

Neuropsychological Research Approaches in the Epilepsies

G. K. NELSON

SUMMARY

The contributions of electro-encephalography to neurology and neurosurgery have tended to overshadow its value for the neuropsychologist as a tool for the study of instability of brain function in relation to the epilepsies and the borderlands of epilepsy. Studies of criminal behaviour have shown a high incidence of epilepsy and abnormal EEGs among murderers and some psychopaths, but no simple link between the epilepsies and criminal behaviour has been demonstrated. Alcohol has been shown not only to change the dominant frequency of the EEG but also to produce epileptic-type EEG discharges in some subjects, suggestive of brief disturbances of consciousness. Temporal lobe dysfunction as reflected in the EEG has been found in psychic mediums and in many members

of a sample drawn from a low-intelligence isolated community, possibly a genetic trait in the latter case. A new project is aimed at studying the contingent negative variation in relation to epilepsy and to anticonvulsant medication.

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It is well known that since its acceptance as a respectable discipline less than 40 years ago, electro-encephalography has more than proved its value in the diagnosis and management of the epilepsies. The achievements of the EEG in the fields of neurology and neurosurgery have tended to overshadow its value as a research tool in behavioural science, particularly for those working in the area where neurology and psychology tend to overlap, namely neuropsychology.

In the study of the electrical activity of the brain in relation to behaviour, indications of instability of brain function are often encountered. Sometimes these have a direct and obvious link with the epilepsies and sometimes they appear to relate to the borderlands of epilepsy,

Neuropsychology Division, National Institute for Personnel
Research, CSIR, Johannesburg

G. K. NELSON

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although not precisely in the sense that Gowers¹ used the phrase.

At the National Institute for Personnel Research a number of studies in these categories have been carried out or are in progress. I propose in this paper to offer a survey of some of these investigations.

CRIMINAL BEHAVIOUR

A short account of a series of studies by our Institute in the area of criminal behaviour in relation to the epilepsies is perhaps not out of place.

There have been many EEG studies of murderers but little has been added to the findings of Hill and Sargent,² Stafford-Clark and Taylor³ and Hill and Pond⁴ of an association between aggressive psychopathic behaviour and EEG abnormalities suggestive of maturation defects, for example excessive theta activity of temporal origin or unilateral temporal lobe slow wave foci. Furthermore, there would appear to be among murderers an unusually high percentage of epileptics. Nevertheless, violent or aggressive behaviour of a directed kind very seldom if ever occurs during an ictal period or immediately thereafter, so that it seems unlikely that there is a narrow relationship between aggressive acts and seizures as such. The occurrence of both in the same individual may be due to a cortical maturation defect as reflected in EEG abnormalities confined to the temporal lobe. Other, not necessarily mutually exclusive, explanations may be found in brain injury or low stress tolerance, either of which could account for both epileptic and behaviour disorders.

These general findings were confirmed by an NIPR study⁵ of 20 persons who had each committed one or more murders, and 2 cases of attempted murder, all 22 of whom had been found mentally disordered or defective, guilty but insane, or in 1 case, already a mental hospital patient. The salient findings were that 6 (27%) of the 22 cases were confirmed epileptics, 16 (73%) had abnormal EEGs, 6 (27%) had unilateral temporal lobe foci and no fewer than 14 (64%) had anterior alphoid rhythms, perhaps suggestive of emotional immaturity.

More recently we carried out a comparative study of 194 prisoners, 100 of whom were classified by an independent panel as non-psychopathic, 56 as aggressive psychopaths and 38 as non-aggressive psychopaths.⁶ The relatively high incidence of paroxysmal EEG abnormalities was striking (40 or 20%), and the aggressive psychopaths showed significantly more abnormal EEG responses to photic stimulation and a significantly greater increase in slow activity during hyperventilation than did either of the other groups. It has been suggested that abnormal activity evoked by photic stimulation is associated with behaviour deviation in children, particularly if epilepsy is present⁷ and may reflect a relative inability to withstand physical and psychological stress. Both criminal and non-criminal psychopaths have been reported to display this form of cerebral instability.⁸

There is thus a clear but by no means simple link between epilepsy and criminal behaviour.

ALCOHOL AND THE EPILEPSIES

The question of a relationship between alcohol intake and seizures in the epilepsies is a complex one. Gowers¹ saw alcoholism as 'a rare cause of epilepsy' (page 24), but Lennox and Lennox⁹ asserted that epilepsy in acute alcoholism is a result of disturbed brain metabolism, while in chronic alcoholism epilepsy may be secondary to a variety of brain lesions.

In non-alcoholic epileptics, Rodin *et al.*¹⁰ found evidence that ethyl alcohol was rather well tolerated, provided anti-convulsant medication was continued, a finding supported by Gastaut and Tassinari's¹¹ study of 3 000 non-alcoholic epileptics.

