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CONTRACT REPORT

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C/PERS 140

A NEUROPSYCHOLOGICAL STUDY OF
EIGHTEEN NAVAL DIVERS

Submitted to :

DEFENCE RESEARCH COUNCIL
for transmission also to the Chief of the Navy.

NATIONAL INSTITUTE FOR PERSONNEL
RESEARCH
COUNCIL FOR SCIENTIFIC AND
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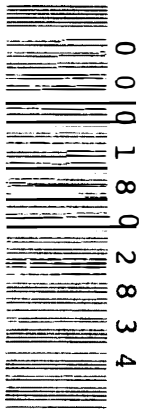
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A NEUROPSYCHOLOGICAL STUDY OF
EIGHTEEN NAVAL DIVERS

G. K. NELSON

NATIONAL INSTITUTE FOR PERSONNEL RESEARCH
COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESE.

APRIL, 1967.



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OPSOMMING.

1. Die doel van hierdie ondersoek was om die elektroenkefalogram (EEG) en metings van outonemiese aktiwiteit by vlootduikers te bestudeer, van 'n kliniese standpunt, ten opsigte van die moontlike uitwerking van duik, en as voorspellers van duikprestasie.
2. Onder 18 duikers was sewe met effens abnormale EEGs, vier waarvan episodiese afwykings en drie nie-episodiese afwykings getoon het.
3. Die gevolgtrekking was dat die vier EEGs met episodiese afwykings op die moontlikheid van latente epilepsie gedui het, terwyl die ander drie op moontlike vertraging van kortikale ontwikkeling gedui het.
4. Dit word beklemtoon dat die mate van afwyking in al sewe gevalle gering was, en ook dat daar geen bewys is van brein beskadiging as gevolg van duik nie.
5. Die moontlike betekenis van sulke geringe EEG-afwykings vir toekomstige duikprestasie kan ook nie op hierdie stadium beoordeel word nie.
6. Die monster was te klein om beduidende gevolgtrekkings ten opsigte van die voorspellingswaarde van ander neuropsigologiese gegewens te bepaal.

7. /...

(ii)

7. Geen beduidende verandering is gevind toe neuropsigologiese funksie na 'n tydperk van 'n paar maaande hertoets is nie.
8. Nogtans word aanbeveel dat die EEG en verwante tegnieke by keuringsprosedures vir duikers ingesluit word, en wel om drie redes :
 - i) om die vroegtydige blootstelling van afwykings soos epilepsie te vergemaklik;
 - ii) om 'n dokument van brein- en outonomiese funksie te verskaf, waarna 'n individuele gevalle in die toekoms verwys sal kan word;
 - iii) om gegewens van 'n groter monster beskikbaar te stel, ten einde die potensiele bydrae van die EEG en verwante tegnieke tot keuring behoorlik te bepaal.

SUMMARY /...

S U M M A R Y

1. The aim of this investigation was to study the electroencephalogram (EEG) and measures of autonomic activity in naval divers, from a clinical point of view, with regard to the possible effects of diving, and as predictors of diving performance.
2. Amongst 18 divers there were seven with mildly abnormal EEGs, four showing episodic abnormalities and three non-episodic disturbances.
3. It was concluded that the four EEGs with episodic disturbances raised the possibility of latent epileptic disorders, while the three others were suggestive of cortical immaturity.
4. It is emphasized that the degree of abnormality was mild in all cases and that evidence of a deleterious effect of diving on the EEG is lacking.
5. Similarly the significance of such minor EEG abnormalities for future diving performance cannot at this stage be assessed.
6. The sample was too small to permit of meaningful inferences concerning the predictive value of other neuropsychological data.
7. No significant changes were found when neuropsychological function was re-assessed after a period of a few months.
8. /...

8. It is nevertheless recommended that the EEG and related techniques be included in selection procedures for divers, for the following reasons :
- i) to enable the early detection of such disorders as epilepsy;
 - ii) to provide a document of brain and autonomic function for future reference in individual cases;
 - iii) to make data available on a larger sample of divers so that the potential contribution of the EEG and related techniques in selection may be properly assessed.

ACKNOWLEDGEMENTS

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The co-operation of the South African Naval authorities and personnel is gratefully acknowledged.

Mr. A. Deppe of the Work Study Division, NIPR, was responsible for liaison. Electroencephalographic and other tests were carried out by Messrs. R. D. Griesel and B. M. Murdoch, Miss Ina van Wyk, Mrs. Barbara Tolmay and Mrs. Valerie Cotton of the Division of Neuropsychology, NIPR.

Mr. R. D. Griesel, Miss Ina van Wyk and Mrs. M. H. Barker assisted in the preparation of this report.

INTRODUCTION / . . .

INTRODUCTION

Although specific evidence of a relationship between EEG data and performance in the diving situation is lacking, it seems possible that various features of the EEG might bear some relation to psychophysiological reactions to the diving situation. Warner (1962) reports a French naval officer as saying that the use of the EEG for the selection of divers in the French Navy has resulted in 67% correct selection.

Foremost among such hypothetical relationships is that concerning abnormality of the EEG. The significance of an actual or "potential" epileptic disorder such as might be revealed by the EEG is obvious, but this concerns only one of the two major classes of EEG abnormality, the other being cerebral cortical immaturity.

Cortical immaturity is a concept based on the established exponential increase of dominant EEG frequency with age, from 2 to 3 c/sec at 2 months to the establishment of a stable alpha frequency in the 8 - 13 c/sec range, which occurs between the ages of 18 and 25 years. The persistence of a dominant frequency below the alpha range beyond the age of 18 years is regarded as suggestive of delayed maturation of the brain, specifically of the cerebral cortex.

