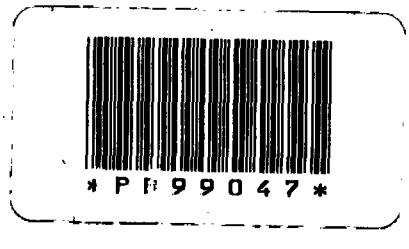
Office Report 1985—22

Report on official visit to the USA and the Eleventh International Congress of Electroencephalography and Clinical Neurophysiology, London July - August 1985

B.R. Mallinson, M.Sc., Chief Researcher

National Institute for Personnel Research
Executive Director: Dr G.K. Nelson



Pretoria
Human Sciences Research Council
1985

CONTENTS

3.5 PSYCHOLOGY DEPARTMENT UNIVERSITY OF NORTH CAROLINA - GREENSBORO

The Electrophysiology Laboratory of the Department of Psychology has been involved in evoked potential research for many years. This has chiefly involved use of the visual EP in selective attention. Recently EPs have been used for research into learning disabilities in children and into the effects of ageing on the brain.

3.5.1 Dr Martha Oakley

An experiment was in progress when I arrived and I was able to see at first hand what was involved. After the technological complexities of Donchin's laboratory the Computer of Average Transients (CAT) in use in this laboratory provided a contrast in approach. The experiment involved recording VEPs to light flashes at various locations in the visual field. Subjects were asked to attend to some flashes and ignore others. The VEPs recorded to the attended flashes were substantially different to those recorded to the ignored flashes. The origin of this effect, whether central or peripheral, was being studied. VEPs were plotted on an X-Y plotter and grand mean averages and mean difference waveforms were calculated and plotted by hand. Dr Oakley indicated that this was the last project for which the CAT was being used as an IBM microcomputer was on order for this laboratory.

3.5.2 Dr Russell Harter

Again a pioneer in research, Dr Harter has studied EPs in visual assessment and the effects of attention and motivation on the early and midlatency components of the VEP. He is at present involved in a national programme investigating the electrophysiological concomitants of

learning disability. A current project related to this programme involved presenting normal and LD children with visual stimuli in a video game format that required a button-press response. Reaction times were measured and both groups were trained to a similar level of achievement. Once this criterion had been reached the tasks were again presented and EPs recorded to the stimuli. Dr Harter's rationale for this experiment is interesting. He believes that too many EP studies merely demonstrate differences between groups that could be shown, more simply by behavioural means. His experiment eliminates the behavioural differences between groups and investigates whether neurophysiological differences are also removed or if the EP shows some neurophysiological compensation in the LD group. His method of data analysis is also unique. Dr Harter believes that to pick a peak at a set time along the EP and to expect it to reflect the complicated changes taking place in the brain is simplistic. He prefers to examine the entire EP for differences between his groups. This involves an analysis of variance at each digitization point along the EP. Variance is plotted against time and the points along the EP where group differences occur are immediately evident. Significant group differences were obtained between the EPs of normal and LD children and we discussed the meaning of these data.

3.5.3 Conclusion

The visit to this laboratory was very stimulating. Dr Harter's innovative approach, especially to data analysis, was enlightening. This requires considerable computer power as approximately 100 analyses of variance need to be calculated simultaneously during collection of an EP. It is possible that our Pathfinder could perform this on-line under FORTRAN control. Another possibility is to perform the calculations off-line on trials stored in files on a Winchester drive. Dr Harter's work may have relevance to local LD groups.

3.6 NEW YORK STATE PSYCHIATRIC INSTITUTE - PSYCHOPHYSIOLOGY LABORATORY

3.6.1 Dr Samuel Sutton

Dr Sutton has been involved in psychophysiological research since the late 1940s. He was the first to describe the late positive complex of the cognitive evoked potential and named it the P300 complex. In recent years he has written extensively on the effect of psychological variables on this component. He has also been involved in research of a more clinical nature with psychiatric patients.

I did not see Dr Sutton's laboratory as it was being revamped with new equipment. Dr Sutton stressed again what had been learned at other centres; the need for multichannel recordings and also the need to record and store single trials.

3.6.2 Dr Gerard Bruder

Dr Bruder is interested in cerebral laterality and psychopathology. In this research, he used behavioural as well as electrophysiological techniques. He has shown that in certain types of affective disorder the normal lateralization seen in temporal and spatial discrimination tasks is disrupted. Both behavioural (dichotic listening tasks) and EP measures have shown this. The work has progressed to the stage where the EP may be used to predict whether a depressed patient will respond to tricyclic antidepressant medication. I asked about similar work on the response of hyperactive children to medication. Dr Bruder pointed out that a previous project has shown that the EP reflects the attentional deficit seen in these children and that this normalized after Ritalin medication. However, this had not been developed into a clinically useful procedure.

3.6.3 Conclusion

The New York Psychiatric Institute's approach was more applied than that of the other laboratories visited. The EP is a powerful procedure even in this kind of research. The methods used by Sutton and Bruder could have relevance in the Division's involvement with drug research.

