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1974-1978

SUMMARY (Director's Overview)

I regard the Applied Psychology Unit's primary role as providing a bridge between the experimental psychology laboratory and practical problems. If we are to fulfil this role we must be able to produce both theoretical work of a high order, and usable practical answers to immediate problems. While such a combination would not be possible in many subjects, the current position within psychology is such that the combination is not only possible but is a very fruitful one, a conclusion which is I think supported by our publications, and by the continuous stream of requests for advice and assistance that we receive.

The range of applications of our work is very wide, and in describing it there is a real danger that the diversity of practical applications will obscure the underlying theoretical concepts which link the many and varied applied studies. A relatively straightforward example of this is the unit's psychoacoustic work, where a single theoretical concept, namely that of an acoustic filter within the auditory system, motivates a range of applied questions including the design of auditory alarms for detectors of chemicals, warning systems for aircraft pilots, methods of audiometry and the design of hearing aids. A similar situation obtains in our work on cognitive psychology, but is less obvious since the underlying theoretical models are more complex, and frequently use somewhat different terminology to refer to broadly similar concepts. Hence Morton's logogen system which was devised to explain context effects in perceiving words has much in common with Baddeley & Hitch's working memory model which was originally designed to study the role of short-term memory in such tasks as reasoning, learning and comprehension. Both have similarities with the concepts developed by Marcel in order to explain his results on conscious and unconscious components in reading. All three approaches are closely related, and provide the basic concepts and techniques for tackling a range of problems which might at first glance appear to have very little in common. Hence the unit's work on arithmetic, on reading, on man-computer interaction, on the design and use of pictograms and on amnesia and dyslexia, all draw heavily on a single coherent underlying approach to human cognition.

Many of the new developments within the unit over the last 3/4 years have stemmed from the attempt to confront this underlying theoretical commitment to cognitive psychology with tractable applied problems. The most obvious application of cognitive psychology is within the area of education, and in the proposals I made in applying for the Directorship of the APU this is the area in which I suggested we should develop. The Board subsequently indicated that such a development was not appropriate, given the Council's general remit, and consequently this led to a rethinking of the possible fields of application. The result has been a concentration on the cognitive skills of adults rather than children, with a developing interest in the application of our skills and techniques to the problems of clinical psychology, and in particular neuropsychology.

In recent years, neuropsychological work has had an increasing impact on theoretical issues outside the clinical sphere. Hence work on patients with defective long- or short-term memory has played an important role in the development of general theories of memory, and information from patients with reading difficulties following brain damage has contributed substantially to our understanding of normal reading. We have over the last four years built up a very fruitful relationship with colleagues in neuropsychology in London, Glasgow, Paris and Oxford, which has led to profitable collaborative work. In the meantime we have been slowly building up our

contact with Addenbrooke's hospital to a point at which we now have excellent links with the speech therapy department where we are carrying out work on aphasia and dyslexia and on evaluating methods of speech therapy, with the EEG department where Wilkins is doing collaborative work on photosensitive and TV induced epilepsy, and with the department of neurology and neurosurgery where we have recently set up a project on closed head injury. Perhaps the most important feature of our recent developments is that we are extending our interests beyond the intensive study of a very few cases selected because they appear to have a very pure defect, to the consideration of much larger groups of less clearly defined patients. For example, head injured patients are unlikely to allow the precise testing of particular models which are provided by the rare "pure" amnesic or dyslexic. They do however present a practical problem of much more immediate significance, since they are vastly more numerous and present a substantial rehabilitation problem. They represent a theoretical challenge in requiring us to study very closely the relationship between our laboratory based tests and the ability of the patient to cope in the outside world; I would be surprised if this did not, for example, lead to a re-evaluation of some of our views on human memory.

An area of cognitive psychology that continues to be a major APU interest is that of the design of information, how one should present information so as to make it most easily understood. It has the great advantage of confronting psycho Unguis tics, an area of considerable theoretical activity, but somewhat subject to the dictates of fashion, with a very down-to-earth practical problem such as that of attempting to help a person fill in a social security form correctly. The result has been a combination of steady theoretical development coupled with a capacity for providing advice and assistance across a very broad range of practical situations. The most recent development in this area is our work on man-computer interaction where current developments suggest that very shortly the general public will be increasingly encouraged to interact directly with computers.

As anticipated, the unit's work on perception has slightly declined. With the decrease in our involvement with work for the Royal Navy, the projects on computer-assisted detection, and on coloured displays have both been terminated. We are however continuing to do work on recognising people, while the recently approved project on accident causation includes a proposal to study perceptual style. The area of psychoacoustics is flourishing. We have developed new technical facilities and undertaken a
range of projects involving auditory warning systems, audiometric assessment and evaluation of hearing aids. I would expect this aspect of the unit's work on perception to continue to develop. There might also be some advantage to strengthening the unit's work in the area of speech perception, an area of traditional strength at the APU which is perhaps less vigorous than formerly, and which would provide a very useful link between our psychoacoustic work and our more cognitive work on language.

A substantial involvement in the area of motor skills continues. In the past this work has focussed mainly on keyboard design and on tracking performance. Both of these continue although they form a less important component than previously, partly because the immediate practical problems that stimulated earlier work have now been solved or bypassed. Work is however continuing on the classical problem of combining two or more skilled tasks, and a new line of research on the skill of handwriting is proving fruitful at both a theoretical and applied level. It is perhaps worth noting the link between the unit's motor skill work and its work in other

areas; hence the work on keyboards ties in rather well with studies of man-computer interaction, particularly where naive users are involved; work on dual task performance ties in very closely with some of the techniques and concepts developed in studying attention and working memory, while the study of handwriting is related to both speech production and memory through questions of mechanisms for maintaining sequential order.

Another of the unit's traditional interests which continue to flourish is work on the behaviour of drivers. A good deal is now known about the manual skills involved and we are now more concerned with the more cognitive perceptual and indeed social factors. This has led to an interest in driver attitudes as well as skills, and to an extension of the work of Brown's group beyond that of driving to an interest in accidents more generally, and in particular to the psychological factors preceding accidents. Additional resources have been given which will extend the unit's work in this general area.

For many years, the unit has had a very active interest in the influence of environmental stress on performance. Our involvement in this general area has continued but at a relatively low level over the past four years. This was partly because the group of people interested in stress was split between the main unit, the Psychophysiology Section and the outstation at Sussex (now the PCPU). The fact that we no longer have naval rating subjects also makes stress work more difficult to arrange; this in turn reflects less preoccupation with environmental stress by the Navy who sponsored most of our earlier work in this area. There are however signs of a revival of interest from both the Navy and the Array, and I would be happy to see us attempt a more systematic and theoretically based approach to the general problem of measuring human performance. I would like to see it moving in the direction of turning what is at present a craft into a technology which would be at least as important within the clinical field where the problems of the assessment of patients with a view to either prognosis or evaluation of rehabilitation techniques is likely to be increasingly important. There are also signs that theoretical interest in individual differences within the general field of cognitive psychology is growing, and this should help provide a more satisfactory theoretical basis for work on neuropsychological assessment. In the long term, it is clearly desirable that the technically sophisticated but theoretically sterile approach to individual differences which underlies the intelligence testing tradition be replaced or at least supplemented by an approach which is more concerned to elucidate the processes underlying differences in performance. I would see our work on the cognitive effects of stress and of brain damage as contributing to this general long-term aim.