It is generally accepted that the effect of ethyl alcohol on the normal EEG is to slow the frequency of the alpha rhythm. An extended study at the NIPR¹² showed that this was dependent on the initial frequency of the alpha rhythms. Where this was below about 9.5 Hz some subjects showed either no change, or even an increase in alpha frequency. During these studies an incidental observation was made which is of more direct relevance to this conference. In an early experiment with 29 subjects, 1 was a known epileptic with a mildly abnormal record before and after alcohol and tea (on different days). Two other subjects showed brief paroxysmal bursts in their EEGs at less than 5 Hz, but only after alcohol. In a second experiment 4 out of 8 subjects showed paroxysmal 3-7 Hz bursts. Only 1 of these had such abnormalities in his record before drinking. In the third experiment, involving 25 subjects, each had, over 5 consecutive days, 5 pre-treatment EEGs, 12 records at 1, 2 and 3 hours after alcohol, and 3 records after a placebo. Abnormal EEGs were seen in 13 (52%) of the subjects, in the form of spike discharges and/or paroxysmal bursts of slow activity. Only 6 (4.8%) of the 125 pretreatment records were abnormal. Only 2 abnormal EEGs were seen after the placebo, and 58 after alcohol. Apart from the 1 epileptic, none of these subjects had any clinical abnormality.

These EEG disturbances did not appear to be localised, and raise the question of involvement of the reticular formation as suggested by Himwich *et al.*,¹³ but the question is, did they represent episodes of an epileptic kind, or were they reflections of non-pathological changes in arousal level, perhaps associated with specific metabolic processes but without clinical or behavioural significance?

Although these EEG discharges were apparently not accompanied by autonomic changes, their wave form suggests that they might have reflected brief intervals of disturbed consciousness, a kind of behavioural impairment after alcohol, which is at least as important in such contexts as road safety as is the relatively steady impairment usually ascribed to alcohol intake.

TEMPORAL LOBE DYSFUNCTION

Because of its more or less diffuse connections with such regions as the hippocampus and the limbic system in general, it is not surprising that functional instability of

the temporal lobe is often associated with the most bizarre of all epileptic phenomena.⁹ For the same reasons it is also surprising that such instability is associated with a wide variety of more or less deviant behaviour patterns, apart from criminal behaviour. The clinical study of Rey *et al.*¹⁴ identified three types of patients with only EEG evidence of temporal lobe dysfunction, the 'epileptic', 'epileptoid' and 'constitutional'. All three had defective personality characteristics, but the 'epileptoid' group had in addition episodic disturbances of consciousness and behaviour, while the 'epileptic' group had generalised seizures.

Temporal lobe dysfunction also has well-established associations with perceptual, speech and psychomotor disorders¹⁵⁻¹⁷ and with learning difficulties.¹⁸ There is very considerable literature dealing with temporal lobe dysfunction in relation to neurosis and psychosis.^{19,20} Episodic psychoses resembling schizophrenia were reported to be often found in association with temporal lobe epilepsy²¹⁻²³ and a biochemical link between epilepsy and schizophrenia was proposed by Reynolds.²⁴ There is a significant association between schizophrenia and epilepsy involving the temporal region of the dominant hemisphere, according to Flor-Henry.²⁵

Epileptic and non-epileptic disorders of the temporal regions are therefore of great interest to the neuropsychologist. Apart from the apparent significance of such disturbances in the aetiology of criminal behaviour, two other research projects rather unexpectedly brought the function of the temporal lobe into the limelight in an initially purely behavioural context.

Psychic Mediums

One of these concerned psychic mediums. Initially our interest lay in possible differences between trance and non-trance EEG patterns. We carried out experiments with 10 women and 2 men who reported mediumistic abilities.²⁶ We were also able to persuade 6 of the women and 1 man to go into a trance during the EEG examination. Hypnotic stimulation was applied as a routine in all cases.

Of these 12 cases no fewer than 10 showed localised EEG signs of unilateral temporal lobe instability, with no preference for left/right or dominant/subdominant hemispheres. In 5 of these 10 subjects the abnormalities were of the kind often found in the interseizure records of epileptics, i.e. focal paroxysmal bursts, spikes or sharp waves. Three others of these 10 had occasional focal sharp waves.

One other case had a partial suppression of alpha rhythms in the left hemisphere and the remaining EEG was normal. Electro cerebral changes during trance were inconsistent.

There were no reports of epilepsy in the histories of any of these 12 volunteers, but their EEGs as a group differed markedly from those obtained by other workers in a variety of more or less parapsychological contexts such as trances and ESP experiments.²⁷⁻²⁹

Because of the small sample involved at least three hypotheses remain to be tested: (i) the incidence of tem-

poral lobe disturbances in this group was fortuitous; (ii) there is a link between temporal lobe dysfunction, and possibly temporal lobe epilepsy, and reports of such parapsychological abilities; (iii) the abnormalities seen fit the mathematical model of Griffith,³⁰ which led to his speculation that the experiences of mediums might have an origin in interhemispheric asynchrony.