Although the relationship between such cortical immaturity and behaviour is neither precise nor consistent it is noteworthy that it is often found in association with emotional instability, psychopathy and /...

and delinquent behaviour (Mundy-Castle, 1955).

Other more subtle characteristics of the EEG pattern in a given individual have a potential relevance in the diving situation. Examples of these are abnormal (but not specifically epileptic) responses to photic stimulation (flicker) and to hyperventilation, both procedures being standard activation techniques in clinical electroencephalography. Another example is an excess of beta rhythm (14 - 30 c/sec) frequently found in association with, but not necessarily diagnostic of, anxiety.

These considerations form the first topic of the present study. The possible EEG effects resulting from a period of diving and the significance of more detailed individual differences (for example in alpha frequency, voltage and index) for diving performance are also dealt with. Finally the predictive value of the EEG is discussed with respect to diving performance.

A I M S

1. To make a clinical assessment of the EEGs of 18 naval divers.
2. To assess the effects of diving on the EEG and the activity of the autonomic nervous system.
3. To investigate the predictive value of EEG and autonomic

variables /...

variables for diving performance.

TESTEES

EEGs were obtained from 18 divers aged 18 to 30 years. For ethical reasons these divers are not identified in this report by name. However a list of names and their corresponding project numbers has been supplied in confidence to the Commanding Officer, Naval Diving School, Simonstown. Of these eight were attending a Diver III course and were aged 18 to 26 years. These eight were first tested in November 1965 and again in January 1966, except for one individual who had his second EEG at the beginning of April 1966.

In January 1966 another four Diver III candidates were tested for the first time.

In July 1966 EEGs were carried out on a group of six diving instructors comprising one Chief Petty Officer, three Petty Officers and two Able Seamen, aged 19 to 30 years. One of the Able Seamen was drowned while diving on September 21st, 1966.

Psychological tests were administered to ten of these divers for comparison with biographical and criterion data (Deppe, 1966a). The results were incorporated into the present study.

The six diving instructors underwent psychological screening (Deppe, 1966b) and these results are also referred to in the present report.

METHOD

1. PSYCHOLOGICAL TESTING

a) Ten divers were subjected to a series of psychological tests

(Deppe, 1966a) as follows :

| <u>TEST</u> | <u>VARIABLE MEASURED</u> |
|----------------------------------|--|
| i. Dark adaptation | anxiety |
| ii. Tilting room - tilting chair | field dependence |
| iii. Rod-and-Frame | field dependence |
| iv. Bass Orientation Inventory | task orientation |
| v. Gordon Personal Inventory | group orientation, sex orientation, cautiousness, originality, personal relations, vigour. |
| vi. Mental Alertness | general intelligence |
| vii. Abstract Reasoning | abstract reasoning ability |

Data from these tests, together with age and education, were analyzed in relation to three criterion variables, Academic Proficiency, Instructors' Assessment and a combined criterion comprising both these assessments. The results were fully reported by Deppe (1966a).

b) The six diving instructors underwent psychological screening by means of the following battery :

| <u>TEST</u> | <u>VARIABLE MEASURED</u> |
|----------------------------|--|
| Bass Orientation Inventory | Task orientation Group orientation |
| Gordon Personal Inventory | Cautiousness, originality, personal relations, vigour |

| | |
|--|-----------------------------------|
| Minnesota Multiphasic Personality Inventory (MMPI) | General adjustment |
| Mental alertness | Mental ability |
| Progressive Matrices | Mental ability |
| Stress interview | Response to others, Motivation |

The results were reported by Deppe (1966b) .

2. EEG PROCEDURES

Case History

Prior to the examination each subject was interviewed briefly with the aim of eliciting information on the following : headaches, "pins and needles" (because of possible epileptic connotations), faints and fits, head injuries, serious illnesses and family history of epilepsy.

All 18 subjects underwent routine clinical EEG examinations at the NIPR, by means of a 16-channel Elther electroencephalograph and 21 electrodes attached in accordance with the international 10 - 20 system. Photic stimulation with an Elther stimulator producing silent orange flashes was given in all cases. All subjects were also required to hyperventilate for three minutes, with continuous EEG recording.

Subjects /...

Subjects 1 to 12 were then subjected to a loud intermittent noise with the aim of examining changes in the EEG, electrocardiogram (EKG), electromyogram (EMG), galvanic skin response (GSR), plethysmogram and respiration.

Subjects 1 - 12 also did the Tapping Fast test, in which they were required to tap with the index finger on a button attached to a counter. Before the first trial of 30 seconds duration they were simply instructed to tap as fast as possible. During the second trial of 30 seconds they were continuously exhorted to tap faster.

Following the routine EEG examination subjects 13 - 18 underwent anoxia and carbon dioxide poisoning with continuous monitoring of the EEG, EKG and respiration. Subjects 13 to 18 were also given a reaction-time test at selected stages of the EEG examination. The results of these latter studies are reported on separately (Griesel, 1967).

Repeat EEG examinations

The EEG procedure was repeated on seven divers after an interval of 2 months and on one after four months.

RESULTS

1. CASE HISTORIES

The incidence of reported abnormalities is shown in Table I. Seven subjects reported one or more abnormal antecedent event or an abnormal relative.

TABLE I/...

TABLE I
ABNORMAL CASE-HISTORIES AMONGST 18 DIVERS

| | Subject Nos. and Comments | Total |
|----------------------------|--|-------|
| Faints | 3 (sometimes); 8 (sometimes); 10 (rare) | 3 |
| Head Injury | 12 (severe), 3 (mild), 5 (severe) | 3 |
| Serious Illness | 6 (malaria); 10 (diphtheria) | 2 |
| Family History of Epilepsy | 1 (grandfather epileptic); 10 (brother epileptic) | 2 |

2. EEG FINDINGS

Individual EEG analyses and interpretations are given in Appendix A.

