, p. 1220.

[19] Observations of A. Boudoin and Fischgold, 64th Congress of French Ass'n for the Advancement of Science, Paris Correspondent, JOURN. AM. MED. ASS'N., Vol. 129, Dec. 22, 1945, p. 1220.

[20] Schwab, *op. cit.*, Note 6, *supra*, pp. 22–23.

[21] HUGHES, JOSEPH, Electroencephalography, AM. JOURN. OF PSYCHIATRY, Vol. 105, Feb. 1949, p. 627.

[22] "The frequent finding of abnormal cortical rhythms in psychopaths and behavior disorders generally suggested that direct evidence of abnormal brain function in criminals might be obtained by electroencephalography." HILL, DENIS, ELECTROENCEPHALOGRAPHY, p. 350 (McMillan Co., N.Y., 1950).

Sol Levy and Margaret Kennard, examining 100 prisoners, found that 30% of the EEG records of such prisoners showed abnormal EEG's as compared to 5–10% usually found in the normal population. LEVY, SOL, and KENNARD, MARGARET, A Study of the Electroencephalogram, as Related to Personality Structure in a Group of Inmates of a State Penitentiary, Vol. 109, AM. JOURN. PSYCHIAT., April 1953, pp. 832–839.

For similar studies, see: HEUYER, G., NEKHOROCHEF, I., and LELORD, G., Semaine Hop., Paris, Vol. 33, pp. 211–220, Jan. 20, 1957. Abstract. JOURN. AM. MED. ASS'N., Vol. 163, Ap. 27, 1957, p. 1652.

[23] ROWNTREE, D. W., Clinical Uses of Electroencephalography, Vol. 50, N. ZEALAND MED. JOURNAL, Oct., 1951, pp. 433–536. Abstract, Vol. 148, JOURN. AMER. MED. ASS'N., Ap. 5, 1952, p. 1255.

raphy in the fields of organic mental disease is acknowledged, there is, as yet, no convincing evidence of specific EEG abnormalities in functional psychiatry disorders, nor is there any evidence that the incidence of EEG variability is any greater in patients with such disorders than in the general population despite the numerous reports in the literature to the contrary. These divergent views in the EEG literature are not only confusing but indicate a pressing need for all workers to agree on accepted normal EEG controls against which to check their respective findings."[24]

Fetterman and Victoroff have concluded:

"The EEG has taken its place with the ECG (electrocardiograph) and other devices as a research and diagnostic instrument. Properly integrated with other clinical laboratory and survey procedures, it can help in removal of persons from jobs they should not hold, evaluate mental capacity following a brain injury, detect latent cortical seizure states such as epilepsy, estimate the effect of environment and toxic agents on cerebral function and separate some hysterical from organic disorders. In medicolegal cases it is of special value in the determination of mental capacity in testamentary cases, culpability in criminal cases, latent and actual cerebral damage in compensation cases and malingering in litigation claiming loss of vision, hearing or tactile sensation."[25]

The Early Use of the EEG in English Cases

The use of the EEG in criminal cases to prove or disprove the sanity of an accused was a logical development arising out of the studies and demonstrations of Hans Berger. However, as pointed out by Gray:

"The study of criminals is among the most difficult of all problems presented to the medical profession. While normal electroencephalograms do not conclusively demonstrate that disease processes such as epilepsy are absent, the presence of waves and spikes is strongly indicative of petit mal attacks. Marked abnormalities of almost any type indicate other psychoses. Crime may have been committed during periods of temporary insanity, but less frequently than alleged.

"Criminals frequently claim amnesia, temporary loss of memory. It is most difficult through clinical examination to determine if the usual cause, epilepsy, is present. To wait for a seizure which may be very long postponed is most unsatisfactory. A normal electroencephalogram casts serious doubt upon the allegation. A record of neuronic discharge indicative of epilepsy may prevent the miscarriage of justice."[26]

Three English cases, all decided in trial courts, illustrate the early use of the EEG in the determination of criminal responsibility. An English soldier, who had fired a rifle at a corporal, claimed that he had no knowledge of the affair and suffered a head injury a few hours previously. Apparently, the attack was without motive. An EEG showed abnormalities compatible with head injuries, and the soldier was discharged. In another case a brutal and apparently purposeless murder was committed. The accused claimed that the act was performed in a period of postepileptic confusion. The evidence of epilepsy was tenuous, but an abnormal EEG was produced. The medical expert testified that an absolute diagnosis of epilepsy could not be made on this evidence, as no subclinical attacks were seen, but he concluded that the EEG made the diagnosis of epilepsy likely. The accused was found "Guilty but insane",[27] and so escaped capital punishment.[28]

In another case, a 20 year old student was charged with the murder of his mother. Prior to the time he had killed her, he had drunk 4 pints of beer. He had no recollection of the killing. Two medical men gave him the same quantity of mild beer and upon examination, they found that the accused's blood sugar content was lowered when

[24] Hughes, Joseph, Electroencephalography, Vol. 105, Amer, Journ. of Psychiatry, Feb. 1949, pp. 627–628.