The unit continues to be very actively involved in providing advice and occasionally assistance across a very wide range of problems. Our heaviest single involvement is with the Post Office for whom we continue to provide both ad hoc advice and a good deal of experimental work on both immediate and long-term problems. We tend to be contacted a good deal by the Press and television both about our own work and for advice on other issues. In general we welcome this since we regard part of our function as helping to provide a reasonably accurate channel of information between experimental psychology and the general public. Such a flow of information also brings us queries of a more substantial nature, some of which lead to experiments and ultimately research projects. We regard this flow of practical problems as a crucial element in our particular approach to psychology.

The Psychophysiology Section has just passed through a rather disrupting period with the installation of a new computer and the long delayed extension and reorganisation of available space. During this period collaborative work with various outside bodies on measuring performance under stress continued, as did the development of portable apparatus for performance monitoring. The new facilities are now fully operational, and work is in full swing on a series of projects on sleep. The most extensive of these is a CEC project in collaboration with a number of European laboratories which is aimed at monitoring sleep in the home and relating both quality of sleep and performance next morning to environmental noise levels.

A study on the verbal ability of deaf school leavers carried out by Conrad and his group at Oxford has now been completed. Virtually the entire population of such children were tested on a range of cognitive tasks, and has been analysed; some preliminary results have been already published, but the main publication will be in the form of a monograph which is nearing completion. It seems likely that the results obtained will be of considerable significance both for the light that they will throw on the current systems of educating the deaf, and also for their theoretical implications for the understanding of normal cognition.

2. COGNITIVE PSYCHOLOGY

This is the area of the unit's greatest theoretical involvement. While the core of the work is covered under Project 1, Projects 9, 11, 13, 18 and 25 all represent extensions of this basic area. It is a difficult field to categorise since the same underlying theoretical concepts underpin a wide range of studies on topics as diverse as arithmetic and face recognition, amnesia and the design of government forms.

2.1 Memory (Baddeley, Barnard, Byrne, Hitch, Hull, Lewis, Moar, Morton, K. Patterson, Woodhead)

The study of memory has remained a central theoretical interest; in addition there has been a growing concern with the role of memory in other tasks. Examples include the role of precategorical acoustic storage in speech perception (13;125 ; 126> 132)t the role of a short-term working memory in reading (4; 5) and mental arithmetic (70; 75) and the role of semantic memory in tasks such as recalling recipes (130) or interacting with a computer, or indeed a government form (221; 223), or a road sign (225).

The concept of working memory has been elaborated by Baddeley and Hitch and continues to develop. At present a distinction is made between a central attentional system which also has memory storage capabilities, and two peripheral memory systems, one involved in sub vocal rehearsal, the other in visual imagery. The applications of the model will be discussed in more detail in the sections on reading and on arithmetic. This approach to memory is discussed and compared to alternative currently held views of memory in a number of chapters and papers (1; 5; 8; 12; 72).

While the bulk of our work on memory has used verbal materials, there has been a growing interest in non-verbal and in particular visuo-spatial memory. In addition to work on face recognition (see p.lj), both Hitch and Baddeley are currently exploring the concept of a spatial working memory, and Moar (120) has carried out an extensive series of studies on mental maps. To do so he devised a new method of externalising a subject's representation of space in long-term memory which is analogous to the triangulation procedure used in surveying. He has already explored spatial representation over a range of different scales, from that of an

individual building to concepts of the world, showing that internal representations are virtually always topologically appropriate, but may be non-Euclidean.

The unit's interest in the design of codes has continued and work by Hull has resulted in a number of papers on specific problems of alphanumeric codes (80; 82; 83) together with an article summarising what is known and providing ground rules for the code designer (81).

Work by Baddeley on amnesia has continued, jointly with Dr. Brooks of the Southern General Hospital, Glasgow. Progress has been steady but rather slow due to lack of good patients and the complexities of collaborating at a distance. We have however continued to explore the range of learning tasks on which amnesic performance is not impaired (22). The pattern of results suggests that the amnesic's problem may not be in learning, so much as in knowing what he has learnt. Hence our subjects are able to utilise newly learnt information in order to do a jigsaw puzzle, perform a skill or re-order a jumbled sentence, but are grossly defective if required to recall the relevant information explicitly.

Closed head injury and memory (Baddeley, Harris, Sunderland)

Closed head injury involves large numbers of relatively young patients and present major rehabilitation problems. Conventional psychometric testing suggests that memory impairment is common. However, little is known either about the detailed nature of the memory defect, or about its implications for the patient's ability to cope with everyday life. A new project is being carried out in collaboration with the department of Neurology and Neurosurgery at Addenbrooke's Hospital; it aims to study i sit.- relationship between performance on laboratory tests of memory and the practical difficulties raised by memory defect. We hope to explore the implications of this for rehabilitation and develop techniques to help the patient cope with defective memory.

2.2 Reading (Baddeley, Barnard, Conrad, Lewis, Marcel, Morton, K. Patterson, Wilcox, Wright)

It is very difficult to summarise work on reading for two reasons: first, the heading covers everything from perceiving printed stimuli to comprehension and speech; secondly, different people have approached different aspects of reading and have shed light on the processes when using a variety of reading tasks for different purposes. Perhaps the best way of organising the work is in terms of "stages" of the process.

2.2.1 Lexical Factors.

The internal lexicon is a hypothetical 'stage' where words are stored as an interface (i) between input and semantics and (ii) between input or semantics and output codes (phonological orthographic). Three aspects of this have been investigated.

(a) Logogen Model. This model, originally developed by Morton to deal with word recognition has recently been applied to the acquisition of phonology in children (138) and to certain kinds of dyslexia (143; 147). The model itself has become more specific - the unit of recognition being shown to be a morpheme not a word (142) - and processes specific to auditory and visual language input being separated from each other and from an output system (129).

(b) The automatic nature of access. Marcel (107) has shown that lexical access is achieved automatically, even when subjects don’t know a word has been presented. The technique used is that of backward pattern-masking and is proving useful in other areas.

(c) Access Codes. It has long been debated whether a direct visual route to the lexicon exists, or whether the route is indirect, involving conversion of a graphemic to a phonological code. In the course of K. Patterson's work with aphasic patients with a reading impairment, strong evidence has been presented (143; 147) that both routes exist normally, the phonological one being impaired in the patients. It is plausible that the lack of such a route is what impairs the acquisition of reading in deaf children as noted by Conrad (44). However Patterson and Marcel's paper (147) suggests direct visual access in the skilled reader.