3.7 ROSE F KENNEDY CENTER FOR RESEARCH IN MENTAL RETARDATION AND HUMAN DEVELOPMENT - DEPARTMENT AND NEUROSCIENCE OF NEUROLOGY

The R F Kennedy Center is an institute of the Albert Einstein College of Medicine of the Yeshiva University in New York. It is a multidisciplinary organisation devoted to research in mental retardation and human development. It does however offer a clinical service and also has a large animal research division.

3.7.1 Dr Diane Kurtzberg

Dr Kurtzberg is involved in a programme of research on electrophysiological indices of normal and aberrant cortical maturation. At the time of my visit a project on EPs in response to speech sounds in normal and low birthweight infants was in progress. Sixteen channel EPs were recorded using a Nicolet Med 80 computer and stored on a hard disk. A consistent maturational trend in auditory EP and parameters has emerged and those of very low birthweight infants show a maturational deficit. The speech sounds used were computer-generated syllables approximating /da/ and /ta/. An additional project using these syllables in an oddball paradigm, to examine maturational changes in the cognitive EP in similar groups, is being implemented. Data are still being collected.

3.7.2 Conclusions

These results raise the possibility of the potential application of EPs in the early identification of at-risk infants. This depends on additional work, however. Additional confirmation of the necessity for multi-channel EP recordings was determined from this visit. Dr Kurtzberg has ordered a Pathfinder EP system to replace the out-of-date Med 80. However, the Pathfinder will have multichannel capabilities and also a hard disk to permit her to continue this research.

3.8 STATE UNIVERSITY OF NEW YORK - PSYCHOLOGY DEPARTMENT

3.8.1 Dr Nancy Squires

Dr Squires has been involved in EP research for many years. She was a student of Donchin and has published many papers in this field. She is head of the Electrophysiology Laboratory in the Department of Psychology at SUNY. Her early work used cognitive evoked potentials but at present she is investigating aspects of EPs (early, mid and late latency components) in certain clinical populations. We discussed the results of these experiments in Down's Syndrome children, multiple sclerosis patients and learning disabled children.

Dr Squires uses a Pathfinder in her laboratory. All experimental data are however recorded on a data recorder prior to digitisation. AD conversion and averaging are performed off-line on the Pathfinder. The system currently has an 8 channel capability but in due course this will be upgraded to 16.

Results show a reduced central conduction time in the BAEP of Down's children, mid-and late latency delays but normal BAEP in many MS patients and conduction delays in learning disabled children who have a history of otitis media.

My Pathfinder experience provided the background for a discussion of technical issues relating to the system. This group had only just received Version 4 software so I was able to offer advice on its use.

3.8.2 Conclusion

The visit to SUNY provided the opportunity to see a Pathfinder in applied clinical use with many affinities to our Division. An important issue is the relevance of recording the electrical activity of the entire auditory system, (brainstem, mid and late latency EPs) for clinical diagnosis. This needs consideration in our laboratory, but could not be achieved without extensive normatisation.

4. 11th ICECN

The Congress was held at the Barbican Centre in central London. This proved to be an excellent venue providing spacious accommodation, plush theatres and large exhibition halls. Over 1500 delegates from 53 countries attended. (see Appendix 1). The scientific programme comprised eight different types of sessions on each day. These were:

1. Symposia

Three-hour platform sessions, each devoted to a major area of clinical neurophysiology conducted by invited speakers.

2. Workshops

Three hour sessions similar to the symposia but conducted by authors who submitted papers.

3. Free Communications

These were presented as posters, grouped on related themes. Posters were displayed for one day and presented at a time

indicated on the programme. A short discussion followed each presentation.

4. "State-of-the-Art" Tutorial Course

Didactic lectures covering the whole field of neurophysiology, and intended for newcomers to the field. These will be published in book form in 1986 and because of this and shortage of time I did not attend any of the tutorials.

5. Invited Lectures

Lectures on fundamental issues in neurophysiology by distinguished invited speakers.

6. Interpretation of Records

Experts presented EP, EEG and EMG records and discussed the interpretation of these.

7. Scientific Demonstrations

Live demonstrations of recent developments in recording procedures were conducted by experts.

8. Data Processing Meeting

Symposia, Workshops and Free Communications devoted to the analysis and display of neurophysiological phenomena.

4.1 OPENING CEREMONY

The welcoming address by the President of the British EEG Society (Dr A M Halliday) was followed by the opening of the Congress by the President of the Royal Society, Sir Andrew Huxley O.M. The President of the International

Federation, Dr R J Ellingson, gave an address. The highlight was, however, the address by the Honorary President of the Congress, Sir Bryan Matthews, C.B.E., F.R.S. He spoke of his work with Lord Adrian in the early days of EEG shortly after Hans Berger's first recording of human brain waves.

4.2 SYMPOSIA

4.2.1 Topography of Cerebral Activity and the Localization of Source Generators

The presentations in this symposium were very technical. The mathematical models of brain activity presented were not meaningful without specialised knowledge in this area. Some of the general statements made however were of importance. The value and indeed the necessity of topographic analysis (either by mathematical formulae or by means of screen displays) in both research on clinical practice was stressed. Significantly more information can be obtained from a topographic map of for example, a paroxysmal EEG discharge than from a paper record of the same phenomenon. A limitation, however, is that the topographic map only reflects brain activity measured at the surface of the scalp. The generators of this activity may lie deep within the brain and the localization of surface activity resulting will depend on the orientation of the dipole. Furthermore irregularities in skull thickness and impedance of the meninges cause variations in scalp activity that do not reflect variations in brain activity. Brain maps therefore require cautious interpretation.