There is no rigid overall relation between the EEG and personality. Gibbs, *op. cit.*, Note 7, *supra*, Vol. 1, p. 78.

The EEG has no absolute value in differentiating the responsible from the irresponsible, Paris Correspondent. Observations of Titeca, Symposium, Belgium Society of Legal Medicine, and Neurology. Vol. 155, Journ. Am. Med. Ass'n., July 31, 1954, p. 1273.

[25] Fetterman, J. L. and Victoroff, V. M., Industrial and Forensic Applications of Electroencephalography, Vol. 4, A.M.A. Arch. Indust. Hyg. and Occup. Med., July, 1951, p. 10. Abstract in Vol. 147, Journ. Amer. Med. Ass'n., Oct. 13, 1951, p. 687.

[26] Gray, *op. cit.*, Note 9, *supra*, Vol. 1, p. 1040.

[27] This is the orthodox finding in English courts where the defendant has been found insane.

[28] London Correspondent. The EEG in Criminal Trials, Journ. Amer. Med. Ass'n., Vol. 121, Jan. 2, 1943, p. 64.

tested with the EEG while under the influence of this beer; the results indicated that the brain waves were erratic and definitely abnormal. The jury, studying the EEG, was apparently influenced by its findings and found the accused "guilty but insane".[29]

No English appellate case, dealing with the admissibility of EEG records in proof of criminal responsibility, has been discovered. In the United States in personal injury cases the EEG has been used rather extensively to prove brain damage.[30] While no reliable source of information seems to be available, the ensuing examination of American appellate decisions indicates that EEG records are used in trial of civil cases on the issue of brain damage and in the trial of criminal cases on the issue of criminal responsibility. Appellate courts have recognized the EEG as valid scientific proof within the rule of the *Frye* case,[31] the polestar which guides the bench and the bar in considering the admissibility of scientific proof.

Considerations of Competency

In considering the admissibility of scientific evidence in general, the New York Court of Appeals in *People v. Magri*[32] recently stated:

> "Almost daily reproductions by photography . . .x-rays, *electroencephalograms*, electrocardiograms, speedometer readings, time by watches and clocks, identity by finger printing, and ballistics evidence, among a variety of kindred scientific methods, are freely accepted in our courts for their general reliability, without the necessity of offering expert testimony as to the scientific principles underlying them". (Emphasis added.)[33]

This, in effect, says that the court will take judicial notice of the working principles of the EEG and that no testimony of an expert nature is necessary to establish its general reliability and the scientific principles underlying the use of the EEG. This is indeed a very liberal approach to a rather complex problem.

Use in Civil Cases: Practically all of the cases examined related to the use of the EEG to prove brain damage either in a personal injury suit or a workmen's compensation proceeding. The holdings in these cases will give us a pretty fair idea as to the evidential worth of the EEG as an instrumentality of proof.

The case of *Egelston v. Industrial Commission of Arizona*[34] involved a situation in which a claimant, seeking compensation for head injuries, introduced the results of a pneumoencephalogram, which is essentially an x-ray of the skull and brain, after removal of spinal fluid from the brain. The results showed some injury to the brain, according to one medical witness, but the Industrial Commission refused to make an award to claimant on the basis of what it considered doubtful evidence. Moreover, the Supreme Court held that it was not error for the Commission to deny claimant's request for another similar test at the expense of the Commission. In the pneumoencephalograph, damage to the brain is ascertained by reading various shadows appearing on the x-ray of the brain whereas in the EEG, no x-ray is involved, the EEG brain wave patterns furnishing the scientific clue as to cerebral injury. Nevertheless, it is important in the study of our problem, to bear in mind that the pneumoencephalograph method is available, although it does involve a painful operation, which the EEG does not.[35]

The first case on the appellate level dealing with the admissibility of an EEG is *Mayole v. B. Crystal & Son, Inc.*,[36] decided in 1943, about four years after Berger's written contributions had come to an end. Plaintiff had sued defendant to recover damages sustained as a consequence of plaster falling upon the plaintiff while he was in a loft building owned by defendant. The New York Supreme

[29] London Correspondent. The EEG as Evidence of Criminal Responsibility, Journ. Amer. Med. Ass'n., Vol. 122, May 15, 1943, p. 190.