(d) How many lexicons? In a review of their work on normal and aphasic people Marcel and Patterson (109) suggested the existence of both an input and an output lexicon, one converting sensory input to semantics, the other converting semantics to speech. Morton (129) has completed a set of experiments which look for facilitation by one stimulus of the naming of another. These experiments suggest not only that input and output lexicons should indeed be separated but also that separate input lexicons exist for each modality (auditory and visual).

In addition to this, Marcel and Patterson (109) have conducted a series of experiments on the representation of different word classes in the two cerebral hemispheres. They suggest that while the output lexicon is restricted to the left hemisphere, input lexicons exist in both hemispheres. These theoretical developments are in line with current neuropsychological ideas and should allow finer grain analyses of reading.

(e) Post-lexical Factors. Baddeley and Lewis have investigated the role of post-lexical "working memory" in reading. Baddeley has suggested (4) that the articulatory loop is used as a holding device in decoding by people learning to read and also that in fluent readers it is what preserves word order in understanding sentences.

The nature of the code used in this system appears to be important for spelling. Marcel (106) has isolated groups of children, adult illiterates and aphasic patients who appear to rely on an acoustic/ articulatory code rather than a phonological one. This leads to predictable errors in the perception and production of consonant clusters.

2.3 Pictographic Instructions (Barnard, Marcel)

This work was undertaken by Barnard and Marcel for the Post Office but is currently motivated by both theoretical and applied interests. The aim is to explore non-verbal means or giving instructions for the use of equipment. Its target is a high level input to design for international usage, population’s limited ir. Language and literacy as well as improvements for normal users. Its theoretical potential is a non-linguistic route to semantics, cognitive structures (e.g. notions of cause and effect) and problem-solving strategics.

We have constructed a flexible piece of experimental equipment which can simulate different real-life technologies. Using this, studies of pictographic sequences of instructions have shown that people presuppose that changes in the state of a machine are brought about only by actions of the operator. This led to mistakes in interpreting machine delays where a change in machine state occurred without further action by the operator. This presupposition could also help to account for the finding that performance was better when following instructions segmented into actions and their effects than when the instructions were "phrased" as signals for an appropriate action (17, 108. In general these studies indicate that the design of graphic

instructions needs to take account of how people conceive of equipment functioning and how they use instructions when interacting with equipment.

2.4 Research on Second Language Performance (Long, in collaboration with E. Harding, Linguistics Dept., and University of Cambridge).

Performance on a task involving a second language rather than a first or mother tongue depends on both the proficiency of a person in the second language, and the linguistic and psychological difficulty of the task. The first study by Long and Harding (103) showed both a general and a selective impairment in second language performance on a summary task. A second part of the study showed an impairment as a function of psychological factors (mostly involving memory) even when people knew the vocabulary and syntax. These results indicate that the second language deficit is multiply determined. Future research will examine in more detail the particular processing stages responsible for the second language deficit and attempt to model the relations between a person's two language systems.

2.5 Psychology of Language and Speech (Barnard, Buxton, Hammersley, Long, Marcel, Marcus, Morton, Simmonds, Skinner, Wright)(Project No. 13)

2.5.1 Language Language understanding has been studied in a variety of contexts.

Research by Wright and Wilcox (226) on the comprehension of sentences has shown that the difficulty in interpreting a sentence may be critically dependent upon contextual factors which therefore need to be included alongside linguistic considerations when developing psychological models of language comprehension. Wright and Wilcox (227) have also shown that the order in which items are mentioned in a sentence has consequences for the way in which emphasis is allocated by the reader and for the way in which people represent the information in ah instruction prior to carrying it out. Both these consequences of order of mention interact with other aspects of sentence structure. Similar interactions were found when comparing the assignment of articles in active and passive sentences (224). Explanations of these interactions are being developed.

2.5.2 Speech

Morton and Chambers have shown that speech sounds and non-speech sounds are processed by separate systems prior to categorisation. When we listen in continuous speech for particular sounds in words (such as an initial b), Morton and Long (134) showed that we can only do so after categorisation into words.

2.5.3 P-Centres

The general theoretical notion of a Perceptual or Production Centre of an event has been introduced by Morton, Marcus and Frankish (135). Its initial application has been, in terms of determining the factors which lead to rhythmic regularity in a sequence of words and in forcing a reconsideration of the notion of simultaneity in dichotic listening.

2.6 Design of Information (Barnard, Wilcox, Wright)(Project No. 9)

This project examines many of the psychological factors influencing how easily people can understand written information. The approach has been heterogeneous rather than uniform, since different types of information raise quite different theoretical and methodological problems (23). Aspects of both the language used and the physical layout of the information have been considered for materials as diverse as questions on forms, picto-

graphic representation of instructions for machinery and tabulations of numerical data (33). It has been shown by Barnard, Wright and Wilcox that some of the current practices on forms actually reduce the legibility of the answers given (19, 20) or are more error prone than alternatives (220; 223). Errors may also increase when the form-filler is constrained by the requirements of an electronic data processing system and care needs to be taken to ensure that maximum use is made of software facilities to reduce the problems for the form-filler. Research on the comprehension of texts longer than single questions or single sentences has highlighted a number of problems and measuring technique are being developed to study the more global aspects of text comprehension.

The accuracy with which people use a numerical table may be determined by psychological aspects of language. When comparing a value with that in a table, people were faster and more accurate in reaching Yes/No decisions about whether the value was more than that shown in the table than they were at reaching decisions about whether the value was less than that in the table (221). Decisions, often involving conjunctions and disjunctions, also have to be made in order to locate the cell in a table. It was found that requiring fewer decisions resulted in better performance (216;. Conjunctive and disjunctive decisions are also made by examination candidates interpreting the rubric for a particular paper (e.g. answer five questions doing at least two and not more than four from any one section). Comparisons among alternative rubric formats showed that simple language forms were not always best (214). Again people's presuppositions may have been one of the critical factors. Reviews of various aspects of the design of information have been published. These have dealt with the use of flowcharts (213). the design of forms (215; 223), the presentation of technical information (217; 218) and the relation between different kinds of research on comprehension (219).

2.7 Linguistic and Cognitive Aspects of the Interface in the Use of Interactive Computing Systems as Problem Solving Aids (Barnard, Hammond, Long, Morton, Ottley)(Project No. 23)

This project classification was brought into being to cover a collaborative project with the IBM United Kingdom Scientific Centre. The project actually started in August 1977. The previous two years involved some exploratory research, defining appropriate issues for the project itself and negotiating the formal contract between MRC and IBM.