4.2.2 Event Related Potentials and Cognitive Proceses

This symposium was for me the high point of the Congress. Six experts discussed their use of EPs in cognitive research. Two of the papers considered mechanisms of selective attention and the effect of damage to certain areas of

the brain on them. Another author showed P300 data collected intracranially during brain surgery. The data strongly suggested multiple subcortical generators contributing to scalp P300. Possibly one of the most interesting papers was by Dr Kutas. She recorded EPs to written or spoken words presented in a sentence. A negative peak at approximately 400 ms varied systematically in amplitude with semantic incongruity. These potentials were also studied in congenitally deaf individuals and an analysis of the topography of the EP in these and normal subjects was used in forming a working hypothesis of the brain in language function.

Once again the flexibility of the EP for cognitive research was evident. The methods used by Kutas could profitably be used to study bilingualism and the functional organisation of a second language in the brain.

4.3 WORKSHOPS

4.3.1 EEG and EPs in Normal and Abnormal Mental Acitivty

Twelve papers were presented covering topics from hemispheric specialization to EP assessment of selective attention in depression. Abnormal EPs, in an oddball paradigm, were described for schizophrenics and one author described the electrocorticographic (ECOG) correlates of naming and verbal memory. The high point of this session was the paper by Prichep and John. This described the neurometric evaluation of psychiatric patients. Neurometric evaluation is based on establishing normative age regression equations for mean values and standard deviations for a number of quantitive features extracted from the EEG. These features include univariate measures of absolute and relative power, coherence and asymmetry in the delta, theta, alpha and beta frequency bands and multivariate measures across various brain regions. Prichep and John have developed over 200

such equations. Values from individual patients are subjected to Z- transformations to assess the probability of abnormality. These methods accurately discriminated patients suffering from senile dementia, manic-depressive psychosis, and unipolar and bipolar depressives from normals and from each other.

The paper was very well received, reflecting the growing popularity of these methods. Many of Prichep and John's normative values can be plotted on a topographic map, making this on extremely powerful means of investigation.

4.3.2 EEG and EPs in Dementia (8 papers)

The use of EPs (middle and late latency) in the study of demented patients was the chief topic, but two studies used computer-analysed EEG data. A study by Giaquinto and Nolfe addressed the problem of whether dementia and normal ageing are separate biological events or merely points on the same continuum. The EEG was recorded on several channels, spectral analysis performed on the data and then asymmetry coefficients computed. Marked differences were seen between demented and normal subjects. The authors concluded that ageing and dementia are different processes. A weakness was a lack of specification of what form of dementia was involved. Another study, using similar techniques, however, showed that computer analysis of EEG activity could differentiate patients with Alzheimer's disease from patients with Huntington's disease and both from normal age-matched controls. In both studies the topographic distribution of EEG measures was used to differentiate groups.

Aminoff and Goodin compared the EEG and P300 in Alzheimer's disease. The P300 was the more sensitive measure although the two measures complemented each other. Blackwood et al showed that the latency of P300 was related to performance

on certain items of the Luria Test Battery in Alzheimer's and Karsakoff's dementias. Hamberg et al reported similar results using subjects suffering from Huntington's disease and their offspring. They also found a high correlation between P300 latency and scores on general cognitive tests especially those requiring speeded information processing.

Wright and Harding compared flash VEPs and PREPs in Alzheimer's patients and normals. They found that PREP latency showed very little change with ageing but that P2 latency of the flash VEP slowed markedly. Alzheimer's patients showed an exaggerated slowing of flash P2 latency. These findings were replicated in young volunteers who had been injected with an anti-cholinergic agent. They concluded that dementia could be related to a reduction in cholinergic activity.

4.4 POSTER SESSIONS

These sessions were attended between the main sessions. Each presentation lasted about 3 minutes with 2 minutes for discussion. The number of posters presented in each session was too numerous to permit discussion in detail. Most posters were of a high standard but some were criticised for inadequate control of experimental variables.

4.5 INVITED LECTURES

Only one of the invited lectures (given by Dr E Courchesne) was relevant. This was entitled, "Electrophysiological correlates of cognitive processes". The electrophysiological activity discussed was the late latency EP. Dr Courchesne listed four aspects that must be examined before EP peaks can be labelled. These are, latency, amplitude, duration and scalp distribution. He also stressed that late EP components are affected by psychological factors such as motivation, attention, cognitive strategy and cooperation.

It is important that these be properly controlled between and within groups before valid comparisons can be made. He recommended debriefing experimental subjects in the attempt to account for the effect of some of these factors. Data should also be analysed according to a theory relating to the behavioural results of the experiment. This may require single trial analysis of the EP data. Dr Courchesne illustrated the above points by describing an experiment investigating the EP correlates of cognition in autistic children.

4.6 INTERPRETATION OF RECORDS

Three experts discussed the clinical interpretation of EP records. The methods described accord with those presently used in the Division and little that was new was learned.

