1

Historical Review of Electroencephalography in Psychiatry

Nash Boutros
School of Medicine, Wayne State University, Jefferson, Detroit, MI, USA

Introduction

The very beginning of the field of human electroencephalography (EEG) emerged directly from the field of psychiatry. Its founder, Hans Berger, was a biologically orientated psychiatrist with strong interests in the relationships between mind and body (Figure 1.1) [1]. In 1924, after years of frustrating failed experiments, his overwhelming dedication and persistence finally resulted in the first non-invasive scalp EEG recordings from humans and in 1929 he launched nearly a decade of landmark publications (all in psychiatric journals) that essentially laid down the very foundation of this new field.

Recent decades have seen a substantial resurgence of interest in biological psychiatry and perhaps this will permit greater utilisation of those strengths of EEG already known to exist as well as those that appear to hold substantial promise pending further research. Berger, if he were alive today, would surely be pleased.

The early pre-clinical era

Richard Caton, a Professor of Physiology, was the first to document the existence of electrical potentials emanating from the brains of live animals [2]. The electrical currents
of the brain concept was not enthusiastically received because leading authorities of the time simply knew that the brain did not produce a global electrical field.

Following Caton’s discovery several exciting developments emerged which not only confirmed his work but also significantly amplified and extended his findings. In one of them Adolf Beck [3, 4] was able to show that the visual cortex of the dog produced large electrical potentials when the animal’s eyes were rhythmically illuminated. Although Beck could not have known it at the time, his work anticipated the later discovery of ‘photic driving’ in the human EEG and the subsequent development of ‘photic stimulation’ for use in activating spike and/or spike wave discharges during clinical EEG studies. Fleischl von Marxow [5] (1890, Vienna) found that the electrical potentials that were recorded could be modified by illuminating the animals eyes and that this phenomenon could be abolished by chloroform. Several early investigators continued to produce evidence that peripheral stimulation of various kinds could produce alterations of the electrical activity detected from the surface of the animal’s exposed cortex [1]. Much of this work anticipated today’s field of human evoked potentials. As this early period was coming to a close, significant technical improvements in recording amplifiers made it easier to obtain recordings of electrical activity from the outer surface of the animals skull and this more than anything made studies with humans possible.
Early history of human electroencephalography

The early history of human electroencephalography is essentially the history of Hans Berger’s work. Berger proceeded over the next decade to publish a landmark series of 23 papers covering many of the fundamental phenomena of the human EEG.

Berger’s achievements are far too numerous to document in detail. Amongst his historical achievements is coining the term alpha waves to describe the 10 Hz activity characterising the awake relaxed EEG of adult humans and, of course, he coined the word ‘electroencephalogram’.

In less than a decade after Berger’s initial publication, the potential use of EEG was being very actively explored in psychiatry and neurology. The strongest correlations between EEG findings and clinical disease involved epilepsy, structural lesions and encephalopathies and this fact essentially moved electroencephalography closer to the discipline of neurology and away from its roots in psychiatry. Although at the same time several minor EEG abnormalities were being found in much higher incidences in samples of psychiatric patients as compared with normals, most of these EEG findings lacked clear psychiatric diagnostic specificity and this operated to reduce interest in EEG amongst many psychiatrists.

The impetus for using EEG in the study of seizure disorders began when Frederic Gibbs became aware of an animal study by Fischer [6] that showed that high-voltage discharges in the brain were produced when the animals were thrown into seizures by administering convulsive drugs. Gibbs and his team soon discovered [7] the diffuse 3/sec. spike and wave and this finding became the EEG signature for petit mal epilepsy. Many other discoveries related to epilepsy soon followed.

Of more specific relevance to psychiatry was the discovery a little over a decade later [8] of the focal anterior temporal EEG spike discharge which became recognised as a diagnostically useful interictal EEG finding in complex partial seizures (previously ‘psychomotor epilepsy’). This EEG finding continues to be under-investigated in order to clearly identify its differential diagnostic implications in the practice of psychiatry. This discovery by Frederick and Erna Gibbs and their collaborators was followed by the description, by the same group, of a number of EEG patterns that tend to be more common in psychiatric patients and have come to be collectively known as the ‘controversial EEG patterns’. Frederick Gibbs (Figure 1.2) is widely regarded as the true father of clinical electroencephalography.

Second only to seizure disorders, space-occupying lesions provided an avenue through which early EEG could begin to prove its clinical value. The early EEG discoveries in structural lesions were particularly relevant to psychiatrists of that time, and up until the introduction of CT scans EEG referral for suspected tumour was an accepted and valuable part of psychiatric practice. This was understandable because the early literature contained numerous references to the frequent occurrence of psychiatric symptoms in patients found to have brain tumours [9–12], a phenomena which has remained constant up to the present.
Unlike the field of epilepsy, where EEG had strong clinical roots and where it still remains as a mainstream clinical tool, the assessment of suspected structural lesions has largely moved away from EEG to embrace the more recent imaging techniques, which admittedly are more definitive. Today, practitioners in metropolitan areas would seldom consider EEG as a first referral option for suspected brain tumour. Nonetheless, one should not forget that in some of the more rural locations EEG may be quite a bit more available than the newer and more expensive imaging techniques and it still will detect focal slowing in nearly 90% of tumours of the outer cortex [13].

In one of his later papers, Berger [14] secured EEG tracings from a psychiatric patient undergoing treatment with insulin and was able to demonstrate that EEG slowing accompanied the induced hypoglycaemia. As Niedermeyer [15] later observed, this ushered in the whole wide field of EEG studies of all types of encephalopathies, including delirium.

Historically, the early EEG discoveries occurring with epilepsy, structural lesions and encephalopathies were of considerable clinical value and were often used in assessing what were sometimes life-threatening events. Thus these were the early uses of EEG which had the highest visibility and recognition and because of this EEG came to be increasingly identified with neurology. Gradually, over ensuing years, most (but not all) EEG laboratories became housed within neurology departments or neurology practices.
The neurology discipline appreciates hard EEG data with well-documented and strongly supported diagnostic relevance. Psychiatry must of necessity (at least at the current state of knowledge) be concerned with EEG findings that are associated with a variety of altered behaviours and not necessarily with diagnostic categories defined by current classification systems. The value of EEG findings in psychiatry must be determined from within the field of psychiatry and cannot be evaluated in terms of the clinical conditions deemed important by neurologists.

**Electroencephalography in psychiatry today**

The interest for electrophysiology in psychiatry is undergoing a renaissance, especially for research purposes; examples are the increasing number of papers on electrophysiological endophenotypes of schizophrenia or multimodal imaging including electrophysiology to unravel neurobiology of psychiatric disorders. Initiatives to promote EEG applications in psychiatry are today found in the mission of scientific societies such as the EEG and Clinical Neuroscience Society (ECNS) and the Psychophysiology Section of the World Psychiatric Association.

**References**