The exploratory research examined two complementary problems associated with the organisation of information presented at a terminal to naive users of interactive computing systems (18). The first problem concerned the appropriateness of alternative organisations for listings of information on a display. Alphabetic organisations were compared with alternatives based on the conceptual structure of the information itself (e.g. by category or spatial location). Potential applications cover a wide range of general data retrieval systems (e.g. the Post Office's viewdata system,orCEFAX) or more specific data retrieval systems (e.g. stocktaking systems). The second problem concerned the appropriateness of alternative organisations of the digits 0 through 9 presented on computer displays enabling direct entry of information via a light pen or proximity device. Linear, keypad and cash register arrangements were contrasted for entry of numerical strings (such as personal income)(101).

Following discussions with IBM the project itself was focused on the nature of simple computer languages which might be appropriate for users of interactive data base enquiry systems who were not themselves

computer experts. A blueprint for an approach to the problem was explored (133), and initial experiments on the project have examined (a) the attitudes of a sample of potential users of such systems and (b) the influence of natural language on the use of instructional commands typically found in existing computer systems.

2.8 Psychological Aspects of Numerical Information Processing (Hitch) (Project No. 11)

The concept of a short-term "working memory" was applied by Hitch to understanding the nature of elementary written and mental arithmetic. The performance of arithmetical skills was shown to depend on the temporary storage of information which is rapidly forgotten. In mental arithmetic this is a particularly severe problem: virtually all errors are due to forgetting rather than faulty arithmetic per se. Further, different calculation strategies place different patterns of demand on memory and arc not equally efficient. These results are related to the general concept of working memory (70; 72) and are used to test a mathematical model of addition (75). The next phase of this research is to investigate how the stored information is coded, and will include the use of selective interference techniques to explore the role of verbalisation and visual imagery.

Applied work has included an extensive 'in-depth' survey of the numerical abilities of young recruits to industry at trainee level (74). Contrary to what would be expected on the basis of general public opinion, the 'four rules' of ordinary arithmetic were performed reasonably well, and there was far greater difficulty with even elementary calculations involving decimals and fractions.

More recent work has examined the efficiency of adding columns of figures using a pocket calculator (77). It turns out that pencil and paper methods are as fast as using the calculator for naive users, but that the calculator is more accurate for all but the shortest columns. Experienced users were both quicker and more accurate using the calculator than with pencil and paper.

Future work in the general area will continue to expand the core of theoretical work, adding more to the links with other areas of cognitive psychology, and using it to support a range of applied investigations. Of the latter, the search for factors improving the comprehensibility of numerical information looks particularly promising at this stage.

3. PERCEPTION

3.1 Recognition and Tactical Decision under Varying Conditions (Project No. 5)

3.1.1 Colour Coding of Tracks in Coloured Noise (Edwards, Poulton)

The tracks of submarines can be coded by colour to indicate their direction and speed. Poulton and Edwards found that this does not increase the time taken to detect them, provided they are not camouflaged by sea noise. When camouflaged however, colour is a disadvantage unless the person knows the colour for which to search (176).

3.1.2 Detection of Targets with Computer Assistance (Murrell)

In noisy visual displays the targets are not always the most conspicuous signals. An automated detection system may be able to use additional cues, which are not available in the visual display presented to the man. Detection was shown by Murrell to be most efficient if the information in the visual display is combined with the

information which is extracted automatically (140)- Naval ratings can combine the information from the two sources, but they perform less well than an ideal observer. In order to combine the information from two sources most effectively, people need to be trained to understand how the sources are related to each other (141).

3.1.3 Person Recognition (Baddeley, Bruce, K. Patterson, D.C.V. Simmonds, Woodhead)

Attention so far has concentrated primarily on faces. Evaluation by Woodhe.id, Baddeley and Simmonds (212) of an ongoing scheme designed to train fa-e recognition showed it to be ineffective. This may have been because of the emphasis on teaching the categorisation of individual features, an approach which Patterson and Baddeley (145) find to be less effective for subsequent recognition than requiring categorisation on more general"personality"characteristics of the face. The latter study also examined the role of disguise, and showed that a change in hair style and the addition or removal of a beard produced large and consistent decrements iu recognition performance. Some current work by Patterson i3 utilising film, and showing for example that if original learning has occurred from films of whole moving persons, tests on static photographs of faces produce rather poor recognition performance. Such results have implications for procedures of eyewitness testimony. At a more theoretical level, Bruce (34) has studied the process of recognising familiar faces, using the faces of politicians and television personalities and has shown that when several faces are being searched for. both their visual and semantic characteristics (e.g. politician or TV) are utilized simultaneously in reaching a decision.

3.2 Triggering Mechanisms in Photosensitive Epilepsy (Wilkins)(Project No. 2)

Two independent series of experiments by Wilkins, one at Runwell Hospital and one at Addenbrooke's Hospital, have established that a substantial proportion of photosensitive patients are sensitive not only to flicker but also to pattern (45; 184; 189). Gratings with a spatial frequency of 2 cycles/degree have been found to be optimal for inducing paroxysmal EEG activity, every patient's individual optimum lying within one octave of this value. The probability of paroxysmal activity has been found to increase with pattern sub tense, individual patients requiring markedly different pattern sizes to induce paroxysmal activity with a given probability. The findings obtained by Wilkins et al (189) with a single pattern-sensitive patient have now been replicated and extended on further patients. In general, the characteristics of visual stimuli to which patients are sensitive are quite consistent with a seizure trigger in the striate cortex (192).

Optical treatment using spectacles with one lens frosted has now been found to be highly effective in three severe cases (190). Treatment with dark glasses is currently under investigation and initial indications are that it may have a more limited effectiveness. A substantial proportion of photosensitive patients are sensitive to television (184) and prevention of TV-induced attacks using polarised spectacles and a polarised screen over the TV (186; 188; 190) has achieved some success.

3.3 Noise Disruption of Auditory Processing (Barton, Johnson-Davies, Milroy, Nimmo—Smith, R. Patterson)(Project No. 22)

Designers of auditory warnings and sound transmission systems often ask us "How can we ensure that the signal the listener is intended to hear will be audible in the environment for which it is intended?" At present, to answer this question auditory threshold is determined by reproducing the particular environment in the

laboratory as accurately as possible and measuring threshold for a group of observers in that environment - a time-consuming and costly process. Consequently Patterson et al (148; 150; 153; 154) have been investigating auditory masking and using the results of this research to develop a general model of masked threshold. The heart of the model is the auditory filter which it is assumed the listener centres on the signal to filter out background noise and so improve the detectability of the signal.

More recently efforts have centred on attempts to generalise the concept of the auditory filter to other areas of psychoacoustics. The chief alternative method to the auditory filter for specifying the frequency discrimination ability of humans is the psychophysical tuning-curve. Patterson and Johnson-Davies have embarked on a project to show that these two concepts - the auditory filter and psychophysical tuning-curves -are two sides of a single coin, but that the auditory filter concept holds more promise because more progress has been made on quantification (151; 152).