4.7 SCIENTIFIC DEMONSTRATIONS

Two scientific demonstrations were attended. Dr C Binnie demonstrated the effect of differing EEG derivations on recording. He recorded the EEG simultaneously on two EEGs and examined the differences between different montages, particularly referential montages. This demonstration was only partly successful owing to the considerable difficulty involved in recording EEGs in the adverse electrical environment of a lecture theatre.

In the second demonstration Dr P Wong demonstrated spatial-temporal mapping of EEG activity. With so much interest shown in EEG mapping during the Congress it was interesting to see this being done "live". The procedure makes EEG analysis, especially the localization of specific EEG features, much easier, although overinterpretation must be guarded against. EEG mapping appears to be regarded as a valid procedure and will probably become a standard procedure in the EEG laboratory.

4.8 DATA PROCESSING MEETING

I attended a seminar entitled "Spatial analysis and display of EEG data". This was probably one of the most popular sessions of the Congress. Dr F Duffy, a pioneer of brain mapping, presented a paper entitled "Spatial Displays". Dr Duffy argued in favour of mapping and he presented data illustrating its reliability and utility. Rappelsberger et al presented data in the form of topographic EEGs collected during mental activity and rest. John and Prichep described their method of neurometric analysis.

These three authors worked independently but presented remarkably similar data. All three showed that normative data can be collected for EEG variables and that these are clinically relevant. Topographic mapping of both normative and patient EEG features further enhances the research and clinical utility of the EEG.

4.9 COMMERCIAL EXHIBITION

Twenty eight companies involved in the manufacture and distribution of neurophysiological equipment exhibited during the six days of the Congress. Thus the features of different systems could be directly compared. Prominence was given to the versions of brain mapping by most exhibitions as these appeared to be what most visitors to the exhibition wanted to see.

Nicolet equipment still appeared to be amongst the best on display although it is more expensive than most. Nicolet's brain mapping system had the best screen resolution and colour and the programming of the system allowed greater flexibility than other systems I viewed. Some exhibitions demonstrated mapping in real time rather than the off-line Nicolet employs. This means that the raw-EEG data

is not available for comparison with the colour map. This may result in over-interpretation of the colour map and is therefore a disadvantage of real-time systems.

4.10 CONCLUSION

The Congress was a high point of my trip. It afforded the opportunity to rub shoulders with, and hear papers delivered by, many of the top names in the field. The standard of papers was very high and many new ideas for research were generated. The opportunity to discuss contributions with researchers from around the world was very valuable and greatly appreciated. Two future trends appear to be brain mapping and multi-channel recording.

5. GENERAL CONCLUSIONS

The two aims of electrophysiological research and application in the Division have historically chiefly been based on the EEG and short-latency EPs (especially visual and auditory). With regard to the former, the Division was one of the first in the Republic to record EEGs and has since maintained a lead in research, clinical diagnosis and teaching of this procedure. If this lead is to be maintained then several new developments in technology which I encountered on my trip will need to be taken into consideration. Chief among these are the techniques of brain mapping and of neurometric assessment. It is strongly recommended that provision be made for the acquisition of the necessary equipment and software to permit topographic analysis on the Pathfinder. As mentioned in the body of my report this is anticipated for release by Nicolet Biomedical early in 1986. It is estimated that the cost involved will be $30 000.

The full potential of the Pathfinder System has not been realised to date with the emphasis on short latency EP measures. If this potential is to be realised then the

current emphasis will need to be supplemented by research using longer latency measures and particularly those reflecting cognitive processes. To this end, it is strongly recommended that a cognitive electrophysiologic research programme be implemented in the Division. Specific research projects could be planned at a later date but areas for research which should be considered are: language processing, particularly in relation to bilingualism; cognitive processing in normal and neuropsychologically disadvantaged children; basic cognitive processes in various ethnic groups and subgroups, cognitive processing in relation to various forms of medication and drugs; electrophysiological measures in relation to scores on tests and subtests of cognition and neuropsychological performance. If such a research programme is to be implemented the necessary multichannel recording and storage of single trials would be catered for by the system upgrading demanded by topographic mapping. No additional cost would thus be involved beyond the $30 000 already mentioned.

APPENDIX 1

Countries represented and number of delegates

Algeria	2	Luxembourg	3
Argentina	7	Malta	2
Australia	52	Mexico	8
Austria	22	Netherlands	82
Belgium	25	Northern Ireland	3
Brazil	1	Norway	10
Bulgaria	18	Peru	1
Canada	44	Poland	18
Chile	1	Portugal	8
Cuba	2	Republic of China	3
Cyprus	2	Republic of South Africa	9
Czechoslovakia	6	Romania	4
Denmark	28	Saudi Arabia	1
Dominican Republic	2	Spain	16
East Germany	3	Sweden	45
Finland	26	Switzerland	27
France	55	Turkey	1
Greece	10	United Arab Emirates	1
Hong Kong	1	United Kingdom	226
Hungary	5	United States of America	204
India	5	Uruguay	2
Indonesia	2	USSR	5
Iran	2	Venezuela	4
Israel	11	West Germany	56
Italy	84	Yugoslavia	16
Japan	190	Zimbabwe	1
Jordan	1		

APPENDIX 2

Symposia

1. Topography of Cerebral Activity and the Localization of Source Generators

1.1	H G Vaughan	Topographic analysis of brain electrical activity.
1.2	P Nunez	The location of cortical sources of EEG.
1.3	P Rappelsberger, H Pockberger H Petsche	Intracranial recording and generators of the EEG.