2.1 EEG Abnormality

Abnormal EEGs were found in seven of the 18 subjects (38.89%). These were Subjects 2, 4, 5, 7, 9, 14 and 15.

The resting record was abnormal in five cases and the response to hyperventilation in one of these and two others (see Table II).

In all seven cases the degree of abnormality was mild, but episodic disturbances occurred in the resting EEGs of two subjects and in the hyperventilation responses of one of these and two others.

Of the eight subjects who underwent the EEG examination on two

occasions /...

occasions, three (2, 4 and 7) showed abnormalities on the first occasion, but only one (7) had a second abnormal EEG. Both records from this subject contained focal episodic disturbances, mostly in the left hemisphere.

Subject No. 5 had a normal EEG on the first occasion but an abnormal record 2 months later (see Appendix A).

The types of EEG abnormality encountered in this group are shown in Table II and described in detail in Appendix A. Samples of EEG abnormalities are given in Figures 1 to 8.

The incidence of abnormality in this group was not significantly higher than that found in other samples of South African military personnel, except one group of army balloters (Table III).

TABLE II / . . .

TABLE II

TYPE OF EEG ABNORMALITY IN A SAMPLE OF 18 DIVERS

| | N | Subject numbers |
|---|---|---|
| <u>Rest</u> : Excessive non-focal slow activity | 3 | 5 ₂ , 14, 15 |
| Episodic disturbances (generalized) | 1 | 2 ₁ |
| (focal) | 2 | 2 ₁ , (7 ₁ , 7 ₂) |
| <u>Hyperventilation</u> : | | |
| Excessive delta and/or theta episodic (generalized) | 2 | 4 ₁ , 9 ₁ |
| (focal) | 1 | 7 ₁ |

TABLE III

INCIDENCE OF EEG ABNORMALITY IN MILITARY SAMPLES

| Sample | N | Incidence of Abnormality % | Significance of difference from divers | |
|---|-----|----------------------------|--|-----------------|
| | | | t | P |
| Divers | 18 | 38.89 | - | - |
| Army ballotees (1964) | 143 | 18.88 | 1.67 | <.05 |
| Air force pupil pilot candidates (1964) | 124 | 33.87 | 0.41 | Not significant |
| (1965) | 203 | 22.66 | 1.37 | Not sig. |
| (1966) | 248 | 21.77 | 1.45 | Not sig. |

3. EFFECTS OF DIVING ON THE EEG AND ON AUTONOMIC AND PSYCHOMOTOR FUNCTION

Twenty four variables were examined before and after diving. Owing to the very small sample size (N = 8) a non-parametric technique (sign test) was employed. The variables examined were :

EEG : Alpha frequency, amplitude, index, organization, location, responsiveness and type; beta and theta incidence; degree of change, recovery time and abnormality of hyperventilation response; responsiveness and abnormality during photic stimulation; abnormality of the resting record and total abnormality.

AUTONOMIC : Heart rate and frequency range during rest, hyperventilation and photic stimulation.

PSYCHOMOTOR : Tapping fast I and II.

Only two of these variables showed an apparently significant change : alpha amplitude (decreased; $p < .008$, one-tailed; $p < .016$, two-tailed) and alpha location (more occipital; $p < .031$, one-tailed; $p < .026$, two-tailed).

4. PREDICTIVE VALUE OF EEG, AUTONOMIC AND PSYCHOMOTOR VARIABLES

4.1 Trainees : For this part of the study only eight divers could be used since two had dropped out of the course. The only significant correlations between test scores and criteria were as follows :

CRITERION /...

| CRITERION | PREDICTOR | CORRELATION | |
|----------------------------------|-----------------------------------|-------------|-------|
| | | r | p |
| Academic proficiency | Heart rate (hyperventilation) | .60 | < .05 |
| | Theta incidence | .68 | < .05 |
| Instructors ¹ ranking | Alpha responsiveness | -.58 | < .05 |
| | Hyperventilation recovery time | .62 | < .05 |

4.2 Instructors : A sample of six is considered far too small for any meaningful analysis. While it is true that Subject 15, who was subsequently drowned in a diving accident, had a mildly abnormal EEG due to excessive slow activity, it would be unwise indeed to make any inference from this single case.

DISCUSSION

1. EEGs

In neuropsychological studies conducted by the U. S. Navy before and after Sealab II (Johnson and Long, 1966) only one of 24 subjects was found to have an abnormal EEG after the experiment, due to an anomalous response to hyperventilation. Suspecting that this might be associated with relative hypoglycaemia, the investigators repeated the EEG after giving the subject a massive dose of sugar. The hyperventilation response was normal on the second occasion.

In the present investigation four subjects had abnormal EEGs with episodic disturbances. In general such abnormalities are found in

association /...

association with latent or manifest epileptic disorders. However their significance in this group is doubtful because of the normal EEGs found subsequently in two of these four subjects. Of the remaining two, one did not have a repeat EEG and one had similar abnormalities in his second record. This diver (subject 5) was the only one in whom there was any relation between a reported antecedent clinical disturbance and EEG abnormality. He had been unconscious following a motor accident three years previously.

The remaining three subjects with abnormal records had EEGs suggestive of cortical immaturity. In considering the significance of this finding, it is again important to note that the EEG concept of cortical immaturity should not be equated with psychological immaturity.

The possible significance of both episodic and non-episodic EEG abnormalities in relation to diving performance is a subject requiring further study. At this stage it can only be stated that the mild EEG abnormalities seen cannot be ascribed to the effects of diving, although the possibility of such effects can equally not be excluded. In any event it must be stressed that the abnormalities were mild.

