

## THE ELECTRO-ENCEPHALOGRAM IN SCHIZOPHRENIA.

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THIS preliminary survey of a group of schizophrenics at Friern Hospital was undertaken in order to find out whether such cases presented any electro-encephalographic deviation from normal. In the event of positive results being obtained it was hoped that, in addition to further lines for research being indicated, some light might be thrown on the issues raised by Hoagland, Cameron and Rubin (1), (2), (3), and Lemere (4) regarding electro-encephalograms in treated and untreated psychotics.

The observations were made with a portable two-channel electro-encephalograph. This has balanced input stages, and uses directly heated high-frequency pentodes for the main amplifiers. A single "Standard Telephones" self-contained portable cathode-ray oscillograph is used, driven from a 2-volt accumulator with an interruptor for the high tension and time base supplies. The two channels are connected alternately 30 times a second to the oscillograph by means of a commutator driven by a spring motor, and the beam is at the same time biased so that the illusion of a double trace is produced on the screen which, being of the after-glow type, preserves an image of the potential changes from the two channels long enough for their form and phase relations to be observed. This equipment is independent of mains and earth connections and is very economical. It is not suitable for exact localization, but was developed specially for this type of preliminary study and for routine clinical testing when the main features of the electro-encephalogram are likely to be the slow delta waves associated with cerebral tumours and epilepsy.\*

As stupor seemed an admirable condition for electro-encephalographic technique, most of the cases selected were of this type. Yet it was soon found that much otherwise excellent clinical material had to be excluded owing to the gross negativism displayed and the lack of the necessary degree of co-operation. Furthermore, blinking and eye movements proved to be an important and

\* The records in Fig. 1 were taken with a three-channel machine from selected patients transported to the Maida Vale Hospital.

unexpected source of fallacy. As clinical phenomena these movements have been mentioned by such observers as Kraepelin (5), Lewis (6) and Stoddart (7), and in their early electro-encephalographic studies Adrian and Matthews (8) recorded the associated rhythmic potentials. In the present investigation they have been found to produce wave forms on the oscillograph screen indistinguishable, in certain circumstances, from delta waves. This difficulty was overcome to some extent by placing the electrodes so as to differentiate between potentials of ocular origin and those arising from further back on the head. In cases where the delta rhythm was not prominent, however, these persistent rapid eye movements sometimes made it impossible to obtain unequivocal results, and it is considered likely that these artefacts are responsible for a proportion at least of the high potential "delta waves" described by some workers as occurring in schizophrenics. Potentials due to blinking should be easily distinguished from those of cortical origin by their form; they are usually spikes of considerable amplitude and are always in the same direction (Fig. 1, A). On the other hand, a fine ocular tremor such as was often found in this series of observations can produce potentials with a form, frequency and size quite indistinguishable from a cortical delta discharge (Fig. 1, B). In such cases location of the origin or focus of the potentials by a study of their phase relations is the only way to avoid error, unless special methods are used to record eye movements independently of their potentials. It cannot be too strongly emphasized that the electro-encephalographic technique, particularly when only one or two channels are used, is very liable to produce artefacts of various sorts, and this seems to be particularly noticeable with schizophrenic patients. The blinking and eye movements described above—indeed any small rhythmic movement—may produce spurious waves, so that it is necessary to prove beyond any doubt that all potentials to which significance is attached can be due only to the brain. The single channel records published by Hoagland and his collaborators do not seem to supply such proof; many of their "delta waves", from which presumably the delta indices (which are arbitrary measures of the proportion of slow waves in a record) are computed, would certainly be attributed to blinks if they occurred in our records. We have found also that blinking and ocular tremor tend to cease when a patient's condition improves, either spontaneously or as a result of treatment, so that Hoagland's correlation between the delta index and the state of the patient may be only a demonstration of habitual movements in schizophrenia. A record of the ocular movements of a psychotic patient may provide a useful empirical test of his condition, but it cannot be called an electro-encephalogram. Although we do not wish to suggest, and certainly cannot prove, that all Hoagland's records consist of artefacts, we consider that his claims should be accepted with reserve. As will be shown later, delta rhythms and other abnormalities do occur in psychotic patients and may ultimately prove of value as some objective measure of the effects of treatment, but the quantitative analysis proposed by Hoagland seems

premature in view of the confusion which may arise, particularly when only one recording system is available.