2. Event-related Potentials and Cognitive Processes

2.1	M I Posner	Cognitive neuropsychology and the problem of selective attention.
2.2	J E Desmedt	Somatosensory event-related potentials (SERP).
2.3	S A Hillyard	Mechanisms of selective attention for auditory and visual stimuli.
2.4	M Kutas	Language processing and cognitive potentials.
2.5	G Mc Carthy	Intracranial recordings of endogenous ERPs in Humans.
2.6	E Donchin	Practical uses of ERPs for assessing overload of cognitive resources.

APPENDIX 3

Workshops

1. EEG and EPs in Normal and Abnormal Mental Activity

1.1	Mieko Ohsuga Y Miyata	Hemispheric differences in EEG alpha activities during verbal and visuo-spatial processing
1.2	M Koukkou D Lehmann W Manske	Hemispheric EEG reactivity and information processing: within and between session characteristics.
1.3	A S Gevins N H Morgan S L Bressler B A Cutillo	Nonstationary directed mutual information flow analysis of right- and left-handed finger movements.
1.4	K Hammond S Butler A Glass	Individual differences in alpha activity during mental activity.
1.5	G Ojemann E Lettich	Electrocorticographic (ECOG) correlates of naming and verbal memory.
1.6	W Guenther D Breithing V Buell H Hippius P Rondot	Hemispheric functional asymmetries in psychotic patients measured by topographic EEG and regional cerebral blood flow.
1.7	Y Nageishi M Shimokochi	The effects of semantic or grammatical incongruity on event-related potentials in Japanese.

1.8	P V Pocock	Phase relationships in alpha rythms in schizophrenia.
1.9	L S Prichep E R John	Neurometric evaluation of psychiatric patients.
1.10	M Matsubayashi F Omura T Kabayashi Y Miyasato C Ogura	Event-related potentials and cognitive function in schizophrenia.
1.11	F El Massiovi Nicole Lesevre	An ERP assessment of selective attention impairment in depression.
1.12	P Abraham C Churcher-Brown	Schizophrenia - diagnosis and prognosis with the help of CNV.

2. EEG and EPs in Dementia

2.1	S Giaquinto G Nolfe	Computerised EEG in the normal elderly and in the demented.
2.2	V Hömberg W Strauss M Hennerici	The value of P3 in evaluation of cognition: Validation with detailed psychometry in Huntington's disease.
2.3	L J Streletz R G Fariello P F Reyes L Catz M Zalewska	Computer analysis of EEG activity in Alzheimer's and Huntington's disease.

2.4 S L Visser, C Hooijer, C Jonker, W von Tilburg, J Posthuma — EEG and VEP in Senile Dementia Alzheimer type: A follow-up study over one and a half years.

2.5 D H R Blackwood, I M Blackburn, D M St. Clair, J Tyrer, J E Christie — Cognitive impairments and auditory event-related potentials in patients with Alzheimer's dementia and Korsakoff's syndrome.

2.6 M J Aminoff, D S Goodin — Comparison of diagnostic yield of EEG and P3 in patients with dementia.

2.7 C E Wright, G F Harding — Visual evoked potentials in normal ageing and dementia.

2.8 J J Tecce, L Cattanach, R J Branconnier, J O Cole — CNV rebound and Alzheimers' disease.

3. ERPs Related to Movement or Cognition

3.1 R Näätänen — Mismatch negativity of the event-related brain potential as an indicator of automatic information processing.

3.2 D S Goodin, M J Aminoff, M M Mantle — The influence of task complexity on the relationship between evoked cerebral potentials and voluntary movement.

3.3	T Kirikae T Mita A Sakai H Suzuki	The characteristics of visual evoked potentials (VEP) associated with the perception of an ambiguous figure.
3.4	F Breton B Renault	Stages of information processing and event-related potentials.
3.5	A Pierson R Ragot N Leservre	Electrophysiological and RT changes elicited by acoustical stimuli according to their hedonistic value.
3.6	M Shimokochi Y Nageishi	Sequential effects on event-related potentials (ERP) and reaction time (RT) during a 10 choice RT task.
3.7	C S Rebert	Components of cerebral systems mediating preparatory set and response to rare events.
3.8	C H M Brunia E J P Damen	Preparation for a movement is different from perception of a stimulus: A slow wave study.
3.9	A Kok	Learning where to look: Electrophysiological and behavioural indices of visual search in young and old subjects.

1. PURPOSE

1.1 To visit Nicolet Biomedical headquarters to gain knowledge and experience in programming and operating the Nicolet Pathfinder II Evoked Potential System.

1.2 To visit laboratories engaged in research into cognitive processes using evoked potentials, with an emphasis on methodology.