[30] Gordy, Dr. Louise J., Concussion of the Brain, 1955 Proceedings of the American Bar Association, Section on Insurance, p. 454. Mundy-Castle, A. C., Electroencephalography and Forensic Medicine, Journ. of Forensic Medicine, Vol. 2, Ap.-June, 1955, p. 95.

[31] Frye v. United States, 54 App. D.C. 46, 293 F. 1013, 34 A.L.R. 145 (1923).

See also Gibbs, F. A., Medicolegal Aspects of Electroencephalography, Canadian Bar Review, Vol. 24, p. 359–388 (1946).

[32] 3 N.Y. 2d. 562, *566, 147 N.E. 2d. 728, 170 N.Y.S. 2d. 335, *338 (1958).

[33] This principle has been repeated several times subsequently: People v. Jones, 10 Misc. 2d. 1067, 171 N.Y.S. 2d. 325 (1958); People v. Duskin, 11 Misc. 2d. 945, 174 N.Y.S. 2d. 527 (1958); People v. Pett, 178 N.Y.S. 2d. 550 (1958).

[34] 52 Ariz. 276, 80 P. 2d. 689 (1938).

[35] In Cole v. Town of Miami, 52 Ariz. 488, 83 P. 2d. 997 (1938), a workman's compensation applicant claimed a permanent damage, including a possible Jacksonian epilepsy, all as the result of a fall. The commission ordered claimant to submit to a pneumoencephalogram. Claimant declined to take such test. It was held that the necessity for taking such test was up to the commission, unless it appeared that such test would greatly endanger the life or health of the plaintiff, without any reasonable prospect of securing information material to the claim.

[36] 266 App. Div. 1008, 44 N.Y.S. 2d. 411 (1943).

Court, Appellate Division, Second Department, held, without discussion, that:

"The (trial) court committed (prejudicial) error in excluding the testimony of plaintiff's medical witness as to the condition or conditions for which the electroencephalograph was a test. It was also error to exclude the electroencephalogram and the records respecting it made in the ordinary course of business. E374-a, Civil Practice Act. . ."[37]

Betz v. Travelers Ins. Co.,[38] is a good illustration of the use of the EEG to prove brain damage in workmen's compensation proceedings. Applicant had been given an award as a consequence of an explosion on the employer's premises, which explosion caused plaintiff's head to be thrown against the ground. Applicant was not satisfied with the award, and subsequent to this determination Dr. P. examined applicant by means of an EEG, found abnormalities present, and concluded that the EEG was strongly suggestive of localized brain damage. Dr. K., basing his conclusion on the EEG, found that applicant had suffered some injury to the brain. The Court of Appeal of Louisiana, First Circuit, remanded the case to the District Court to allow the plaintiff to take the testimony of Drs. P. and K. as to such EEG for the purpose of showing whether plaintiff suffered any brain damage, reserving to defendant the right to introduce similar evidence.[39]

Snyder v. Jensen[40] also involved a personal injury case. Plaintiff was a passenger in an automobile and sued the host driver for a permanent brain damage. Plaintiff's medical witness, Dr. M., as part of his medical examination, ordered an EEG. This was done under his direction at Washington University School of Medicine, St. Louis, the doctor being in charge of the department of neurology and psychiatry. Dr. M. interpreted the EEG graphs and made a finding indicating a disorder of the brain, which he took into account in concluding that there was permanent brain damage; he also found that the pattern is different when the brain is diseased as compared to a normal pattern. Defendant objected on the ground of hearsay. The Supreme Court of Missouri concluded that (1) there was sufficient identification and authentication of the EEG since it was made at his request and direction while he was head of the department and (2) the doctor could base his opinion on the EEG as well as other evidence in the case.[41]

In *Melford v. Gaus and Brown Construction Co.*,[42] an almost parallel situation, plaintiff, a minor, struck his head on a heavy plank on the ground. It was contended that plaintiff sustained permanent brain damage. Three EEGs of plaintiff were made by Dr. F. A. Gibbs, a renowned expert and author in electroencephalography;[43] all the EEG tests bore notations identifying them as ones taken of the plaintiff. Dr. Gibbs, at the trial, testified that when the tests are made he sets up prescribed conditions which give objective findings when extraneous radiation disturbances and patient disturbances are held to a minimum; that the particular tests are made when the patient is asleep and this was true of the plaintiff; that the tests were made by a technician under the direction of Dr. Gibbs. There was also testimony that experts can tell from examining the tracings whether the results of a given test are valid.