In the course of the present survey thirty cases were examined. The majority had been under care for between three and ten years, but a few were of recent onset and three were in advanced dementia. Of eleven cases of catatonic stupor not receiving any special therapy, ten presented a true delta rhythm resembling in form and amplitude that found in epilepsy, but differing in that it did not originate from a fixed cortical focus (Fig. 1, |c). This rhythm

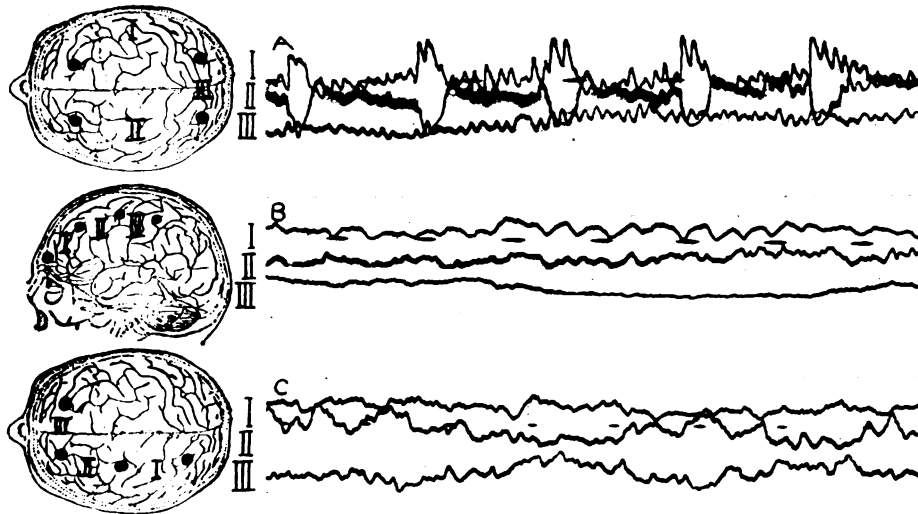


FIG. 1.—A. Patient A. F.—. Eyes open, talking. The rapid rhythmic waves are the alpha rhythm, and proceed from the parieto-occipital region on both sides. The five large slow deflections in leads I and II are due to blinks. B. Normal subject, eyes open. The small delta-like potentials in lead I (smaller and in phase in lead II) are due to a fine ocular tremor. C. Patient S. W.—. Catatonic stupor. Eyes open. The irregular slow discharges are mostly from the frontal lobes. The height of the Roman numerals on the left shows the size of deflection corresponding to an input of 50 microvolts. The time-marker shows seconds.

was more marked in the more stuporose cases, in most of which repeated examination showed that the abnormal discharges persisted over a period of weeks, during which time the clinical condition of the patients remained unchanged. In one case where a spontaneous remission occurred, the delta rhythm diminished, and in a few days had entirely disappeared. Hoagland's claims are therefore qualitatively confirmed.

Since the apparatus used for these observations provided only two channels, precise localization of the potentials was difficult, but in general the frontal lobes showed more delta waves than the rest of the cortex, though the source appeared to vary from moment to moment. It was soon realized that the investigation would have to be continued with more elaborate equipment using

three or more channels so as to follow these wandering foci, but the scope of these preliminary observations was deliberately limited to the collection of qualitative data and the tracing of sources of error.

An exceptionally detailed study was made of one case who, in some respects atypical clinically, presented an electro-encephalographic abnormality of a kind different from that of the other patients. This was a prominent alpha rhythm which persisted independently of visual activity and continued during conversation and reading (Fig. 1, A). It is presumably present during all waking activities. Not confined to the occipital cortex it arose from wide parieto-occipital areas, varied in intensity from side to side and had a frequency of about nine per second. It was least marked in occasional mildly negativistic phases. This patient, a Jewess, aged 21, was admitted to Friern Hospital in November, 1937. Her psychosis followed a period of semi-starvation last summer when she made what appears to have been a drastic attempt at "slimming". She returned home from ten days of convalescence at the seaside talking incoherently of meeting the "doubles of film-stars", of "going on the films" and of being thrown into mysterious trances. Phases of excitement and stupor followed, and she eventually became violent and was certified.

On admission, confusion, preoccupation with visual and auditory hallucinations, violent conduct and degraded habits were prominent symptoms. She was mildly toxic but well nourished and free from organic disease. Her appearance however, was, and still is somewhat peculiar owing to the wide dilatation of her pupils and the unblinking fixity of her gaze. The period of these investigations coincided with a fairly progressive clinical improvement, although recently she has lost ground. Always ready to give an account of herself she replies relevantly at first, but soon tends to lapse into trains of thought determined by subjective rather than objective associations. She expresses herself, in terms of clichés, naïve aphorisms and ingenuous platitudes, very seriously but with a complete absence of discrimination and self-criticism. She fails to distinguish between fact and fantasy, between dream and waking experiences. The following is a verbatim sample of her chatter :

Asked where she lived she replied, "Opposite the 'bus garage, next to Dr. . . . and Dr. . . . I am consoled by my work, P . . . Street is so very cosmopolitan, we work for what we work for, consolation, love and compensation, good looks and clothes, artificial make-up and consolation in dancing . . . like all girls some of my ideas come from dancing." Again questioned regarding hallucinatory experiences involving a "cradle" to which she had previously referred she said, "The psychology of the cradle . . . it works in relays with opticians and psychology on the balance and an actor on the left side of the stage in colour . . . it's a toy replica of the cot in the ward . . . it is a patented one."