1.3 To attend the 11th International Congress of Electroencephalography and Clinical Neurophysiology (11th ICECN) in London.

2. BACKGROUND

2.1 NICOLET BIOMEDICAL

The Pathfinder Evoked Potential System was acquired by the Division of Neuropsychology in 1982. The System amplifies, filters, digitises and provides an average of the minute electrical impulses emanating from the brain in response to sensory stimulation. Both stimulus presentation and data acquisition are controlled by a number of Z 80 microprocessors, in turn controlled by a 20 bit mainframe processor. The system can be programmed to operate automatically using Nicolet's command language, MECOL, or it can be upgraded to run FORTRAN 77. There are three Pathfinder Systems in South Africa at present. Two of these are in hospitals and are used primarily for clinical purposes. The research applications of the Pathfinder in the Division are therefore unique in South Africa and demand a thorough knowledge of the computer operating system. The local agents are not able to provide support in this area and, in fact, often call on our expertise to solve the problems of other customers. In addition, Nicolet regularly upgrade the operating system and considerable time is required to learn the new commands for each upgrade.

The Pathfinder manual is written at a high level and is often difficult to understand. Nicolet Biomedical have overcome these problems in the USA by appointing a training manager and offering Pathfinder training courses.

It was felt that the capabilities of the Pathfinder, especially in research, would be better utilized after direct training at Nicolet and discussions with their engineers. Specific areas for dicussion would include the possibility of acquiring the FORTRAN 77 option and future hardware and software developments. A week-long visit to Nicolet Biomedical headquarters in Madison was therefore arranged through their international representative, Dr Jon F Peters.

2.2 LABORATORY VISITS

The NIPR has a long history of research using electrophysiological methods to investigate personality and intelligence. In the late 1940s the first Director, Dr S Biesheuvel, purchased an electroencephalograph to study electrocortical concomitants of temperament. Later, Mundy-Castle and Nelson investigated the EEG correlates of intelligence. Although early hopes of a direct correlation between aspects of EEG activity and intelligence had largely evaporated by the 1970s, recent developments, using evoked potentials (EPs) have rekindled these hopes.

The Division of Neuropsychology has recorded EPs for many years. Interest, however, has centered on the so-called exogenous or early components, reflecting sensory function. These have been used by the Division to investigate the visual function of albinos, as an aid in diagnosis of multiple sclerosis and in the assessment of visual and hearing deficits in infants, as well as to measure the effects of drugs and of malnutrition on the central nervous system.

The late latency or endogenous components of EPs are used in cognitive research. Our experience in recording these components is limited. If a research programme in cognitive electrophysiology is to be initiated then a visit to laboratories using this technique would be useful. At my request Dr Jon Peters of Nicolet arranged visits to the laboratories of five of the leading researchers in this field.

2.3 CONGRESS

The International Federation of Societies for Electroencephalography and Clinical Neurophysiology (IFSECN) was founded in London in 1947. The Federation, of which the South African Society for Electroencephalography and Clinical Neurophysiology is a member, arranges an international congress every four years. This is the premier congress in the field of EEG and EP and the 11th Congress was arranged for London in August 1985. Leading figures in EEG and EP research deliver papers and conduct symposia and workshops. This congress represented a rare opportunity to gain knowledge and experience in a short period and to make contact with researchers from around the world.

3. VISITS

3.1 NICOLET BIOMEDICAL - MADISON

Nicolet Instruments Corporation manufacture and distribute high technology electronic equipment. Their world headquarters is situated on the outskirts of the university town of Madison. The Biomedical Division produces electrophysiological equipment whereas other divisions produce Lasers, SONAR, X-Ray, Digital Oscilloscopes, Fast Fourier Analysers and other signal analysis equipment, all for industrial use. My stay at Nicolet was hosted by Dr Robert Pronk, the engineer responsible for the Pathfinder, who arranged meetings with various members of staff.

3.1.1 Mr Fred Mount - Training Manager

Mr Mount is responsible for training Pathfinder customers in MECOL and FORTRAN programming. We discussed difficulties experienced with the Version 4 software, recently supplied. Some were due to "bugs" in the software and these would be corrected in the next release. Mr Mount demonstrated some of the more troublesome commands and gave me sample programs using them. We worked through Pathfinder exercises and I now feel competent in most of the troublesome areas. Some discussion was devoted to programs I had written and I found his comments very valuable.

3.1.2 Dr Robert Pronk - Senior Development Engineer

Dr Pronk, a medical physicist, is responsible for development of the Pathfinder. The Pathfinder's major new hardware development is the Topographic Mapping System.

This system is based on colour-coded maps of brain electrical activity, with areas of equal voltage in each frequency band displayed in the same colour. It provides a means of reducing the vast quantity of information in an EEG into a concise and easily assimilated format. The colour maps may be displayed in succession at high speed to give a "cartooning" effect. Changes in activity in time and location can thus be easily identified. The cartooning may be interrupted and the display at that moment stored or printed out. Normative data may be stored in the system and patient and normative maps compared visually or in statistical terms. This system is in its final stages of development and will probably be released early in 1986.