It seems that diving as a career is a most attractive one to certain personality types. While the relevant personality attributes still await precise identification, it seems possible that they might be reflected in such EEG anomalies as are described in this report. However the validity of such an hypothesis remains to be established.

2. EEG, AUTONOMIC AND PSYCHOMOTOR CHANGES AFTER DIVING

The only changes in eight divers after two months of diving (four months in one case) were an apparent decrease in alpha amplitude and an apparent tendency of the origin of alpha activity to shift from the parietal towards the occipital region.

Such changes, if genuine, would suggest an increased arousal level and accelerated cortical maturation rate. Not only is it difficult to detect a relation between such processes and diving over such a short interval, but the period of observation was not at the beginning of the diving career of any subject. Furthermore the proportion of significant differences that emerged from this analysis suggests that these findings are due entirely to chance (Sakoda et al., 1954).

RECOMMENDATION

Although the results of this preliminary study are inconclusive, it is recommended that the EEG be included amongst other procedures applied to divers before they are accepted for training. Justification for this is to be found firstly in the possibility of early detection of such disorders as epilepsy, secondly in the availability of a document of brain function which could be consulted in the event of subsequent accidents or other unplanned incidents during the diver's career, and thirdly in the potential contribution of the EEG to selection procedures, a potential that could only be finally assessed if information on a relatively large sample of divers were available.

REFERENCES / . . .

R E F E R E N C E S

- DEPPE, A. H. (1966 a) : A critical study of operational and psychological and research requirements in diving. CSIR contract Report, C/PERS 138, submitted to Defence Research Council.
- DEPPE, A. H. (1966 b) : Psychological testing of S. A. N. Diving School instructors. CSIR Contract Report, C/PERS 137, submitted to Defence Research Council.
- GRIESEL, R. D. (1967) : A neuropsychological study of the reaction of six naval divers to hypocapnia, hypercapnia, anoxia and pure oxygen. CSIR Contract Report, C/PERS , submitted to Defence Research Council.
- JOHNSON, L. C. and LONG, M. T. (1966) : Neurological, EEG and psychophysiological findings before and after Sealab II. U. S. Navy Neuropsychiatric Research Unit, San Diego, California, Report No. 66 - 19, April 1966.
- MUNDY-CASTLE, A. C. (1955) : Electroencephalography and forensic medicine. II Forensic implications. J. forensic Med., 2, 95 - 117.
- SAKODA, J. M. , COHEN, B. H. and BEALL, G. (1954): Tests of significance for a series of statistical tests. Psychol. Bull., 51, 172 - 175.
- WARNER, S. A. (1962) : The Second World Congress on Underwater Activities (summary). R. N. Diving Mag. 9, 3, 13 - 19.

APPENDIX A

INDIVIDUAL EEG REPORTS OF CASES

WITH ABNORMAL RECORDS.

SUBJECT 2 /...

SUBJECT 2

1st EEG 16.11.65 (Fig.1)

The resting record was mildly abnormal due to occasional isolated 4 c/sec disturbances, the former in the right parieto-temporal area, the latter in the right temporal region. In addition there were rare generalized sharp-tipped 8 c/sec bursts of medium voltage.

The response to photic stimulation was normal but there was one left fronto-central focal 6 c/sec burst during hyperventilation.

Such episodic disturbances are generally regarded as raising the possibility of an epileptic disorder, but would also be compatible with mild maturation defect.

2nd EEG 1.4.66

This record was normal in all respects, suggesting that the abnormalities seen on the previous occasion were associated with a factor such as transient metabolic imbalance or with a mild maturation defect.

SUBJECT 4

1st EEG 25.11.65 (Fig. 2)

The resting EEG and the response to photic stimulation were normal. During hyperventilation, however, there were occasional brief generalized bursts of slow activity, a non-specific abnormality.

2nd EEG 25.1.66

All aspects of the EEG were normal.

The apparent abnormality of the response to hyperventilation

seen / . . .

seen two months previously must therefore be regarded as of little significance.

SUBJECT 5

1st EEG 25. 11. 65

The record was normal in all respects.

2nd EEG 25. 1. 66 (Fig. 3)

The resting EEG was mildly abnormal due to excessive slow activity, most prominent in the right post-temporal area.

The responses to photic stimulation and hyperventilation were normal.

The record raises the possibility of a mild fluctuating cerebral dysfunction which might be related to the injury suffered three years previously.

SUBJECT 7

1st EEG 25. 11. 65 (Fig. 4)

The resting EEG was mildly abnormal due to excessive diffuse slow activity occasionally appearing in bursts in the left parieto-occipital area.

The response to photic stimulation was normal, but hyperventilation evoked a right fronto-temporal burst of waves at alpha frequency.

The record is suggestive of a possible latent epileptic disorder or a maturation defect.

2nd EEG /...

2nd EEG 25.1.66 (Fig. 5)

The resting EEG was again abnormal due to excessive slow activity, This time mainly of left fronto-temporal origin.

The responses to photic stimulation and hyperventilation were normal.

The inconsistent origin of the focal disturbances in these two EEGs favours an interpretation of mild maturation defect.

SUBJECT 9

EEG 25.1.66 (Fig. 6)

The resting EEG and response to photic stimulation were normal.

During hyperventilation, however, there were a number of high-voltage generalized 7 c/sec bursts, a non-specific abnormality, although one often found in association with epileptic disorders.

SUBJECT 14

EEG 20.7.66 (Fig. 7)

The resting EEG was mildly abnormal due to a number of low-voltage bilateral parieto-temporo-occipital runs at 2 and 6 c/sec.