3.4 The Design and Evaluation of Auditory Warning Systems (Barton, Johnson-Davies, Milroy, Nimmo-Sraith, R. Patterson, Piatt) (Project No. 21)

Auditory warnings have the distinct advantage that they will alert an operator irrespective of where he is looking. The sound source can thus be located in an otherwise unusable portion of a console or dashboard. As a result auditory warnings are being used in ever increasing numbers. Unfortunately they are often designed without due regard for the environment in which they are to be used - sometimes they are not even audible. On this project we evaluate auditory warnings and establish guidelines for their design.

At the request of the Chemical Defence Establishment an auditory warning intended for use on a chemical detector was evaluated. The warning proved inaudible in the intended environment and its frequency characteristic was unsuitably narrow. We provided guidelines for a preferred warning sound, the manufacturer produced an improved warning which upon evaluation proved satisfactory (149).

Operational pilots flying civil aircraft with a relatively large number of auditory warnings make a small proportion of errors when asked to identify tape-recordings of the warnings in their aircraft. In stage 1 of a project initiated by the Civil Aviation Authority in March 1977 we are recording the warnings while the aircraft are flying and attempting to determine whether the observed confusions are inherent in the existing warning sounds or whether the situation could be alleviated with the use of a short training tape. In stage 2 of this project, now beginning, we will attempt to create a set of confusion resistant non-verbal auditory warnings for use in civil aircraft. They will be tested against existing warnings and verbal warnings.

What distinguishes speech, auditory warnings, and music from noise is that their waveforms are repetitious and so produce one or more pitch perceptions. The design of a distinctive set of auditory warnings that do not interfere with each other when they occur simultaneously requires an understanding of human pitch perception. Recent research by Patterson, Johnson-Davies and Milroy has confirmed a long established suspicion that the auditory mechanism for extracting the pitch of complex waves is more similar to an autocorrelator than to a spectral analyser as previously assumed. Our research supporting this view has been reported in a number of journal articles and a book chapter (148; 150; 151; 152; 153; 154).

3.5 Improved Methods of Audiometric Assessment and Design of Hearing Aids (R. Patterson, Milroy)(Project No. 3)

The standard hearing test, the audiogram, provides only the most gross prediction of speech intelligibility. It tends to reveal damage only after significant damage has occurred. Recently a number of investigators have measured the shape of the auditory filter which describes the frequency selectivity of the car and, as such, represents the basic discriminative power of the ear. Most of the work was done on normal hearing subjects but there is some data on patients with hearing disorders which indicates that they have less exacting filter shapes than normals. Thus we have begun a project to produce and assess a clinical test for auditory filter shape which, it is hoped, will measure factors more relevant to speech perception, and detect hearing loss at an earlier stage so that corrective action can begin before gross damage occurs.

An experiment to estimate auditory filter shape, that can be run in 15 minutes on groups of hearing impaired patients or normals, has been designed and the component parts assembled. Further progress awaits the establishment by the new Institute of Hearing Research of a network of clinics, where patients can be tested in greater numbers.

4. MOTOR SKILLS

4.1 Studies of Multitask Performance (Brown, McLeod)(Project No. 8)

Under what conditions can one do two things at once? The answer to this question is of theoretical significance since it has obvious implications for our understanding of attentional processes, and is of practical importance in job design. Brown (27) has reviewed dual-task techniques for measuring mental load, while McLeod has shown that a variety of auditory/vocal output tasks such as the identification of words and tones, or mental arithmetic, can be performed without interfering with the timing of a concurrent task involving manual responses to visual stimuli (112; 113). This has important implications for procedures currently used to measure mental load, since it implies that effects which have so far been attributed to central attentional limitations are crucially dependent on the particular responses required.

A novel method of measuring response interference has been developed which has thrown light on the age-old controversy of whether simultaneous independent motor responses are controlled sequentially or in parallel (114). Similarity of the muscular action required to execute responses on the two tasks appears to be a crucial factor. (113; 115)

4.2 Keyboards etc. (Dennett, Long, Nimmo-Smith)(Project No. 10)

This research has a wide brief and addresses problems as and when they arise from applied contexts, primarily from the Post Office. For example, Long (90; 94) evaluated the effect of delaying auditory and visual feedback occasioned by the introduction of buffer storage into a terminal. These studies led to the consideration of the function of visual feedback, for typing in isolation. Two primary functions were observed (92): error correction (by means of sight of the printed copy) and referencing the hands (by means of sight of the keyboard). Other research is motivated by likely future needs rather than current problems; an example is the evaluation of a proximity or pointing device for the entry of numerical data by naive users as an alternative to the conventional keyboard (101).

Work is not restricted r.c keyboards or alternatives. Long, Dennett, Marcel and Wing have evaluated the effects on estimated waiting time in the context of telephone usage in future electronic networks of class of call, distance of the called party and dialling time (100; 206). Large effects of the first two factors were recorded. Work by Logie, and Nimmo-Smith has included ihe development of statistical rjcasureraent techniques for evaluating skilled performance (102). Other work is expected to focus on the needs of the very naive user in interactive data retrieval systems (94).

4.3 Handwriting (Baddeley, Wing)

Research by Wing has focused on both the movement control aspect and the more linguistic aspects of writing. There has been computer programme development for the purposes both of collecting precise and detailed information on the skill of writing, and also for the storage and subsequent analysis of large amounts of data. Dutch workers have already demonstrated the importance of timing control in handwriting. A model of timing control of successive strokes in handwritten letters has been developed on the basis of data collected from extensively practised subjects writing single letters (204; 205; 207). This is currently being extended to the analysis of timing control in writing words, where contextual factors become an important factor. Since both left and right handers are included in the sample, it is hoped to investigate gross differences in cerebral organisation.

At a more applied level, we are exploring the use of handwriting as an index of motor performance which may be sensitive to stress; both alcohol (209) and Sleep loss have so far been shown to affect handwriting (53). Other applied problems include the constraints often placed on the writer in filling in forms where the requirement to write in specified locations has been shown to impair performance (208).

Work on slips of the pen by Wing and Baddeley (210) has shown the distribution of errors is not random throughout the sentence, the distribution of such slips being different from that of spelling errors. Further analyses of a corpus of material stored by computer are now under way to throw light on the mechanisms underlying the production of such slips.

5. DRIVER BEHAVIOUR

5.1 Perception and Decision in Transport-Systems with Particular Reference to Accident Causation" (Brown, Copeman) (Project No. 6)

An attempt is being made by Brown and Copeman to produce a taxonomy of road accident causation, defined in psychological terms relating to antecedent behaviour (attention, perception, decision, etc.), rather than in terms of mortality, morbidity, or factors associated with the apportioning of blame, as used in official statistics. Field studies have been conducted in connection with TRRL (Transport and Road Research Laboratory) on an experimental paradigm using matching of directly viewed and mirrored targets, to investigate the potential contribution to road accidents of misperception of speed and distance by visually-impaired drivers.