The Illinois court held that the testimony of Dr. Gibbs justified the inference that the machine was properly calibrated and in proper functional order and that the graphs were made under competent technical care. The court also rejected the argument that the technician who made the EEGs should be produced in view of the fact that Dr. Gibbs himself authenticated such documentary proof. The court also held that another neurologist, in answer to a hypothetical question, including the testimony of Dr. Gibbs that the EEG showed permanent brain damage, could testify that there was brain damage. A reading of the opinion indicates that the court was impressed by such testimony and affirmed the award in favor of the plaintiff.

The necessity for calling a neurosurgeon in addi-

[37] *Ibid.*, N.Y.S. 2d cit., p. 412. In Accord: People v. Jones, 171 N.Y.S. 2d. 325,* 330 (1958); Wheeler v. United States, 211 F. 2d. 19 (C.A.D.C. 1958).

[38] 68 So. 2d. 666 (La. App. 1953).

[39] On a remand, the District Court reaffirmed the original award after listening to the additional testimony by Drs. P. and K., for the plaintiff, and Dr. K., for defendant. On appeal by plaintiff, this judgment was affirmed: Betz v. Travelers Ins. Co., 82 So. 2d. 379 (La. App. 1955). The Court of Appeal of Louisiana, First Circuit, emphasizes the point that while the EEG may demonstrate the exact locality of irritative lesions, confirmatory objective symptoms permit determination more accurately and that the EEG has not established a new method of sufficient certainty to replace careful clinical observations.

[40] 281 S.W. 2d. 802 (Mo. 1955).

[41] See also Louisville and Nashville Railroad Co. v. Tucker, 262 Ala. 570, 80 So. 2d. 288 (1955), in which an award of $50,000.00 for permanent brain injury was upheld on the basis of EEG and other evidence in the case.

[42] 151 N.E. 2d. 128 (Ill. Apps. 1958).

[43] Dr. Gibbs is the coauthor of the most comprehensive work on the EEG; see Note 7, *supra*.

tion to an EEG expert was recently considered by the Texas Civil Appeals Court in *Lantex Construction Co., v. Lesjal.*[44] The case involves a typical brain injury situation, plaintiff striking his head after he fell off a scaffold, into which defendant's truck had run. A Professor P., an expert at making an electrical diagnostic test on an EEG,[45] testified that he made such test on the plaintiff and that it reflected brain damage. He also stated that he was not a neurosurgeon and could not say what might have caused the brain damage. The EEG testimony was admitted. Plaintiff had intended to put on a neurosurgeon, but never got around to it. However, a medical doctor on behalf of plaintiff did testify that as a result of the fall plaintiff was rendered unconscious, that he did foam at the mouth; that he remained unconscious for six hours; that as a result of the accident plaintiff suffered from headaches and loss of memory and that he did have a brain concussion. The Texas court, in upholding the right to have the EEG received in evidence on the theory that the EEG findings were compatible with the doctor's observations, concluded:

> "Consequently, the electroencephalogram having been identified as that of the plaintiff and offered by a competent witness, and there being supporting testimony that plaintiff had sustained a concussion in the fall, the jury were entitled to consider the testimony."[46]

An analysis of these decisions would seem to indicate a rather liberal attitude on the part of the courts in admitting the results of EEG tests in civil cases. Will the same principles apply in criminal cases on the issue of criminal responsibility?

Use in Criminal Cases: The admissibility of the EEG on the issue of criminal responsibility was considered for the first time by an appellate court in *State v. Shiren,*[47] decided in 1951. The accused was indicted and convicted of an assault and battery and causing death by reckless driving of an automobile. The state contended the defendant was intoxicated. The accused's defense was illness, which caused him to "black out", and defendant offered to prove that his doctor performed an EEG on him; that an EEG discloses any abnormalities in brain wave pattern and ordinarily will reveal whether one has suffered a stroke depending upon the part of the brain wave involved; that defendant's doctor had obtained EEG results which would indicate a brain disease. The trial court rejected such offer of proof. The Superior Court of New Jersey, Appellate Division, held that the exclusion of the offered medical testimony as to the results of the EEG was erroneous and affected defendant's substantial rights.