3.1.3 Mr Jaap Kap - Software Engineer

Mr Kap has been responsible for developing the FORTRAN 77 option for the Pathfinder and also for writing FORTRAN applications programs. Although FORTRAN 77 requires a

hard disk some of the smaller applications programs can run on our floppy-disk-based system. Program difficulties experienced with these were discussed and apparently relate to the fact that they were orginally written for Systems with a Winchester hard disk. Ways of overcoming these difficulties were discussed and noted.

The advantages of using FORTRAN 77 as a programming language were also discussed. This option provides more flexible use of the System and for special data processing needs. FORTRAN has been fully integrated into the Pathfinder operating system and can therefore be used to set all stimulus and acquisition parameters; it may be intermixed with Assembler and keyboard command mode; may issue MECOL routines; and may also be used to access data directly, even during acquisition. Extreme flexibility of operation as is often required in research contexts, is thus attained.

3.1.4 Dr Linn Roth - Product Manager

The following additions to our System, discussed with Dr Roth, would be necessary to permit topographic mapping and FORTRAN operation:

1. Winchester hard disk

2. 256 K memory board (present system has a 128 K memory board)

3. Signal conditioning board (this permits input from an EEG and increases recording capacity from 4 to 32 channels).

4. Colour board and screen.

These enhancements would also allow multichannel recording of EPs and the storage of EP data in single trials, necessary for cognitive evoked potential research. The cost of these enhancements would be about $30,000

3.1.5 Dr Greg Furno - Software Engineer

The Version 5 operating system was discussed. This will be available in 1986 and embodies several improvements on the previous version. It includes a screen-based editor rather than the line editor in the present version; the "raw" electrophysiological input can be displayed together with the average and a zoom and scroll function is available. The latter enables one to zoom in and examine a particular area of the averaged waveform without having to change the time-base. The system will also have a built in wordprocessor.

3.1.6 Dr Mike Vivion - Consultant

Dr Vivion is a consultant to customers using Nicolet equipment. His particular field of interest is auditory assessment. Our work in this area using the BAEP appeared in keeping with similar assessments in the USA. However, Dr Vivion felt that we should consider recording middle and late latency EPs as well. This would provide information concerning the auditory pathways from the cochlear to the secondary association areas of the cortex. The mid latency potentials are also capable of providing frequency specific information in patients with hearing loss.

The emitted potential, for assessing cognitive stress was also discussed. This is recorded to the absence of a stimulus and its amplitude may be an indication of the extent to which cognitive resources have been allocated to a secondary task. This may prove to be a viable area of research.

3.1.7 Dr Rick Schoefler - Software Engineer

Problems experienced with the Frequency Analysis Package (FAP) for the Pathfinder were discussed with Dr Schoefler, who was responsible for its development. It transpired

that our Version of FAP was a preliminary release and this contained certain faults. We now have the correct version and since returning to South Africa it has been installed and is operating successfully.

Dr Schoefler also demonstrated the new version of FAP. Enhancements include a trend analysis routine, the addition of a spectral edge indicator on the compressed spectral array and the ability to store the quantification data to disk. This program will probably be released, together with the version 5 operating system, during 1986.

3.1.8 Conclusion

The visit to Nicolet Biomedical may be termed a success in the following respects. The programming difficulties we had experienced have been resolved and many new ideas and sample programs obtained. First-hand knowledge of future software and hardware developments was obtained. This should assist in planning future research within the Division. Nicolet's policy of continuing product development and improvements, most of which are passed on free of charge to Pathfinder owners, became very clear during the visit. Most important, contacts were made with the people responsible for development of the Pathfinder. Direct contact will be made with them should any problems arise in future.

3.2 UNIVERSITY OF WISCONSIN - MADISON

3.2.1 Dr Kurt Hecox, Department of Neurology, University of Winconsin - Madison

Dr Hecox has established a world wide reputation in the use of evoked potentials for the assessment of hearing. His department offers a clinical service for local residents and is involved in many areas of basic and applied research.

The laboratory uses four Pathfinders each connected to a 70 Mbyte hard disk. Two programmers are engaged in the full-time production of Pathfinder programs. Basic research includes work on the cochlear origins of the BAEP and whether changes seen in BAEP variables under various stimulus conditions are centrally or peripherally mediated. Applied research involves the use of the BAEP to determine the toxic effect of certain drugs and pollutants on the auditory pathways of laboratory animals and in the development of a digital hearing aid.

Our discussion centred around the use of the BAEP for hearing assessment. Dr Hecox's remarks concerning our methodology were very complimentary.

3.2.2 Conclusion

This visit provided a view of the Pathfinder in use in highly sophisticated research based on the flexibility of FORTRAN programming. However, this research area is best left to departments of audiology and neurology and would not be appropriate for our Division. The opportunity to receive first-hand confirmation of the appropriateness of our BAEP methodology in hearing assessment from a source of this stature, was appreciated.

3.3 ILLINOIS INSTITUTE FOR THE STUDY OF DEVELOPMENTAL DISABILITIES - CHICAGO

This multi-disciplinary Institute is situated on the campus of the University of Illinois at Chicago. There are clinically oriented departments such as physiotherapy and orthopaedics as well as the more theoretically oriented departments of genetics and biochemistry.