The responses to photic stimulation and hyperventilation were normal.

The record is suggestive of mild cortical immaturity.

SUBJECT 15

EEG 20.7.66 (Fig. 8)

The resting EEG was mildly abnormal due to excessive low-voltage frontal /...

frontal, occipital and diffuse slow activity.

The responses to photic stimulation and hyperventilation were normal.

The record is suggestive of a mild degree of cortical immaturity.

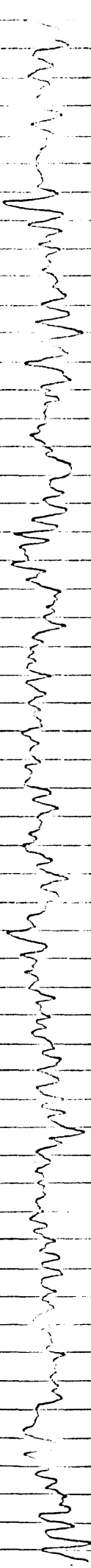
This subject drowned while diving on 21st September 1966.

FIGURES /...

FIGURE 1
SUBJECT 2 (1st EEG)

Rare isolated focal slow waves in the right fronto -
temporal area (channel F8 - T6).

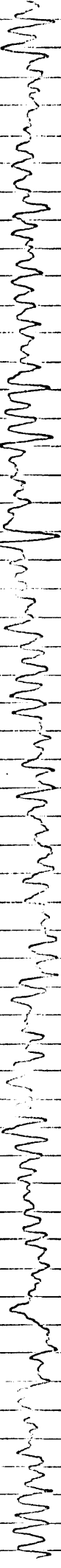
C5-T5



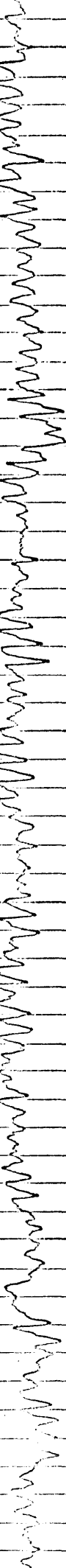
T3-A1



T6-P4



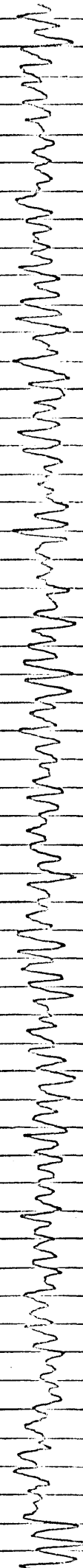
P4-P0



P0-P3



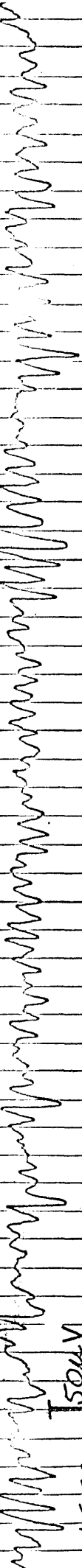
P3-T5



F8-T6



F7-T5



150uV

FIGURE 2

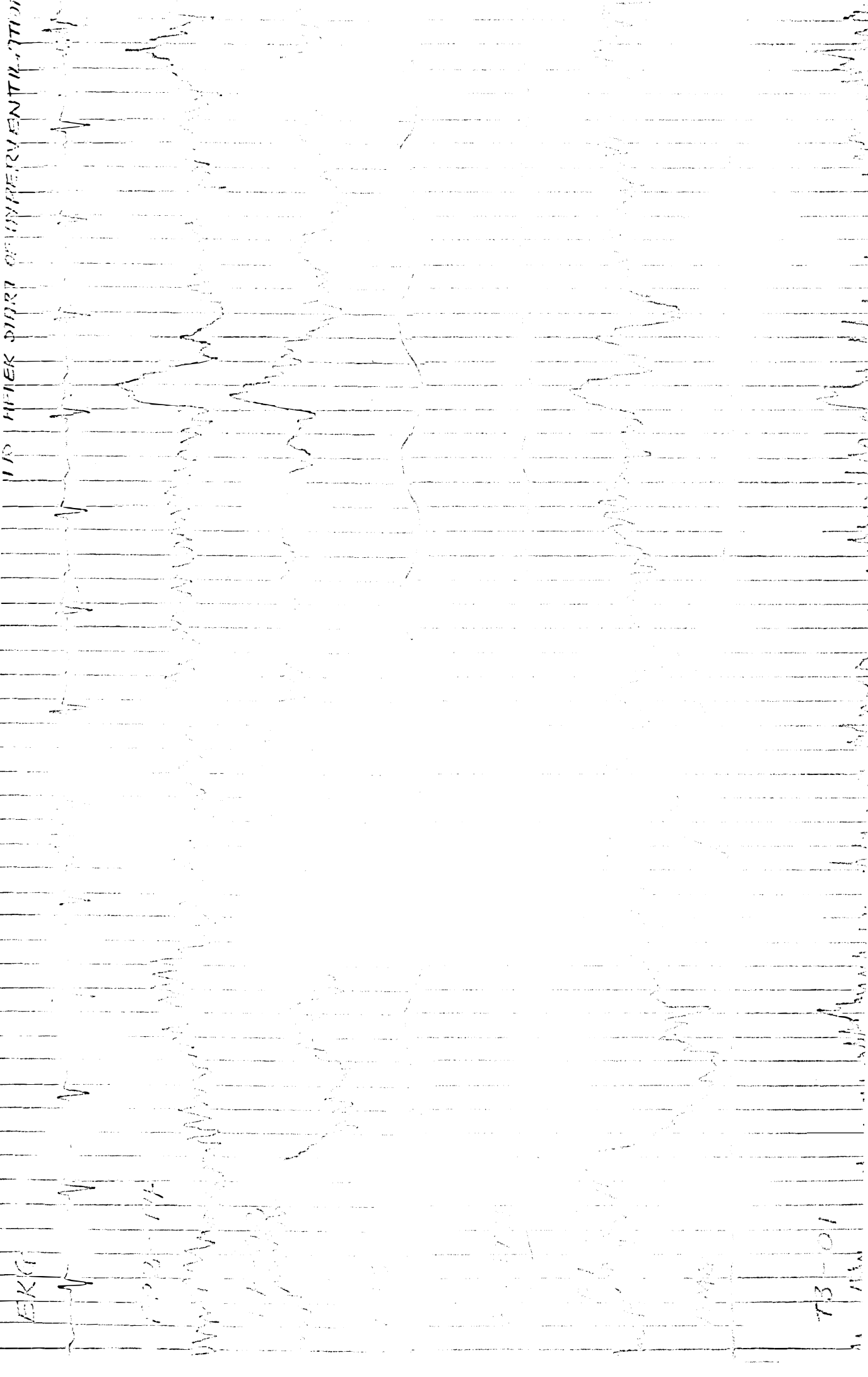
SUBJECT 4 (1st EEG)