5.2 Drivers' Attitudes and Behaviour in Relation to Road Traffic Offences (Brown, Copeman, Colbourn, Laidlaw)(Project No. 24)

Our research has established that the high-risk group of younger male drivers are not substantially different from older and female groups in their knowledge and application of rules and procedures. However, they are deviant in their misperception of distant traffic hazards and in their perception of the serious consequences attached to traffic offences (31). Studies of younger drivers' control movements supported eye-movement investigations by other laboratories, in suggesting that younger male drivers over concentrate on vehicle-control skills at the expense of decision-making ir. relation to the traffic environment.

The current TRRL contract specifies work on a follow-up study of younger drivers' perceptions of 'overt' and 'covert' traffic offences. Laboratory studies are in progress to establish the viability of a postal questionnaire, to collect data from large representative groups of the UK driving population.

6. STRESS

6.1 Effect of Environmental Stress upon Performance

6.1.1 Performance in Continuous Noise (Forster, Grierson, Poulton) (Project No. 4)

Forster and Grierson (48) have performed a series of experiments which cast doubt on the previously held view that loud noise produces a narrowing of the attentional field. A new look by Poulton (167) at experiments on continuous noise suggests that the deterioration in performance in continuous noise may be due to the masking of either acoustic cues, or inner speech, both of which may normally be used in quiet. If so, prevention of the deterioration in performance is a simple psychophysical problem of making the cues audible, or substituting adequate visual cues.

6.1.2 Fatigue in Junior Hospital Doctors (Carpenter, Edwards, Poulton)

Our results indicate that for brief periods doctors can compensate for loss of sleep, provided they are sufficiently awake to appreciate the importance of what they are doing. But dull routine tasks are likely to suffer from loss of sleep. Long hours of work were not found to degrade performance unless they involved loss of sleep (180).

6.1.3 Physical Disturbances (Carpenter, Edwards, Poulton, D.C.V. Simmonds)

These studies include Poulton's work on steady and gusty winds of moderate strength and on the vibration produced by low-frequency noise (174; 179), work by Carpenter on the bang and sudden change in weight on firing a simulated missile from the shoulder, and the work by Simmonds and Poulton on the spontaneous rotary shake which occurs in holding a camera with a heavy long-focus lens (183). In all cases the physical disturbances interfered with precise motor skills. But this may in some cases be compensated for by the increase in behavioural arousal which the physical disturbance also produces. In the low-frequency noise, performance was reliably better on a 30-minute 5-choice tapping task, and also on a 30-minute visual vigilance task, than in the control condition. Advice has been given on methods of reducing camera shake, and on the design of the control systems of Army and Navy missiles which have to be aimed manually.

6.1.4 Transfer Bias in the Interaction of Noise and Heat (Edwards, Poulton)

In an experiment by Poulton and Edwards on the interaction of noise and heat (174), there were four conditions: noise by itself, heat by itself, noise combined with heat, and a control condition without noise or

heat. In a design where the same subject was tested in all four conditions the only observed effect was a decrement in heat. When subjects were tested in only one condition however both noise and heat tend to improve performance. Within-subject designs are suspect since they give rise to transfer between conditions (177).

6.1.5 Bias in Subjective Judgments (Poulton)

Subjective judgments of the effects of stress sometimes contradict the results of tests of performance. In addition to bias by transfer, Poulton has described seven distinct biases in quantitative subjective judgments. Ways of avoiding the bias have been suggested (173).

6.1.6 Development of a Cognitive Test Battery (Baddeley, Lewis, Thomson, Wing)

The APU has traditionally been concerned with the measurement of human performance under stress. This interest continues although it is not at present a major research area. A test of semantic processing is being developed by Baddeley, Lewis and Thomson which allows an estimate of the speed at which the subject can access information in long-term memory. So far this has been tested using alcohol as a stressor and has proved to be sensitive (2). Lewis and Baddeley are continuing to provide a battery of tests for use in the Royal Naval Physiological Laboratory trials on deep oxyhelium diving. It is already becoming clear that reliable impairment occurs at 1000 feet, a depth at which it has previously been claimed that performance is unaffected.

6.1.7 Diver Performance and Selection (Baddeley, Godden)

In addition to our work with the Royal Naval Physiological Laboratory, Godden and Baddeley have been involved in two projects on divers. The first was concerned with context dependent memory in divers. We showed that material learnt in one environment (on land or under water) was much better recalled in that environment than in the alternative context. When memory is tested by recognition, no such effect occurs (58). An extension of this work showed that learning a manual skill on land could actually impair its performance under water is compared to a control group which has no pre-training. Implications for diver training are obvious.

We have just completed the first stage of a Department of Employment sponsored project with Stirling University on the selection of trainee divers. The final report includes a detailed description of the range of jobs undertaken by commercial divers involved in both inshore harbour works and offshore North Sea oil diving. Divers entering the three officially recognised training schools within the UK were given a range of tests, and are currently being followed up to study the relationship between test performance and subsequent diving career (10).

7. HUMAN FACTORS

7.1 Perceptual and Control Problems in Postal and Telecommunications Systems (Baddeley, Barnard, Brown, Copeman, Dennett, Long, Marcel, Hull, Wing)(Project No. 7)

This project covers all the research and advisory activities of the APU under the human factors consultancy with the Post Office. Research activities during the past three years have included:

1. A study by Barnard of structured conversation between Directory Enquiry Operations and the public.

2. Brown, Hull and Hartley's comparisons of alternative methods of constraining handwritten postcodes for machine reading.

3. Investigations by Brown, Hull and Cox of difficulty in telephone call data-entry and retrieval by switchboard operators (33).

4. Design of pictograms in user instructions by Barnard and Marcel (17).

5. Work by Brown and Hull on the discriminability and memorability of colour cues among a new range of postage stamps.

6. Investigations of variables affecting waiting behaviour during post-dialling delays in the telephone network by Long, Dennett, Marcel and Wing (100; 206).

7. Assistance from Brown with the preparation of a Post Office Human Factors Handbook.

8. A study by Hull and Baddeley of factors affecting memorability among altered postcodes.

9. Numerous ad hoc studies of various ergonomic factors in display and control design for P.O. equipment.

Among the more demanding advisory activity principally undertaken by Brown, could be included:

(a) Effects of modifications to a range of telephone switchboards.

(b) Design of coding desks and displays for postal sorting.

(c) Design of microfiche information retrieval systems for Directory Enquiries.

(d) Ergonomic problems in equipment and procedures design, deriving from changes in minimum height requirements following the Sex Discrimination Act.

(e) Hardware and software design problems associated with the proposed introduction of a Directory Enquiry/Computer Information Retrieval System.

