E.E.G. FINDINGS IN 100 CASES OF SEVERE ENURESIS

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The purpose of this paper is to describe one aspect only, namely the electro-encephalographic, of the perennial problem of enuresis.

One hundred children and adolescents with severe enuresis and without any discoverable organic condition were investigated. All suffered from nocturnal enuresis but a considerable proportion were wet during the day as well. Sixteen had had a dry period of varying duration, the remainder having been persistently enuretic from birth. Encopresis was noted in addition in four cases. Apart from ordinary physical examination and urine testing, the majority had had extensive investigations, e.g., intravenous pyelograms and cystometrograms. The sample does not represent a fair cross-section of children and adolescents suffering from enuresis as the ones who had been amenable to simple treatment did not as a rule reach us, so that there was a heavy loading in favour of the more severe type of case. No children were included who were mentally defective or markedly backward, nor where there was any clinical history of epilepsy, 'fits' or attacks of unconsciousness. The sex distribution showed a preponderance of males, as was to be expected, with 63 boys and 37 girls. No child was included under the age of 5 and the age distribution was as shown in Fig. 1.

Procedure

Care was taken to reassure the children about the examination. No tracings were included which were technically unsatisfactory owing to the child being uncooperative. Recording was undertaken in most cases soon after a meal but in a small minority after the ingestion of glucose.

Records were taken mainly on an 8-channel 'ediswan' electro-encephalograph but with some on a 6-channel machine from the same makers. The machines were linked to automatic low frequency wave analysers which were used routinely. After recording from standard electrode positions over-ventilation was performed vigorously for two to three minutes in 75 cases. In the remaining 25 it

was only poorly practised. After a further period of record taken at rest, photic stimulation was applied both as 'free flicker' and with an electronic trigger mechanism (Hewlett, 1951; Turton, 1952).

Criteria Adopted

The evaluation of children's records presents far greater problems than in the case of adults. There is considerable difference of opinion between various

FIG. 1.—Age distribution of the series.

centres as to what constitutes a normal record for any given age. Earlier workers undoubtedly did not allow sufficiently for the wide variation in records taken from apparently normal children of the same age group. For instance, Smith (1938) found a well developed alpha rhythm in most children by the age of 3. Lindsley (1939) at 5 years found an

average frequency of 8.4 c.p.s. with a range only between 7.3 and 9.4 c.p.s. Similarly Brill and Seidemann (1941) found very little scatter in the alpha frequency of 100 normal children from 4 to 15 years. Gibbs and Gibbs (1941) give examples of normal and questionably normal records. Jasper (1949) quoting Bernhard and Skoglund stresses that the increase in the dominant E.E.G. frequency with age approximates to a logarithmic curve in common with many growth processes. Once again the rhythms increased rapidly in frequency to the age of 5 and remained relatively static from 5 to 10 years with a dominant alpha rhythm.

Henry (1944), in a large scale survey, in addition to studying alpha development paid attention to the incidence of slower activity in children of 6 years and over, and was surprised at the amount which he found. Walter (1950) gives valuable criteria of normality and stresses the wide variation in each age group. Pond (1951) strikes a similar warning note.

Our own concept of normality was to some extent influenced by the literature, but it was strongly felt that many of the earlier papers provided too rigid criteria. Hence, as a result of our own experience and the more recent studies mentioned above, we have tried to err on the side of caution and have disregarded many minor deviations from the so-called normal.

In the age group 5-6 years marked theta activity was regarded as normal, but a persistent and dominant delta rhythm of high voltage combined with an absence of alpha and theta at 6 to 7 c.p.s. was considered to be immature. In the next age group, 7-8 years, these criteria also held true except that in some of those records considered abnormal there was an alpha component revealed by analysis but not readily visible in the primary trace. In the other age groups the same principles were applied but to a lessening degree.

No attention was paid to rhythmic delta and theta discharges evoked by over-breathing provided they did not persist for more than half a minute after cessation. Of those performing satisfactorily, 34 showed no significant alteration and these were principally aged 11 and over. Forty-one showed rhythmic slow discharges and in 21 the responses persisted after termination but for not longer than 30 seconds.

In childhood failure of the cortical rhythms to follow or respond to photic stimulation and the paucity of the evoked responses has been noted by Walter and Walter (1949). Our results show a steady increase of evoked responses with advancing age. Fig. 2 shows the number of children on whom

photic stimulation had no apparent effect on the record. This was not considered abnormal. The electronic trigger mechanism produced similar results.

FIG. 2.—Diagram showing patients who did not respond to photic stimulation.