3.3.1 Dr Patrick Ackles - Department of Electrophysiology

Dr Ackles is at present involved in research into infant cognitive processes and perceptual development. For example, a current project concerns cognitive/perceptual development in 4 week to 18 month old normal and Down's Syndrome infants. Evoked potentials were recorded in a traditional "Oddball" paradigm to visual stimuli appropriate for each age. The stimuli were presented by a slide projector controlled by an Apple computer. Nine channels of electrophysiological data were collected and trials stored individually on a Winchester disk. Each trial was individually edited and rejected if muscle or eye movement artefact was seen. Relevant trials were then averaged together and peak analysis performed according to topographic distribution across the scalp. Behavioural data on the infants' responses were also collected. Since the project is still in progress data are preliminary. However developmental trends for the latency and amplitude measures of each EP peak are emerging. These correlate well with the behavioural data. In addition cerebral organisation for each group is studied by examining correlations between the electrical activity at each electrode.

Dr Ackles's results demonstrate that it is possible to record cognitive EPs in very young infants and that these show developmental trends. Further, they can be used to differentiate normal from at risk groups of infants.

3.3.2 Conclusions

The following lessons were learned from this research:

1. the importance of recording EP distribution over the scalp enabling measurement of brain organisation as well as being an aid to peak identification;

2. the identification of artefact on a trial by trial basis;

3. the value of storing data on a trial by trial basis permitting the re-averaging of trials using different criteria. For example, the trials recorded to a frequent stimulus in an oddball paradigm could be re-averaged grouping the trials preceeding, or those following the rare stimulus.

These procedures offer the Division the possibility of new approaches to the study of developmental changes and differences between normal and neuropsychologically disadvantaged populations. Cognitive EP differences in various ethnic groups may provide insight into cognitive development and also a means for the early identification of cognitive disabilities.

3.4 PSYCHOLOGY DEPARTMENT - UNIVERSITY OF ILLINOIS - CHAMPAIGN

The University of Illinois's Psychology Department ranks amongst the top five psychology departments in the United States. Post-graduate study is offered to about 200 students in seven areas. The Psychology Department also houses the Cognitive Psychophysiology Laboratory which I visited. This laboratory studies the electrical activity of the brain, with particular emphasis on cognitive function.

3.4.1 Dr Michael Coles

Dr Coles hosted my visit and showed me their laboratories. Their EP research uses a PDP 11/40 minicomputer. This controls all aspects of data acquisition and is interfaced with a Lab Logic System that controls stimulus presentation. Temporary data are stored on one of two hard disks and later transferred to magnetic tape for permanent storage

or subsequent re-analysis. FORTRAN software is used with Assembler subroutines operating in parallel.

A minicomputer rather than a special-purpose averager is used because of the flexibility it offers. This permits a trial-by-trial analysis of data, rather than only an average of many trials. The advantages of trial-by-trial analysis is that intertrial variance may be calculated and trials selected for averaging on the basis of the subject's response to each stimulus. Use of the mini-computer also allows individual trials to be inspected for eye-movement artefact and for the artefact to be removed. This system was installed in 1975 and may now be somewhat outdated when one considers the power of modern microcomputers. It remains, however, a very elaborate setup and allows the researchers to perform very sophisticated work.

3.4.2 Dr Gabriele Gratton

Dr Gratton described the method used for removing eye-movement artefact from the EP record. Identifying eye movement and discarding trials with this artefact is considered to discard potentially useful information. An eye movement correction procedure (EMCP) uses a computer algorithm that recognises the eye movement pattern and calculates a propagation factor for each electrode position. These measures are then applied to remove the artefact from each trial. EP components are identified in individual trials by means of a "Woody Filter". This procedure is somewhat complicated and was difficult to comprehend in the short time available. Dr Gratton has however published numerous articles and these give details of this procedure.

3.4.3 Professor Emanuel Donchin

Professor Donchin is head of the Psychology Department at the University of Illinois. He has a particular interest

in cognitive electrophysiology. He is a pioneer in this field and it was a privilege to spend time in discussion with him.

Prof Donchin was interested in the history of our Division especially the fact that we had such close ties, through Mundy-Castle, with the famous Grey Walter. He appeared to be acquainted with the early work of Mundy-Castle and Nelson and we spent time discussing this. He reaffirmed what Coles and Gratton had said about the drawbacks of special-purpose averagers and his reasons for choosing a minicomputer-based system. He was not aware that Nicolet had produced a FORTRAN package for the Pathfinder but felt that this would be essential if we were planning a cognitive electrophysiology research programme.

Prof Donchin was preparing a paper for the congress in London on using the EP to assess cognitive workload. We discussed this at length especially the prospect of using these procedures for research with our black population.

3.4.4 Conclusion

The visit to the Cognitive Psychophysiology Laboratory highlighted several key issues, the most important being single trial analysis. The crucial computer requirement for single trial analysis is an adequate storage facility. For example, a typical experiment would record data from possibly 20 subjects, 2 sessions per subject, 300 trials per session with 16 channels per trial, that is 192 000 EP records. These can be stored in the Pathfinder in files of 16 records each resulting in 12,000 files. It is clear that a floppy-disk based system is inadequate for this and that a Winchester drive is essential.