Irregular delta disturbances (channels 2, 3, 6 and 8)

during hyperventilation. Electrocardiogram (EKG, lead 1) contains

muscle potential artifact. RESP = respiration; PLETH = plethy-

smogram; EMG = electromyogram (integrated).



IR HIEK DIRT OF HYPERVENTILATION

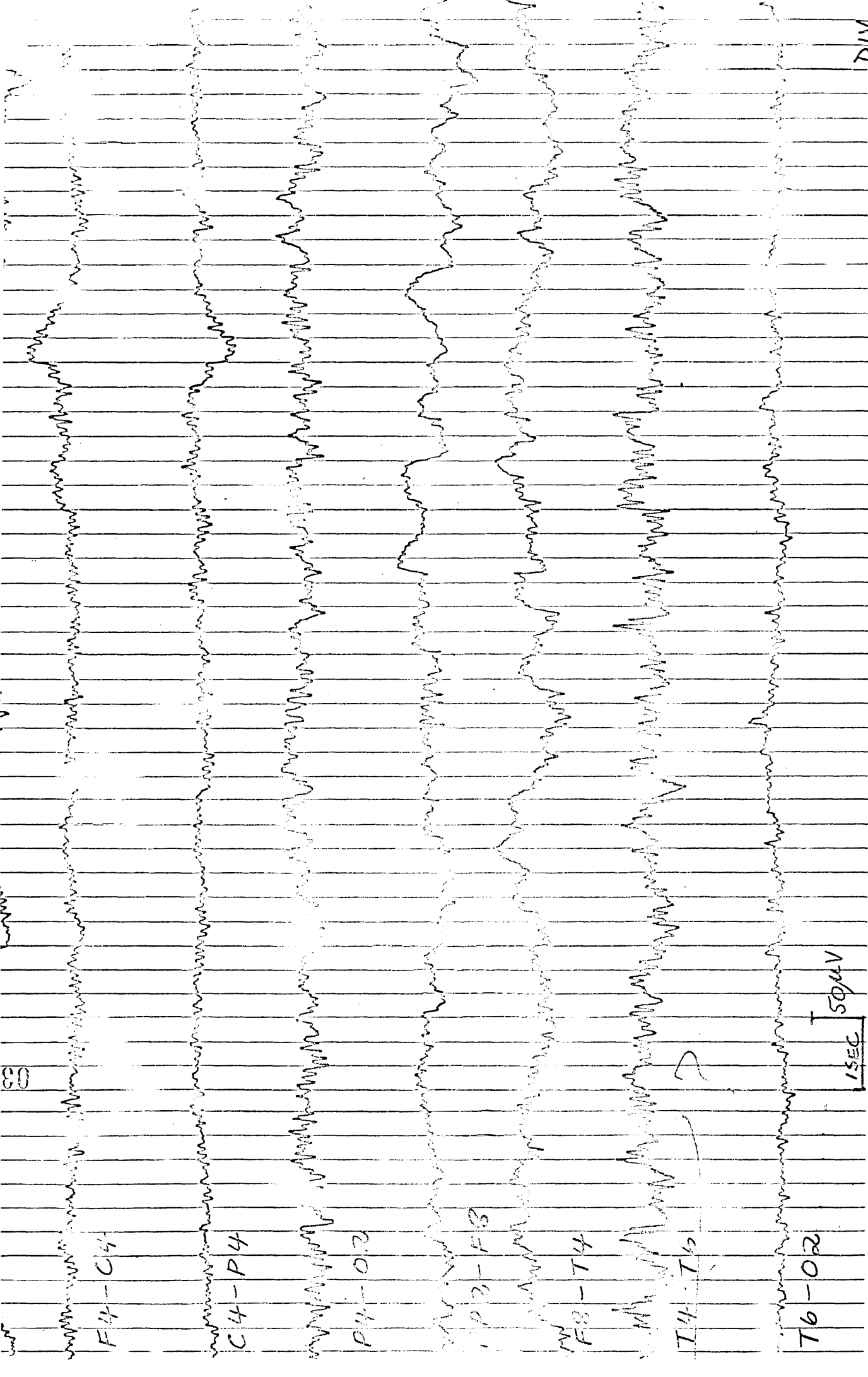
ECG

73-01

FIGURE 3

SUBJECT 5 (2nd EEG)

Excessive medium - voltage delta activity in the right
parieto - post - temporal region. (channels P4 - 02 and
T4 - T6).