(f) Keyboard design for equipment handling data from the national Giro system.

7.2 Effects of Trends in Task Characteristics on the Psychological Well-being of Telephone Switchboard Operators (Brown, Wastell, Wilson)(Project No. 19)

Suggestions and complaints received by Brown via the Post Office Human Factors Research Committee indicate that the job satisfaction of telephone operators is possibly being insidiously degraded by successive changes in switchroom equipment and procedures. Studies will investigate (a) The critical social factors relating to the job, as perceived by groups of operators, and (b) The relationships between performance measures and physiological indices, among individual operators working at the switchboard.

7.3 Provision of Human Factors Information on Work and System Design (All APU Staff)(Project No. 12)

The unit receives 300-400 requests per year for information, advice or assistance. These range from enquiries to requests for research to be carried out. Press queries range from being asked by the television programme Tomorrow's World to advise on techniques for training English batsmen to withstand Australian fast bowlers, to invitations to supply further details of the unit's research; Wilkins' work on spectacles to control TV induced epilepsy is one example of this, others include Brown's work on young drivers and the work by Godden and Baddeley on diver performance.

A second class or enquiries ask for advice or assistance with specific problems. These may be concerned with a special area of expertise within the unit as in the case of the many enquiries we have had from local authorities concerned with our work on the design of forms. Other examples are the request for advice on the design of stress experiments- which come from a range of sources including the British Antarctic Survey, the Royal Lifeboat Institution and such government laboratories as the Institute of Aviation Medicine and the Army Personnel Research Establishment. In some instances, we do not h3vc the expertise to advise directly, but we can usually assist by redirecting the enquiry to an appropriate outside authority.

Most enquiries can be answered either directly or via a visit from the enquirer, and do not require any further research. Occasionally however a query will lead to a small experiment aimed at providing the necessary information, or in some cases to a major research commitment. The unit's new project on closed head injury is a case in point. We were initially invited by Dr. Freda Newcombe to advise on the interpretation of results of a major study of memory impairment in closed head injury carried out jointly by a number of groups of neuropsychologists in this country and the Netherlands. This led to an involvement in suggesting further experiments and ultimately to the decision to attempt to become more actively involved in this area, leading to the setting up of a major new project. Other examples of this process are the joint man-computer interaction project with IBM (Project No. 23) and Project No. 21 on the design and evaluation of auditory warning systems.

We regard our outside contacts as important for two reasons. First they allow us to act as a channel of communication between psychologists and the general public, and secondly because they provide an important source of new and potentially fruitful problems. Such additional stimulation is a crucial factor in determining the particular mix of pure and applied research that characterises the unit's work.

8. OXFORD OUTSTATION

8.1 Verbal Abilities of Deaf School-leavers (Conrad, Kyle, McKenzie, Morris, Weizkrantz) (Project No. 18)

This project represents a two-pronged concern with certain verbal abilities of children who are sufficiently hearing-impaired to justify special education. Tests were given for almost all of them, and this is a logical point at which to evaluate academic attainment - an outcome which the project generated as a major side-issue. Specifically we have examined the principal skills which deaf children need if they are to communicate socially or vocationally with the non-deaf world, namely: reading, comprehension, lip-reading and vocal speech. At the same time, and also pursuing our second concern, a number of other tests were given, more directly related to problems of cognitive development in the relative absence of auditory linguistic input. These were tests of intelligence, memory and the ability to use speech silently as a cognitive tool.

Almost the entire population of such children was tested - nearly 600. There were two reasons for this apparently redundant effort. Firstly, by the time a sample of 600 children is broken down by degree of hearing loss, cause of deafness and level of intelligence, sub—groups are becoming quite small. Secondly, and in any case, the current educational structure is such that sampling by proportion in fact necessitates visiting every

school. The effect of achieving a virtual 100% sample is that we now have a unique descriptive analysis of a deaf population in terms of many of its medical, psychological and educational characteristics. This permits us to mention a few minor examples, to compare reading ability of genetically deaf children with those whose deafness is acquired at birth, to relate handedness to cause of deafness, or speech quality to audiogram profile, to compare different educational treatments, and examine the role of onset age of deafness. The main data relate to the development of internal speech in deaf children.

Whilst a little data collection spilled over into 1976—7, most was completed during the first two years. In some cases (reading, intelligence) suitable test instruments were available. In others (speech quality, internal speech) we developed our own tests. Data collection then involved school visits and conventional testing conducted by one member of scientific staff together with one or more technical officers. Testing was carried out in some 40 Special Schools and 48 Partially Hearing Units.

The period 1976-7 was principally devoted to analysis of data - which is available in substantial amount and detail. But concurrently a significant proportion of data reporting has been completed. In view of the comprehensiveness and coherence of the project it was felt that its value would be dissipated in a lengthy series of journal articles. But a small number of such articles have appeared. (40; 41; 42; 43; 44) The data merit extended monograph treatment and arrangements for publication have now been made.

The next year will see completion of this monograph. It will present a detailed account of the ability of deaf children to communicate verbally at the end of their school life. These skills will be assessed with reference to medical history, audio logical characteristics, cognitive function and pedagogic implication. In essence we find that degree of pure-tone hearing loss, level of intelligence and ability (and willingness) to "think phonetically", together account for most of the variance in performance data. But the relative contributions of these three variables differ markedly and meaningfully from one skill to another.

9. PSYCHOPHYSIOLOGY SECTION PROJECTS

9.1 Portable Apparatus for Assessing Deterioration of Skill (Houghton, Wilkinson)(Project No.14)

The main goal of this research is the development of a battery of five small, highly portable devices for assessing various aspects of performance. Tvo of them. Four Choice Serial Reaction Time and Simple Reaction Time, are complete and available from the manufacturer (200). There are two tests, one of Short Term Memory and one of Vigilance, in prototype form and being tested operationally. The fifth test, Tracking, is in the design stage.

9.2 Performance After Reduced Amounts of Sleep (Glenville, Herbert, Wilkinson)(Project No. 15)

During 1975 and early 1976 Herbert has analysed and reported on data acquired previously to produce five papers on various aspects of the quality of sleep in relation to performance (63; 65; 67), mood (62), and subjective reports (66). He also administered a questionnaire to some 352 people in the Cambridge area to obtain details of their habits of sleep and also of other features of their life and environment to which the quality of their sleep might be related. The general aims of this project are, first, to enquire into such

relationships and, second, to form the basis of a pool of poor sleepers who might be invited to take part in future experiments.

Glenville (5t) assessed the performance of the staff of International Computers Limited, on the portable tasks of Project 14, studied over a period -jf weeks, at various times of the day and night. The main purpose of the study was to assess the effect of loss of sleep on people when they transfer from the day tj the night shift. Reliable individual differences in susceptibility to loss of sleep were observed, suggesting, that it may be possible to select people Cot night shift work.