Results

Forty-nine per cent showed records which were normal or borderline normal. In the former category were all the records, 26, that gave rise to no serious doubts in classification. Seven cases showed mild epileptiform features but these were only of a rather dubious nature and it was felt safer to classify them as borderline normal. The remaining 16 of this group showed an excess of slow activity but as these were principally between the ages of 5 and 7 it was felt wiser to include them also among the borderline normals.

In eight cases abnormalities of an epileptiform nature were pronounced and the records were considered to be definitely abnormal but sustained seizure patterns did not occur. Fig. 3 shows such a record taken from a boy aged 14. In a further 14 the records were considered pathognomonic of epilepsy. Eight of these showed a resting record with seizure patterns and in the remaining six these occurred only when activation procedures were employed. Fig. 4 shows seizure patterns occurring in a 9-year-old girl during photic stimulation. Two showed a focus in the left temporal lobe. A definite excess of slow activity above that to be expected for their age was found in 28 cases. In all of these this

FIG. 3.—Epileptiform record from boy aged 14 with paroxysmal discharges.

FIG. 4.—Evoked seizure patterns in a girl aged 9.

persisted throughout the record and the children were not unduly agitated or apprehensive. Fig. 5 shows a record from a girl aged 10 with dominant theta activity and absence of an alpha rhythm. There was one further record which was considered to be primarily organic with a well marked delta-and-spike focus in the left parietal lobe. Four children had further records taken; in two cases two repeats and in two a further single tracing. None of these differed significantly from the original. The table gives the results in detail for the various age groups.

Discussion

Although there are numerous references to the E.E.G. in behaviour disorders there are few specific references to enuresis. Secunda and Finley (1942) examined a group of children with behaviour disorders including some with enuresis, and found a high proportion that they described as immature borderline or immature tracings. Michaels and Secunda (1944) investigated 122 cases in an attempt

Record	5-6 yrs.	7-8 yrs.	9-10 yrs.	11-12 yrs.	13-16 yrs.	Over 16 yrs.	Total
Normal ..	9	6	5	—	1	5	26
Borderline normal ..	13	5	3	1	1	—	23
Epileptiform features ..	—	3	4	—	1	—	8
Epileptic ..	1	3	3	4	3	—	14
Immature features ..	5	7	8	4	2	2	28
Focal organic ..	—	—	—	1	—	—	1
Total ..	28	24	23	10	8	7	100

to evaluate the possible relationship between immature abnormal E.E.G.s and enuresis and other neurotic traits. They found a positive correlation between enuresis and an abnormal E.E.G. but this was not so in vague and complex behaviour disorders.

Left fronto-parietal.

Left parieto-occipital.

Right fronto-parietal.

Right parieto-occipital.

CAL: 50 μ V
1 SEC

FIG. 5.—Immature record with dominant Theta (4-5 c.p.s.) in a girl aged 10.

Cattell and Pacella (1950), however, in contradistinction, using a small sample of 42 patients of whom fewer than 45% were enuretic, found no difference in tracings taken from various types of behaviour disorder.

Gunnarson and Melin (1951) examined 96 enuretics after the third year of life. Sixty-four were continuously enuretic from birth, and 26 had had a dry period varying from a few months to several years. Only two showed an epileptiform E.E.G. which is a considerably smaller proportion than in our series. They found a greater proportion of abnormal records in the always wet children, with 52% having a slow record and 25% a moderately slow record, and they believed that this was to a great extent due to some form of brain change, most likely immaturity. Their results are comparable to our own.

Sessions Hodge and Hutchings (1952) examined electro-encephalographically 27 of a group of 131 enuretic children. Five of these showed a record of an epileptic nature while the other 22 showed a 'non-specific' abnormality varying in degree of severity.

Our results indicate that a high proportion of severe enuretics show an abnormal or borderline E.E.G. The principle abnormality is a 'too slow type of E.E.G.', as described by Gottlieb, Knott and Ashby (1945) in primary behaviour disorders. It is tempting to link up what might be called an 'immature' E.E.G. with an immature uninhibited cystometrogram, as described by Stalker and Band (1946), these being different aspects of basic failure of cortical development.

The number of epileptic records is rather surprising; it might have been that chance factors introduced an excess, despite the fact that many of the patients had spent a period of time in hospital where trained observation was possible.

It seems likely that a considerable proportion of severe enuretics who do not respond to any of the ordinary simple measures have in fact a physical

basis for their disorder. The E.E.G. appears to be of value in determining the nature and severity of the basic disturbance.

Summary

The E.E.G.s from 100 cases of severe enuresis but without any organic condition were studied in detail.

Only 26 of these were completely normal and a further 23 were on the borderlines of normality.

Of the abnormal records 28 showed a too slow or immature type of record. A further one showed an organic type of tracing.

The remainder, 22 in all, were of an epileptiform type with 14 of these showing typical seizure patterns either at rest or during activation procedures.

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