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FINAL TECHNICAL REPORT

covering the period
December 1st, 1961 - November 30th, 1962.

Conducted by

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BRAIN AND BEHAVIOR

Intracerebral electrographic studies in
the Human Brain

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FINAL TECHNICAL REPORT

covering the period of December 1st, 1961 - November 30th, 1962.

During this period, the examination and treatment of four patients started in the previous period, was completed. Additional six patients, two female and four male, were studied and attended to, using intracerebral depth-electrography.

Clinical Results.

Clinical results obtained in the patients treated have been very satisfactory. The patients are back at work, all improved.

Two farmers needed a lot of personal care before the operation. They are now able to take care of themselves, dress themselves, eat and do a little work on the farm.

Two housewives are improved to the extent that they are again taking care of the home.

The two last patients, a movie director from Sweden, and a farmer from outside Oslo, are also both back at work. They are very pleased with the operation. The movie director, is again able to take care of his business. Prior to the operation he was not capable of writing his own name.

The patients operated during the previous years are in the same good condition as they were at the end of last year. It seems that the results are lasting.

Research in Progress.

During the later part of the period extensive work has been carried out to collect the data accumulated during the passed ten years of depth-electrographic studies. Particular emphasis was made on the stimulation data from the 85

patients studied in Norway. These data are collected and coded on IBM card, and in the process of being written up.

The various types of responses obtained to electrical stimulation are classified. They have been grouped according to the various neurological systems being responsible for the responses obtained.

The effect is coded as mentioned on cards, giving type and strength of stimulus, as well as the X-ray localization of the electrode. It was felt necessary to use the IBM cards, as the material now consists of 3,500 electrode points in 85 patients. (1)

The systematical work-up of the material has already given valuable information of general scientific interest. It will also improve our future technique for data collection.

The evaluation of the patients' level of consciousness and/or degree of alertness has been rather difficult. After having tried out a number of tracking tests we have developed a technique by which the patient is following with a flash-light a slow moving photocell in the ceiling of the examining-room. This photocell moves in a standard pattern, and on one of the recording channels is written out automatically, when the lightbeam is on the photocell. In this way one gets continuous data of the patient's ability to track, and to which extent this is affected or interrupted by the electrical stimulation.

The scientific material collected related to the mechanism of speech in ten patients was written up first. In the preliminary write-up, our findings related to the complicated relationship between agraphia and aphasia were noted. Responses, such as arrest of speech and laughing with or without vocalization, were also described.

A documentary sound movie taken during actual sessions of stimulation was put together, and the results were presented at the Ski-meeting in March 1962. This presentation of the data was most valuable as it gave us an opportunity to discuss, not only the findings, but also the method for presentation, with colleagues at the Montreal Neurological Institute. Later with colleagues at Walter Reed Army Institute of Research, these discussions were elaborated

on as to how the data should be presented in the future.
(2 - 3).

Further related data are presently collected to clarify the picture in an effort to hopefully add another piece of knowledge to the great puzzle - the human brain.

Technique.

More accurate data about the size and location of the structures in the brain visible on X-rays have been obtained by making planigraphic studies of the head in the frontal and sagittal plane prior to introduction of the electrodes.

To describe the location of the electrode point within the brain several methods have been tried. At first we described it's proximity to known structures. However, the inaccuracy or difference in the brain proved this way unfruitful. As known from Blundell and Bailey's work we must accept a plus - minus 0,5 cm difference in the location of the point within a nucleus, even in the thalamic regions, compared with the standard brain. The abovementioned technique was therefore completely abandoned. The electrode's position is instead given in milimeter,

ant. - post.

dors. - vent.

left - right

in relation to the mid point between foramen Monroi and Commissura Posterior in the mid sagittal plane on a standard brain.

It will thus be possible to treat the data statistically, and on the basis for the known biological spread, be possible to extract the statistical centers of spots which are parts of one or more described brain function and it's proximity to other regions. These data are accurate. In an appendix we will speculate about relationship between the spots and known structures in the brain.

In this way we give the standard position by three numbers in milimeter.

The measurements are taken from the X-ray pictures, and corrections are then made for the distortion in the picture, from the actual size in the head.

These corrections are most easily made by the use of geometrical diagrams.