Further evidence for individual differences in the effect of one nights loss of sleep were obtained in a study of performance in the laboratory (521. Data from a second larger scale study have been collected and are being analysed.

While on detachment at. the Navy Medical Neuropsychiatric Research Unit, San Diego, California, Wilkinson (with Mullaney) examined the feasibility of using the Modi lug Miniature Portable Sattery Tape Recorder, with an appropriate preamplifier, to record sleeping and waking EEG activity in the home. The record of EEG from the Medilog was shown to compare well with that take.i: simultaneously by normal methods from the same, electrode. The sleeping EFT- was recorded successfully at home, but the waking EEG was often obscured by movement artefacts (201).

9.3 Effects of Single or Combined Stresses (Adams, Herbert, Millar,Tyler, Varey, Wilkinson) (Project No. 16)

A series of experiments has been completed in which the Psychophysiology Section, APU, has combined with outside establishments who have facilities for administering particular kinds of stress, the unit's contribution being that of expertise in measuring performance. These experiments, with references to published reports, are summarised briefly as follows:

(a) With British Medical Association: Duty Hours of Young Hospital Doctors. Effects on the Quality of Work

The results of a questionnaire sent to 6,500 young hospital doctors in Britain were collated, analysed, and published. The main questions were, first, to discover how many felt their hours of duty were so long as to affect their working efficiency and, secondly, to define those specialities and kinds of hospitals in which working efficiency appears most threatened by long hours (202).

(b) With Welcome Research Laboratories: Residual Effects of Hypnotic Drugs upon Performance.

The main question was whether taking sleeping pills at night improved performance the next day due to better sleep, or impaired it, due to the residual effect of the drug. No overall effect was observed but the results suggested that good sleepers might be impaired and poor sleepers improved by the procedure (155). Also: The Effects of Low Doses of Amylobarbitone Sodium and Diazepam on Human Performance. Clinical and subclinical doses of these drugs were shown to impair performance, particularly prolonged vigilance (59).

(c) With British Airways Medical Service: Effects of Time Zone Changes on Performance and Physiology of Airline Personnel.

Female airline personnel spent A full days living as a group in an isolated apartment. Some were subjected to two 8-hour retardations in time, representing, approximately, a westerly flight from the Far East via USA to

UK. During this period performance was impaired due to time zone changes. A therapeutic agent (mepitrazole hydrochloride) failed to alleviate the effects (181).

(d) With British Gas Corporation, R&D Division: Environmental Temperature at the Work Place: Effects on Comfort and Performance.

Employees of BGC Headquarters assessed their comfort as regards environmental temperature and carried out 1-minute performance tests (Portable Simple Reaction Time test) every hour for two working weeks. Results indicated wide individual differences in the degree to which temperatures, both higher and lower than normal, affected performance and comfort (198).

(e) With Middlesex Hospital: Effects of Anaesthetics for Minor Surgery upon Subsequent Performance.

Following minor surgery and the administration of anaesthetics in the morning, performance of patients on the Portable Four Choice Reaction Time test was below normal in the afternoon and evening. Patients should not be released to drive, walk home etc. too soon. A report is in preparation.

(f) With Charing Cross Hospital: Assessment of Hypertensive Patients using Performance Tests.

The Portable Four Choice Reaction Time test is being used to provide objective indications of hypertensive symptoms, and of the possibility of differentiating hypertensive personalities. The experiment is still in progress.

(g) With Birkbeck College, London: Effects of Fatigue on Marine Pilots.

The Simple and the Four Choice Reaction Time tests have been used to assess the performance of marine pilots before, during, and after bringing ships into port. Data have been collected and are being analysed.

(h) A laboratory study showing adverse effects of noise upon short-term memory r.as been completed by Millar (117), and a review chapter has been written by Herbert surveying the effects of environmental factors on performance (64).

9.4 Physiological Correlates of Performance under Stress (Wilkinson) (Project No. 17)

No in-house work has been carried out on this project due to restricted accommodation and also the time required to bring a new computer into full operation. Two experiments have been conducted by Wilkinson while on short visits to laboratories overseas, both were theoretically oriented and concerned with the relationship between the level of performance and concurrent changes in the electroencephalogram (EEG). Besides seeking to discover general laws relating to the way in which the brain functions, this research seeks methods by which states of human alertness can be monitored from an analysis of EEG records.

The first experiment was carried out at the Navy Medical Neuropsychiatric Research Unit, San Diego, California, and related performance on a 40-minute test of signal detection to evoked potential and slow potential changes in the EEG during the task. A paper is about to be submitted for publication.

The second experiment was carried out at the Department of Psychology, University of Illinois, USA and repeated the previous study but with EEG recorded from more locations on the scalp and with improvements in technique designed to answer some questions raided by the first study in San Diego. The experimental work has been completed and the data are being analysed.

A review has been published (196) which summarises earlier contributions from this laboratory on the relationships between event related potentials in the EEG and performance. It discusses the implications of

these and other contributions to the literature, in assessing the aetiology of a later positive wave of the evoked potential (P300) which appears to vary in amplitude with such behavioural phenomena as selective attention, expectancy, and response confidence.

9.5 Effects of Noise on Sleep (Campbell, Macmorland, R. Patterson, Roberts, Styles, Wilkinson)(Project No. 20)

This study was initiated in August 1977 and forms part of a multinational project partly supported by the Commission of the European Communities to examine the effects of traffic noise upon the sleep of people in their own homes. The aim is to make physiological recordings, particularly the electroencephalogram (EEG), during a night of sleep at home, to administer questionnaires the next morning to learn the person's own opinion of the quality of the previous night's sleep, and to administer performance tests also during the morning of the next day in order to assess behavioural efficiency. All three of these measures might be expected to vary as a function of the quality of sleep and one of the main questions of the study is how far they agree with each other and how far one or more of them can be taken as a reliable objective index of the quality of sleep. In terms of the traffic noise the aim of the experiment is to determine what kinds of noises are most damaging to people's sleep and, in a more general way what levels of traffic noise should be permitted. If individuals differ considerably in the degree to which their sleep can be disturbed by noise, a further aim is to determine the characteristics of those individuals whose sleep is most at risk. In particular, age is a parameter to be studied in this regard.

A satisfactory method of carrying out physiological recordings in the home has been developed. Four channels of physiological information, one channel of behavioural response (a button press whenever awake at night), and the noise level in dB(A) are amplified, where necessary, multiplexed, and transmitted through a radio link to a receiver and tape recorder elsewhere in the house. This is done by a small (70 x 70 x 23mm) module attached to the top of the person's head throughout the night. The analogue noise record is taken in parallel on the tape recorder.

So far, 4 people have been tested for 16 nights each. These trials have in general demonstrated the feasibility of the whole procedure and, in particular, shown that the method of recording causes minimal inconvenience and disturbance for the sleeper.

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