F4-C4

C4-P4

P4-O2

P3-F8

F8-T4

T4-T6

T6-O2

50µV
1SEC

FIGURE 4

SUBJECT 7

Medium - voltage delta disturbances in the left
parieto - occipital area (channels C3 - P3 and P3 - 01).

FPI - F3

F3 - C3

C3 - P3

P3 - O1

FPI - F7

F7 - T3

T3 - T5

T5 - O1

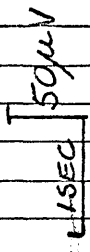
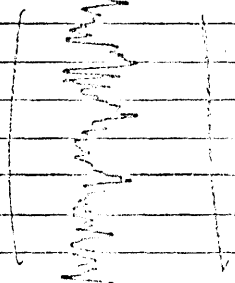


FIGURE 5

SUBJECT 7 (2nd EEG)

Excessive irregular medium - voltage 1.5 - 2.5 c/sec

activity in the left fronto-temporal and temporal areas

(F8 - T4 and T4 - T6).

1000

F4-C4

C4-P4

P4-O2

F2-F8

F8-T4

T4-T6

T6-O2

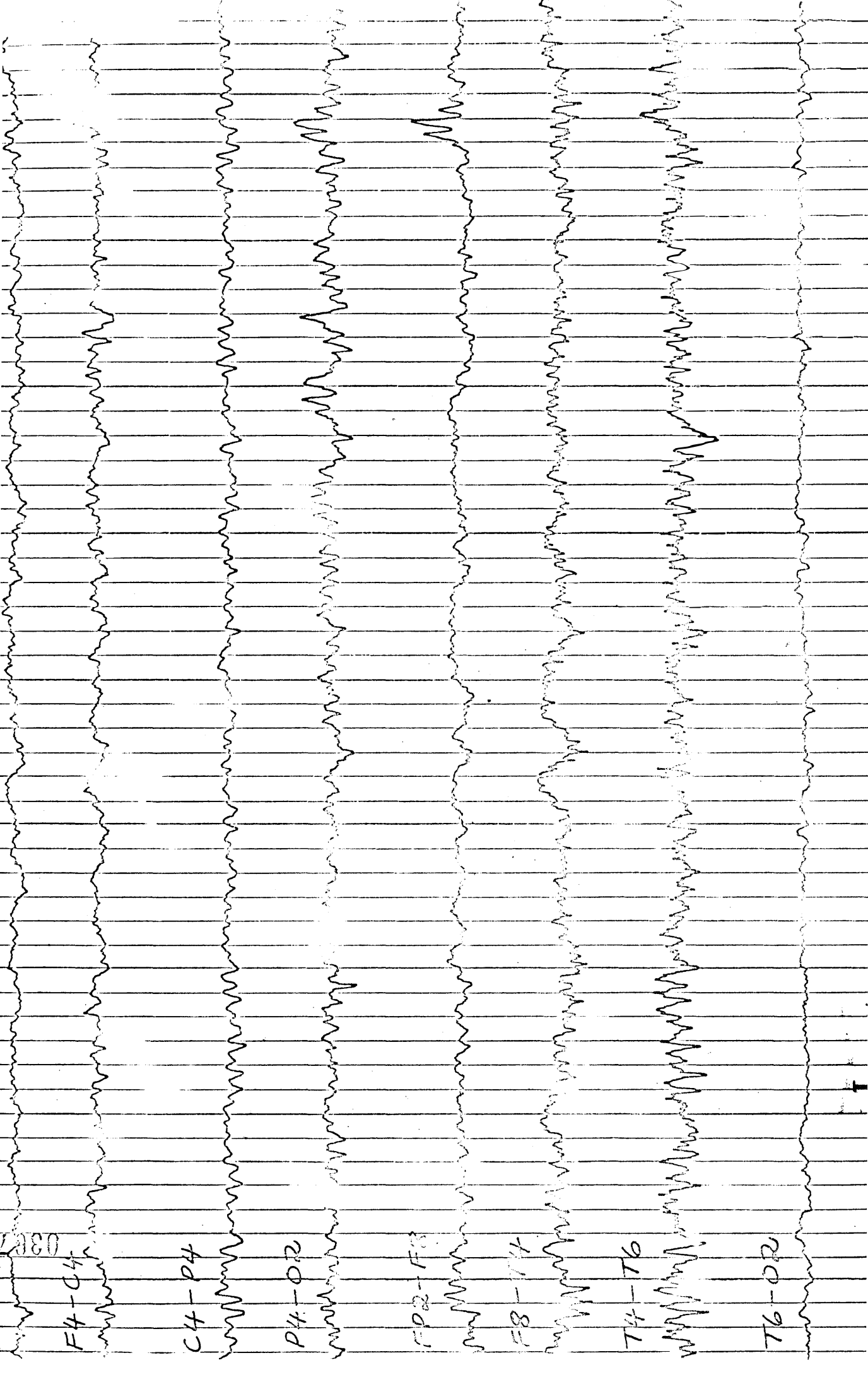


FIGURE 6
SUBJECT 9

Excessive generalized high-voltage theta and delta activity during hyperventilation. The electrocardiogram (EKG, lead 2) contains muscle-potential artifact associated with movement.

RESP = respiration; PLETH = plethysmogram; EMG = electro-myogram (integrated).