In co-operation with the laboratory, Mr. Kaiser in Copenhagen has persued the development of automatic pattern recognition with "yes" and "no" data reduction system, which will enable us to collect the data from future studies in a way in which it may be handled in electronic data handling machines. The EEG data will with this system be automatically correlated with tracking ability, behavior and physiological data as EKG, O₂, respiration, blood pressure and pulse rate. (4 - 5).

Miscellaneous.

In the spring Dr. Hammon from the Walter Reed Army Institute of Research in Washington was sent across to study in detail our technique for depth-electrography, and this gave us a valuable opportunity for exchange of information.

Dr. Olivares, Chief Neurosurgeon from Santiago, Chile, and Dr. Thulin, Assistant Chief at Sahlgrenska Sjukhuset, Department of Neurosurgery and Neurology, University of Gothenburg, also spent two months studying the technique. At the end of spring term, Dr. E. Weinstein from Walter Reed Army Institute of Research spent two weeks with us, studying our data.

This international co-operation has been most valuable for the research here at the laboratory.

In the fall of 1962 the author was invited down to Madrid and Lisbon, and discussed the findings in depth-recording in connection with the treatment of Parkinson's disease at the University of Madrid, Spain, and at the Edgar Monitz Research Institute at the University of Lisbon, Portugal.

Stimulating exchange of information and ideas resulted from these visits.

Unfortunately this report has to be finished before the results of the present work-up has been finished, but the present contract is continued under contract no. DA-91-591-EUC-2746, and we are looking forward to, in our next report, to be able to present the data in a finished form.

At the end of the year the general development of the laboratory has been very satisfactory. Up to now the patients have been on the same ward with other patients at the hospital. A special unit at the hospital has now been made available for the care of our patients. This will greatly improve our ability to study the patients, and to give them more special care. The medical staff to care for the patients will also be increased.

The scientific possibilities of the laboratory are also improved by an increase in the staff. The Professor of Psychology at the University of Oslo, has recently taken special interest in our studies, and this will broaden the scope of our investigations.

In addition to our clinical results we hope to contribute to the general knowledge of the brain and consciousness within the limits imposed by the clinical and therapeutic needs of the patients.

As of December 1st, there is no unused money under the contract. Expenses have been running according to budget.

No permanent equipment has been acquired. The research on a whole has gone according to plans.

Carl Wilhelm Sem-Jacobsen
Main Investigator and
Director of Research

SCIENTIFIC PUBLICATIONS SUPPORTED BY THIS CONTRACT AND

SPECIAL ENCLOSURES.

1. Code sheet for the IBM cards.
2. Illustration of findings related to speech.
3. Sem-Jacobsen, C.W.
"ELECTRICAL STIMULATION - EFFECTS ON SPEECH
IN SOME AREAS AROUND THE THIRD VENTRICLE"
Presented at the 16th annual meeting of Nordisk
Neurokirurgisk Forening, Odense, Denmark,
27. - 28. August 1962.
4. Sem-Jacobsen, C.W. and Kaiser, E.
""YES-NO" DATA REDUCTION IN EEG AUTOMATIC
PATTERN RECOGNITION"
Presented at the 16th Annual Meeting of American
EEG Society, Atlantic City, N.J., June 1962.
Journal of EEG and Clinical Neurophysiology,
February, 1963, Vol.15, No.1, p.148.
5. Society Proceedings Scandinavian EEG Society,
Fifth Meeting, April 1962, Oslo, Norway.
Journal of EEG and Clinical Neurophysiology, Vol.14,
1962.
Paper 10:
Sem-Jacobsen, C.W. and Kaiser, E.
""YES-NO" DATA REDUCTION IN EEG AUTOMATIC PAT-
TERN RECOGNITION"
Paper 13;
Sem-Jacobsen, C.W.
"ELECTRICAL STIMULATION - EFFECTS ON SPEECH IN
SOME AREAS AROUND THE THIRD VENTRICLE"
Paper no.8 is from the Walter Reed Army Institute
of Research.
6. Sem-Jacobsen, C.W. and Deistad T.
"ELECTRICAL STIMULATION - EFFECTS ON ALERTNESS
AND SPEECH"
Journal of EEG and Clinical Neurophysiology, August
1962, vol.14, no.4, p.585.

7. Sem-Jacobsen, C.W.

"DEPTH-ELECTROGRAPHIC NEUROSURGICAL TREATMENT OF EXTRAPYRAMIDAL DISTURBANCES. DANGERS AND NECESSARY PRECAUTION"

Movie presented at the 16th Scandinavian Neurological Congress, Oslo, 22. - 25. August 1962.