These products of her imagination were rendered with a complete absence of affect and without any apparent attempt at modification or suppression,

Speaking and behaving like an automaton, she differs from the other cases examined in her facility and spontaneity. Her volitional defect betrays itself in weakness rather than abulia, in a failure of control rather than its perversion into negativism. Administration of benzedrine, atropine and prostigmine affected neither the psychosis nor the electro-encephalogram.

These apparently coincidental variations of clinical and electro-encephalographic findings assume some significance when considered in the light of the fact that some time before the commencement of these investigations another case of persistent alpha rhythm had been observed. This was a subject who had been frequently used as a "normal control" for tests and demonstrations on account of the high potential and regularity of his alpha rhythm. Opening the eyes, reading and conversation all failed to inhibit the discharge, which was presumably present during the whole of his waking life, as in the case of A. F—, just described. For about a year this phenomenon was considered useful as a technical aid, but unimportant as far as the subject himself was concerned. When, however, a typical schizophrenic illness necessitated his removal to a mental hospital further investigation was undoubtedly indicated. An analysis of his past history reveals that although of different race and sex and of higher intellectual calibre and attainment than A. F—, he presented a remarkable clinical resemblance to her. It is now apparent that even during the time when his services as a control were in such demand his unusual spontaneity, garrulity and exaltation were pathological, and the ambitious theories he propounded were really impracticable schizoid fantasies. In the later stages of his illness the morbid process of course became quite obvious, delusions of reference and persecution associated with auditory and visual hallucinations developed, and phases of catatonic stupor and excitement occurred. It is worthy of note that he, too, was lacking in powers of discrimination and self-criticism, and that his essential resemblance to A. F— was a volitional weakness and facile automatism rather than negativism during the period when his electro-encephalograms were taken.

Of the remaining cases six were undergoing cardiazol therapy. All these showed normal wave forms, including two who prior to the initiation of this treatment exhibited delta waves. (These, incidentally, were the only two cases examined both before and during therapy.) Three chronic dements of the "extinct volcano" type gave normal results, and of three hebephrenes one was normal, one showed a delta discharge, and one both normal alpha and delta rhythms. Seven other cases were examined, but in these, both the results obtained and the clinical classification as to schizophrenic type were equivocal.

Generalization from the data collected in this study would be unprofitable, not only because of the comparatively small number of cases examined, but also because the nature and meaning of the cortical potentials, even in normal subjects, is by no means understood. The most reasonable general hypothesis is that the larger and slower the potentials generated, the less is the degree of

normal activity in the part of the cortex concerned. On this basis it may be tentatively put forward that two types of abnormality may be considered to occur in schizophrenia. Firstly a variation within the physiological range, that is, an unusual persistence and prominence of the normal alpha rhythm, involving chiefly the post-central regions,\* and secondly a truly pathological delta discharge most marked in the frontal lobes, not in one area only but appearing intermittently in many places. It should be made quite clear that neither of these appearances is diagnostic of schizophrenia, nor do they throw much light on the pathogenesis of the disease. If, as many think, the alpha rhythm indicates a state of rest in the visual association areas, it is tempting to believe that those patients exhibiting a persistent discharge of this type are suffering from an inability to mobilize their powers of sensory association—an interpretation which may be another aspect of the volitional weakness noticeable in their clinical pictures. The cases with a delta discharge cannot be described even in terms as indefinite as this. By analogy with the other conditions in which delta waves are prominent, these patients must be in a more strictly pathological state than those in whom there is merely an exaggeration of a normal character. What the aetiology and relations of this state may be we cannot even guess, and the technique does not seem to have helped so far in choosing between the various theories of schizophrenia, which are all elastic enough to accommodate a delta discharge in the cortex. The multiplicity and intermittence of the abnormal discharges holds out some hope of an ultimate correlation with changes of mood and symptoms, and it is considered that almost continuous observation of a few patients over a long time with three or more channels is the only way to define the problem and prepare a crucial experiment.

We wish to record our thanks to Prof. Golla, Director of the Central Pathological Laboratory of the London County Mental Hospitals where the apparatus was constructed, and to Dr. Brander, Medical Superintendent of Friern Hospital, for his encouragement and the facilities which he granted us in the investigation of cases under his care.

#### SUMMARY.

1. The electro-encephalograms of thirty schizophrenic patients have been observed with a portable two-channel apparatus.
2. Eye movements and blinking were found to produce artefacts which make the interpretation of some results difficult, and throw doubt on the value of Hoagland's "delta index" as a measure of the degree of abnormal activity.
3. A certain number of the patients displayed a true delta discharge which had no fixed focus, but was most marked in the frontal lobes of the more stuporose cases.

\* We were unable to confirm Lemere's observation that a prominent alpha rhythm is rare among schizophrenic patients.

4. The delta discharge vanished in two cases undergoing cardiazol therapy, and in one case of spontaneous remission.

5. Two cases are described in which a persistent alpha rhythm was associated with a psychosis featuring volitional weakness.

6. The implications of these results and the need for further study with more elaborate apparatus are briefly discussed.

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