Forest Workers of Knysna

A second study in which the function of the temporal lobe assumed prominence was aimed at an extension of work that had revealed a correlation between the alpha frequency of the EEG and scores on intelligence tests.³¹ Because we had studied only relatively high-intelligence groups up to that time, we felt the need to repeat the investigation on a low-intelligence sample. We settled on the forest workers of Knysna, a community of several thousands with a two-century history of social and cultural isolation and intermarriage.

EEG examinations were carried out on 94 men and 2 women. A comprehensive battery of tests comprising the South African standardisation of the Wechsler-Bellevue Intelligence Test and a number of non-verbal tests of intelligence devised by the NIPR were administered to the majority of these subjects.³²

There were again low but significant correlations between alpha frequency and scores on the cognitive tests, but we were startled to find that 49-51% of these subjects had abnormal EEGs, all but 1 containing bilateral shifting foci in the temporal lobes, usually in the form of sharp waves, spikes or bursts of rhythmic activity at 2-14 Hz. These foci were predominantly left-sided in 29 cases, bilaterally equivalent in 10 and mainly on the right in only 9 subjects. In addition there were often generalised paroxysmal disturbances and the over-all degree of abnormality was mild in 11 cases, moderate in 13, and severe in 24. The remaining abnormal record had occasional bilateral frontotemporal theta runs and bursts.

There was no over-all relationship between EEG abnormality and clinical history. There was only 1 obvious case of epilepsy in the abnormal group and 2 possibles in the normal group. However, there was a clear tendency for the abnormal group to achieve poorer scores on the tests of mental ability.

There are no precise data on the incidence of epilepsy among the forest workers of Knysna, although it seems that it may be somewhat higher than in the rest of South Africa. Nevertheless, the very high incidence of EEG abnormality in this sample, and the predilection of these abnormalities for the temporal region remain surprising. The intensive study of temporal lobe epilepsy by Bingley³³ reported that foci of this kind among non-tumour patients were often associated with a syndrome of intellectual, affective and volitional 'adhesiveness' or 'viscosity', frequently with mental retardation, circumstantiality, stubbornness and pedantry. At least some of these characteristics of Bingley's syndrome of 'ixizophrenia' were typical of the members of our sample.

Whether or not these temporal lobe foci reflected latent epileptic conditions, their aetiology was a mystery.

The prolonged isolation of the community suggested the possibility of a genetic contribution, but other causes such as birth injury and infantile malnutrition could not be excluded. A subsequent NIPR expedition investigated 131 children of the original sample. Abnormal EEGs, mostly with temporal and occipital foci, were found in 42%, in spite of improvements during the past few decades in respect of obstetric, nutritional and educational facilities in the area. Thus the genetic hypothesis was supported, but there was again no obvious relationship between EEG abnormality and history. Typically epileptic, that is to say paroxysmal, abnormalities occurred in the EEGs of 20 of these children in the resting state, while there were 33 with focal disturbances. Paroxysmal responses to hyper-ventilation were equally common.³⁴

The possibility of a preponderance of epileptic or epileptoid patterns of brain function and behaviour, linked with diminished intellectual ability, in communities of this kind raises fundamental questions relating to the optimal use of manpower, and more specifically, the association between epileptic disorders and integrity of cognitive brain function.

COGNITION AND THE EPILEPSIES

The ever-increasing complexity of the technological environment that man is developing for himself is making corresponding demands on him. If we are to keep pace with this harsh new world no effort can be spared to identify the factors that may inhibit mental ability. It is generally accepted that there is no simple relationship between intelligence and the epilepsies. It appears that with adequate medical and social care the intellectual ability of many patients will increase and their cerebral dysrhythmia decrease,⁹ but questions have been asked about the relative effects of an epileptic disorder and anti-epileptic medication. This is an issue of particular importance for the developing brain.

With the aim of throwing more light on this problem the NIPR is currently engaged in a project based on the assumption that in a society with a multiplicity of cultural and ethnic backgrounds one of the more reliable indices of the integrity of brain function may be its electrical activity, in particular the contingent negative variation or CNV, first described by Walter *et al.*³⁵ This is a relatively slow electrical change in the cortex that appears to reflect a state of expectancy. This presupposes the ability to ascribe a particular significance to a stimulus of an essentially simple nature, for example, a click or a light

flash presented as a warning that another and different stimulus will be presented, requiring a prescribed, usually motor, reaction on the part of the subject.

The CNV has been reported to be altered in various pathological conditions and it is our ultimate aim to determine the relative contribution to such alterations of an epileptic disorder and medication in different ethnic groups. We have established that in normal subjects the CNV appears to be a phenomenon that is reliable over short and relatively long periods. It is hoped that studies of the CNV in epileptics will be completed this year.

I wish on behalf of the NIPR to express our appreciation to the Witwatersrand Branch of the South African National Epilepsy League, for arranging for the donation for the purposes of this project of a multichannel magnetic data recorder.

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