A copy of this 45-minutes movie of scientific results is available at the Walter Reed Army Institute of Research. It deals also with speech and electro-stimulation.

8. Nordlie, R., Denstad, T., Sem-Jacobsen, C.W., Hartviksen, K. and Herlofson, H.B.

"OM PARKINSONS SYKDOM OG DEN NEVROKIRURGISKE-DYBDEELEKTROGRAFISKE BEHANDLING VED FORSKNINGSSINSTITUTTET PÅ GAUSTAD SYKEHUS"

Symposium in Neurological Society, Oslo, Nordisk Medicin, 1962:68:1467.

The paper is written and presented in Norwegian.

"PARKINSON'S DISEASE, THE NEUROSURGICAL AND DEPTH-ELECTROGRAPHIC TREATMENT AND RESEARCH AT THE RESEARCH INSTITUTE, THE EEG LABORATORY, GAUSTAD SYKEHUS"

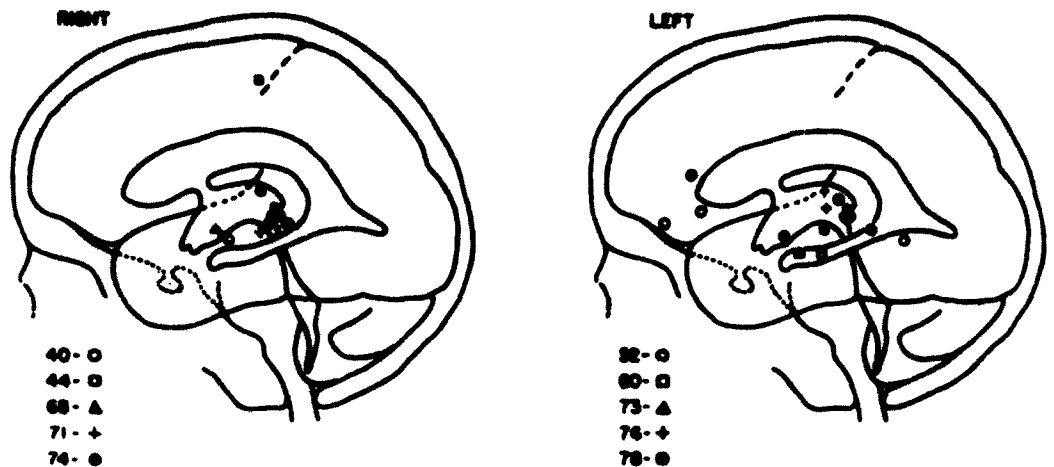
		G-No.
		Electrode
		Diagnose
		Sex
		Age
		E-stim Total
		Volt
		Response
		Positive
		1/10 Amp.
		Type stim
		L/R
		Lead Metal
		Lead Plastic
		Ant.
		Post.
		Dors.
		Vent.
		Left
		Right
		Attitude towards
		I Motor
		II Tremor
		III Rigidity
		IV Speech
		V Visual
		VI Smell & Taste
		VII Vestibular
		VIII Sensation
		IX Pos. & Neg. Mental
		X Memory
		XI Agrafi & Afasi
		XII Consciousness
		XIII Cardio. Vasc.
		XIII Vegetativ
		XIV Sex
		XV Recording

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Audio

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SPEECH



Areas where electrical stimulation had an effect on the patient's ability to speak.

Patients number 10, 44, 68, 71 and 74 had the electrodes in the right hemisphere. Patients number 52, 60, 73, 76 and 78 had the electrodes in the left hemisphere.

None of the patients were lefthanded.

The symbols after the patient's number illustrate in which location these patients were stimulated. All points stimulated were about 1,5 cm from the mid-line.

There were no difference in the effect of the electrical stimulation whether the right or left hemisphere was stimulated. The findings indicate that the speech mechanism in these regions near the mid-line is well represented on both sides.

In one patient arrest of spontaneous speech and vocalization were elicited from the same point. Stimulation of this point with a minimum current produced also dramatic change in mood. The patient started to smile followed by laughing. This is very well illustrated in a movie from our study, of which Walter Reed Army Institute of Research has a copy.

**ELECTRICAL STIMULATION -- EFFECTS ON SPEECH IN SOME AREAS AROUND
THE THIRD VENTRICLE**

by

Carl Wilhelm Sem-Jacobsen, M.D.

Speech disturbances are seen in treated as well as in untreated cases of Parkinson's Disease.