From the standpoint of criminal responsibility, *State v. Piggle,*[48] is important. In a Wyoming prosecution for murder, defendant entered a plea of insanity. Pursuant to the statute, the court directed defendant to be taken to the state hospital for mental examination. He was subsequently taken to the office of Dr. P., a neurologist and neurosurgeon, Salt Lake City, Utah, where Dr. P. took an EEG of the accused while the latter was awake. There were no facilities for taking an EEG in Wyoming at that time. Dr. P. testified that the test showed no abnormality. He admitted that the test was better while the patient was asleep, but he concluded that taking the test while the accused was awake made no difference in this case. The appropriate hypothetical question put to the doctor included the findings of the EEG. The doctor concluded the accused was sane.

Defendant objected to the EEG test on the ground that it should have been given while he was asleep, but the court held there was sufficient evidence beside the EEG to warrant a conviction. As to defendant's complaint that he should not have been taken out of the state for the purpose of taking the EEG, the Wyoming court held that defendant's lack of objection to the EEG test was a waiver and that the test was actually taken for the benefit of defendant. The court also held that such taking of the test did not violate the Fifth Amendment, and that the physician-patient privilege did not apply because the doctor was not accused's physician.

This case sustained the use of the EEG to prove that the defendant was sane, although experts for both the state and defendant relied on EEG findings.

Although the authorities in the criminal field

[44] 315 S.W. 2d 177 (1958).

[45] The opinion does not indicate whether the expert was a medical doctor.

[46] *Ibid.*, S.W. 2d. cit., p. 184.

[47] 15 N.J. Super. 440, 83 A. 2d. 620 (1951).

[48] 298 P. 2d. 349 (Wy. 1956), rehearing denied 300 P. 2d. 567 (Wy. 1956), cert. den. 352 U.S. 981, 77 S. Ct. 384, 1 L. Ed. 2d. 366 (1957).

In the recent case of State v. Goza, 317 S.W. 2d. 609 (Mo. 1958) both the state and defense experts relied on EEG tests. Defendant was convicted. The Supreme Court of Missouri affirmed without discussing the evidential aspects of the EEG, although it refused to accept as conclusive the defense medical testimony that the EEG showed brain damage.

are few in number, one can conclude that the EEG has been accepted as a scientific instrumentality of proof on the issue of criminal responsibility. Obviously, in considering the admissibility of an EEG in a particular case, the court must consider the limitations of the EEG. If they are substantial, then the evidence is incompetent; if trivial or of minor consequence, the courts will undoubtedly admit the evidence and instruct the jury that the limiting factors may affect the weight of such proof.

The writer's general conclusions with respect to the use of the EEG have been supported by a very recent decision of the Wisconsin Supreme Court in the case of *State v. Carlson.*[49] Carlson had been convicted of arson and third degree murder, as the result of the arson. Carlson's plea in each case was not guilty by reason of insanity. The arson and murder cases were tried together. The defendant, while awaiting trial, was tested at his own request by means of an EEG. At the trial Dr. D., who took the test, was called as a witness on behalf of the defendant.

Upon objection by the state to any testimony by Dr. D. as to the results and interpretations of the test, defendant, in the absence of the jury, offered to prove that Dr. D. did make the test; that Dr. D. made an interpretation of the test; that the EEG pattern showed a brain abnormality that was probably of organic origin, resulting from brain trauma; that Dr. D. could not state from her findings that the defendant did not know the difference between right and wrong; that the findings did not indicate any mental disease in Carlson; that disturbances of the type she found in Carlson are found in individuals who have an organic condition acquired early in life from one of several causes plus emotional background consisting of instability of the individual's environment; that such a person has an impulse to carry out the act and has no control; that he will carry out the act to completion because he has no control; and that the EEG tracings arise from the organic cause and that the emotional factors cause the rage reaction; that these individuals do not have normal control.

The trial court sustained the state's objections upon two grounds: (1) The results of the tracing would be of no probative value except preliminary to further testimony; and (2) that if the findings tended to prove that any misconduct of defendant would be attributable to irresistible impulse rather than lack of ability to distinguish between right and wrong, her testimony would not be relevant to the issue of insanity, since Wisconsin follows M'Naghten. Upon appeal the Wisconsin Supreme Court held:

1. The results of the EEG tests, standing alone without other medical testimony, are of no probative value. The court pointed out that here there was no medical opinion offered, based on the EEG, the facts as to defendant's background and early life, and circumstances of the alleged offense, as to defendant's mental capacity or condition at the time of the offense, defendant then being 17 years of age.