EKG

FP2-T4

T4-O2

RESP

PLETH

FP1-T3

EMG

180 SECS. AFTER START OF HYPERVENTILATION

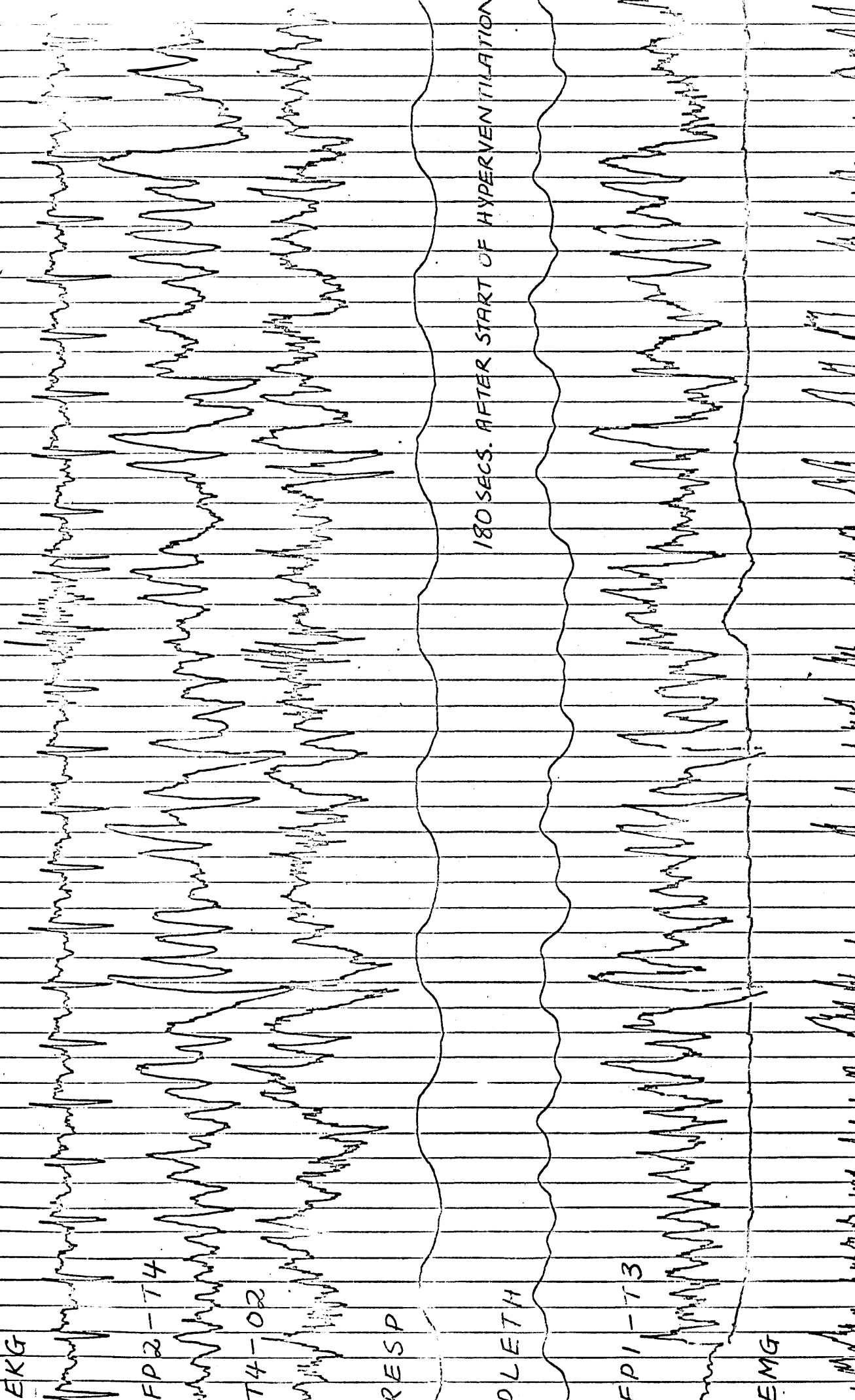


FIGURE 7

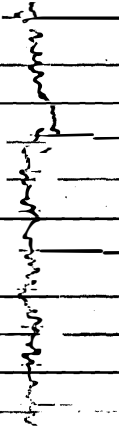
SUBJECT 14

Medium - low voltage 2 c/sec disturbance in the left centro-parietal area (Channel C3 - P3). Large deflections in channels FP1 - FP3 and FP1 - F7 are artifacts due to eye-movements.

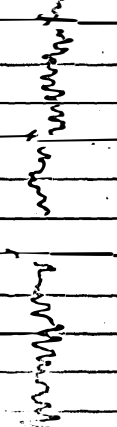
FP1 - F13



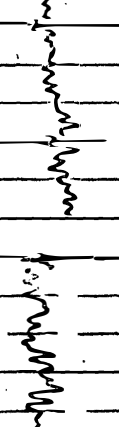
F13 - C31



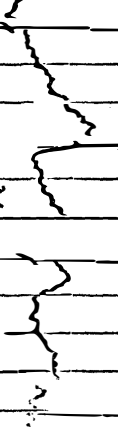
3 - P



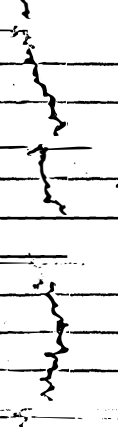
P3 - O1



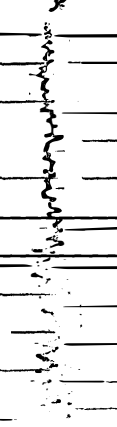
FP11 - T2



V1 - T



F131 - T5



1:50 a.m.

FIGURE 8

SUBJECT 15

Isolated focal sharp waves also slow activity in the frontal, anterior temporal and parieto-occipital regions of the left hemisphere.

FPI-F3

F3-C3

C3-P3

P3-O1

FPI-F7

F7-T3

T3-T5

T5-O1

1 SEC 35 μ V

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BEN + K342
Doc 180249
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W N N R
G S I R