A movie was shown illustrating the location of areas dealing with the speech mechanism within the general region where therapeutic lesions in cases of Parkinson's disease are made.

In connection with depth-electrographic/neurosurgical treatment of patients observations important for normal mental well-being have been reported earlier.

In the course of our intracerebral studies of patients under this type of treatment observations related to the mechanism of speech have been made. In 14 patients, two suffering from mental disorders, 11 from Parkinson's disease and one from intractable phantom limb pain, observations have been made by the use of depth electrodes.

The recording points have been located near the third ventricle about 1,5 cm from the midline in capsula interna, nucleus

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From the EEG Laboratory, Gaustad Hospital, Vinderen, Oslo, Norway. The study was supported by the Ford Foundation, Foundation Fund for Research in Psychiatry, and European Research Office, United States Department of the Army.

Summary of paper presented at the 16th annual meeting of Nordisk Neurokirurgisk Forening, Odense, Denmark, 27 - 28 August, 1962.

dorsalis and ventralis lateralis thalami as well as neighbouring structures. At some points only speech was effected, at other points motor movements or sensoric phenomena were elicited. In some instances the ability to clear thinking was effected. No stimulations resulting in tonic or clonic movements or petit mal like states of consciousness have been included.

The following changes in the mechanism of speech were observed:

1. Change in voice, tone and pitch.
2. Difficulties due to lack of air control.
3. Arrest of spontaneous speech, but maintained ability to read.
4. Arrest of speech with intact ability to use mimic muscles, tongue, and finger movements. This aphasia-like response was combined with agrafi.
5. Arrest due to loss of motor control without arrest of simple movement.
6. Facilitation of speech.
7. Vocalization.

The findings indicate that we here are dealing with a central of representation of speech. The cortical representation responsible for these modalities of speech has been mapped by Drs. Penfield and Rasmussen.

Our observations may help to map the connection between these areas and the midline structures.

As illustrated by the movie important areas dealing with the mechanism of speech are located in the general area in which therapeutic lesions in cases of Parkinson's disease intermittently are made.

Reprinted from Journal of EEG and Clinical Neurophysiology,
February 1963, Vol.15, no.1, p.148.

"YES-NO" DATA REDUCTION IN EEG AUTOMATIC PATTERN RECOGNITION

by

Carl Wilhelm Sem-Jacobsen M.D.

and

E. Kaiser.

In the present approach the EEG potentials are described successively by a number of "yes" and "no" answers to different criteria. At the end of each half-wave eight questions pertaining to this potential formation are answered by means of an electronic set-up consisting of one unit detecting the zero cross-over and eight sub-units, answering: Is this amplitude higher than 20uV? - Is this amplitude higher than the mean amplitude for the preceding 10 sec. or 1 sec.? - Is the duration longer than the mean duration over the preceding 10 sec. or 1 sec.? - Is the present frequency lower than 15 c/s, 8 c/s. or 4 c/s.?

The answers, the "yes-no" combinations "(words)"

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From the EEG Laboratory, Gaustad Hospital, Vinderen, Oslo, Norway. The study was supported by the Ford Foundation, Foundation Fund for Research in Psychiatry, and European Research Office, United States Department of the Army.

Summary of paper presented at the 16th Annual Meeting of American EEG Society, Atlantic City, N.J., June 15-17, 1962.

characterizing each half-wave is instantaneously punched by a tape puncher, thus producing sequential digital information. The sequences of "words" are suitable for pattern recognition as "blocs" in a computer.

The recognition takes place as a continuous comparison of incoming data to a large number of patterns, "blocs" stored in the computer.

A punch speed of 50 "words"/sec. is necessary per EEG channel. With a puncher capable of 150 "words"/sec. and an electronic switch we will analyze and compare three channels in D.E.G. (depth electrography), and/or correlate two EEG channels with biological and psychological data recorded simultaneously.

In simulators and space flights, EEG, EKG, and other biological data will be correlated with tracking ability and performance during stress. Thus correlating psychological stress tolerance with performance in laboratories and space.

The, "Yes-No" data reduction in EEG automatic pattern recognition, is primarily designed for correlating the spontaneous paroxysmal activity occurring simultaneously in frontal, parietal, temporal and midline structures. This paroxysmal activity is altered by change in behavior, but an accurate analysis has so far been futile. It is our hope that by the use of computers a interpretation of these data will be possible.