2. The results of the EEG test, if properly supported by medical opinion, are admissible on the issue of insanity even in a M'Naghten state, if they reasonably tend to show the mental condition of the defendant at the time of the offense.

In reaching its conclusions, the court makes no reference, whatsoever, to any authorities on the subject.

Summary

On the basis of the cases decided by the appellate courts to date, we may say with absolute confidence that the EEG, when used to prove or disprove *organic* brain damage or epilepsy, has passed the test established by the *Frye* case.[50] Certainly, we may say that for this particular purpose the EEG has "gained general acceptance in the particular field to which it belongs". However, the EEG, though persuasive, does not *ipso facto* prove or disprove *organic* brain damage or epilepsy and, by inference, sanity or insanity. The EEG is only a diagnostic tool used by the medical man to reach a preliminary conclusion whether there is or is not organic brain damage or epilepsy, and a final conclusion whether the individual is sane or insane. The observer medical witness must still rely on his general observation and examination of the patient, who, as the psychiatrists say, must be considered as a whole. The pure expert, basing his conclusions not on observed facts but upon facts assumed in a hypothetical question, must arrive at his opinion on the basis of all the evidence pertinent to a particular hypothesis, including the results of an EEG test. In other words, the EEG can only be interpreted with the aid of case histories and clinical findings.

Moreover, the EEG merely proves that there was or was not organic brain damage or epilepsy

[49] 93 N.W. 2d. 354 (Wis. 1958).

[50] Frye v. United States, 293 Fed. 1013,* 1014 (C.C.A., D.C., 1923).

in the case of a particular individual. Here again to reach the conclusion or opinion that a particular individual was sane or insane, the opinion of the medical man will have to be based on proven case histories and clinical findings of the individual, including the results of the EEG studies. Obviously, as appears from our study of the English cases, the findings of the EEG have a very persuasive effect upon the jury.

We have a more serious legal problem when we consider the EEG findings to prove or to disprove a claimed *functional* psychiatric disorder, as distinguished from organic brain damage or epilepsy. The disagreement among the medical authorities has already been noted and in itself should be sufficient reason why EEG results as to *functional* psychiatric disorders should be excluded, until such time as such test is generally accepted in the field. We know that many of our criminals are psychopaths suffering from a *functional* and not an organic, disorder.[51] For this reason alone, the courts should exclude EEG tests to prove *functional* disorder, until such time as the scientists themselves can agree on their value in this field. It should be pointed out that none of the courts has considered this specific problem.

Assuming that in general an EEG test is admissible, certain preliminary requirements must be satisfied. The general principles and reliability of the EEG need not be proved by expert testimony, as the court will take judicial notice of them, if the view of the New York courts is accepted as controlling. The test must be identified as being those of the particular individual involved and must be authenticated. Authentication includes proof that the machine was properly calibrated, in proper functional order, and manned by competent operators. A properly trained technician may make the test and may testify as to the significance of the findings. However, a medical man is still necessary to interpret the findings with reference to the particular individual involved, as that is a medical question. A doctor, under whose *direction* and *supervision* an EEG is taken, can authenticate such graphs, without calling the technician. Under some decisions EEG records made in the regular course of business are admissible under the regular entry statute.

It is very apparent, on the basis of past developments, that the EEG will continue to assume a dominant role in the trial of criminal cases in which the issue of insanity is in the picture.

Several questions are raised by this study. There is an indication in the literature that the EEG is useful in determining barbitrate intoxication.[52] Might not experimental studies be made to determine whether the EEG could be of help in determining *alcoholic* intoxication and whether the EEG may be used in conjunction with other machines now in general use in the field, such as the Harger Drunkometer, the Intoxicometer, the Alcometer, and the Breathalyzer?

It also seems quite logical to suggest that brain wave patterns of persons subjected to the standard lie detection tests now in use should be studied on an experimental basis to determine whether there is any correlation between conscious deception and the form of the brain wave.

[51] See SUTHERLAND, EDWIN H., AND CRESSEY, DONALD R., PRINCIPLES OF CRIMINOLOGY, pp. 117–137 (5th Ed. Lippincott Co., N.Y., 1955).

[52] Note 23, *supra*.