

## Abstracts of the Fourth International Winter Conference on Brain Research

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**An Integrated Software System for Acquisition and Display of ERP Data.**  
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Considered from a software point of view all evoked response potential (ERP) paradigms are similar, consisting essentially of the presentation of a series of stimuli and the collection of ERP data over a period around each stimulus. There may also be a behavioural component such as a requirement that the subject respond to certain events by pressing a button. On this basis, a software system for the acquisition and display of ERP data has been developed. The system operates within a general computing environment on an LSI 11/73 microcomputer under either TSX-plus (multi-user) or RT-11 (single-user) operating systems. Data from electroencephalogram (EEG) or electro-oculogram (EOG) sources are manipulated using a sequence of four programs. A parameter program sets up parameter files which govern the operation of the experimental (data acquisition) and averaging (data reduction) programs. Averaged ERP data are delivered to a graphics program for display and/or hard copy reproduction. The system is user friendly, being menu-driven and flexible. The principal characteristics include; software control of stimulus generators; sampling windows of 8192 samples/stimulus over 8 channels at sampling rates up to 1 kHz; real-time artifact rejection; facilitation of practice sessions and behavioural-only tasks (no EEG/EOG data collected); versatile plotting of averaged ERP data; and addition of new experimental paradigms with up to 9 experimental conditions with minimal effort. The result is a laboratory software system which is simple to use, versatile, easily maintained and which operates in both multi-user and single-user computing environments.

**A Comparative Study of the Cognitive Effects of Phenytoin and Carbamazepine in New Referrals with Epilepsy.**  
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We have compared cognitive function in new referrals with epilepsy well controlled on single drug therapy with either phenytoin or carbamazepine and in an untreated control group. Patients on phenytoin performed consistently less well on memory tasks than those on carbamazepine or those who were untreated. Although patients on phenytoin overall showed a trend towards poorer performance on a tracking task, higher blood levels of this drug were correlated with better tracking performance. The correlation between blood levels of carbamazepine and tracking performance was in the opposite direction to that of phenytoin. Also, blood levels of carbamazepine were negatively correlated with measures of anxiety, depression and fatigue. Our findings have implications for the choice of drug in the management of epilepsy and also for the reported claims of a psychotropic effect of carbamazepine.

**Brain Damage Among Abalone Divers.**  
Andrews, G., Holt P., Edmonds, C., Lowry, C., Cistulli, P., McKay, B., Misra, S., & Sutton, G. University of New South Wales, Sydney, Australia.

Abalone divers in South East Australia experience repeated decompression stress and are often irritable and confused after diving. Forty-eight experienced divers and 47 surface fishermen matched for education, alcohol consumption, history of other brain damage and age were compared on a neuropsychological test battery. The battery comprised the Symbol Digit Modalities Test; the Single and Double Simultaneous Stimulation Test;

logical memory, visual reproduction and paired associate learning sub-tests from the Wechsler Memory Scale; and the Controlled Word Association Test. The abalone divers did less well on five of the seven tests but when an age difference was controlled for and the alpha level set to allow for the multiple testing, no significant differences remained. The lack of difference was reflected in the cumulative test battery score. We conclude that despite accounts of brain damage in other compressed air divers there is no evidence of intellectual deficit in the group of abalone divers tested.

#### Fractionated Simple Reaction Time as a Function of Varied Levels of Cocontraction Prior to Rapid Elbow Flexion.

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Initiation of rapid elbow flexion under three levels of cocontraction was studied in six adult male human subjects. Each subject received three blocks of 10 trials in each contraction condition for a total of 90 trials. Subjects were provided with feedback of their agonist (biceps) electromyograph (EMG) data in digital format and were instructed to maintain a level of EMG activity (until stimulus onset) corresponding to: 1) baseline, 2) approximately 30%, or 3) approximately 80% of maximum voluntary cocontraction (MVCC), depending upon the experimental condition. Although it is evident that requiring human subjects to monitor a digital display of agonist EMG while remaining alert for an auditory stimulus results in increased variability of reaction times, preliminary results indicate that simple reaction time (SRT) is shorter under the 80% cocontraction condition. Furthermore it has been observed that the decrease in reaction time is present primarily in the premotor time (PMT) component of SRT. It is possible that this 'saving' in PMT results from early recruitment of all available motor units prior to stimulus onset. In the non-cocontraction (baseline EMG) condition, early recruitment is not facilitated and must take place following the imperative auditory stimulus. Thus a reduction in SRT was not

observed in the absence of cocontraction despite the advantage gained from reduced antagonist muscle resistance.

#### The Effects of a Lengthy Period of Under-nutrition on the Synapse-to-Neuron Ratio in the Rat Hippocampus.

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Recent evidence showing alterations in spatial memory due to a short period of undernutrition during early life has implicated the hippocampus as one of the brain centres which may be particularly adversely affected. However, there are very few quantitative morphological studies which have examined the neuronal and synaptic populations of the hippocampi from undernourished animals. An experimental group of male rats were undernourished from the 18th day of gestation until either 21, 75 or 150 days of age when groups of well-fed control and experimental rats were killed by intracardiac perfusion with 2.5% sodium cacodylate buffered glutaraldehyde. The right hippocampus from each rat was dissected out and processed for electron microscopy. Stereological procedures at the light and electron microscopical levels were used to estimate the numerical densities of granular cell neurons and molecular layer synapses in the dorsal lip of the dentate gyrus. These estimates were used to calculate synapse-to-neuron ratios. There were  $5055 \pm 346$  (mean  $\pm$  SE) and  $4974 \pm 217$  synapses per neuron in 21 day old control and undernourished rats respectively. By 75 days of age the values had increased to  $9215 \pm 588$  and  $6683 \pm 237$  respectively. The difference was statistically significant. By 150 days of age the value for control animals had fallen once again to  $6518 \pm 209$  whereas the undernourished rats had increased slightly to  $7689 \pm 288$ , the difference between the two groups being statistically significant. These results indicate firstly, that the rat hippocampus is vulnerable to undernutrition even during the post weaning period and secondly, that a lengthy period of undernutrition may alter the developmental growth curve for synapse-to-neuron ratios.

Septo-Hippocampal and Commissural Pathways Synapse on the Same Interneurons in the Rat Dentate Gyrus.

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The dentate gyrus region of the rat hippocampus receives major extrinsic innervation from the entorhinal cortex, via the perforant path, from the medial septum, via the septo-hippocampal pathway and from the contralateral hilus via commissural fibres. The septo-hippocampal input appears to form inhibitory synapses on the interneurons which mediate recurrent inhibition of granule cells. An experiment was designed to ascertain whether the commissural and septal inputs both synapse on the same interneurons. A recording electrode was located in the dentate gyrus of anesthetized rats and stimulating electrodes were located in the medial perforant path, the medial septum and the contralateral hilus. A single pulse applied to the perforant path produced a field potential with a pronounced granule cell population spike. This population spike was markedly reduced when the perforant path pulse was preceded at from 5 to 25 ms by a pulse to the contralateral hilus. The amount of inhibition induced by the commissural input was reduced when a medial septal pulse was applied within 3-5 ms of the commissural pulse. This disinhibition was critically dependent on the temporal relationship of the septal pulse to the commissural pulse, and not to the perforant path pulse. This finding suggests that the septo-hippocampal pathway inhibits the interneurons through which the commissural pathway is able to inhibit granule cells.

Biochemistry, Genetics and Juvenile Delinquency.

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Since juvenile delinquency is defined by legal codes and legal responses rather than by specific behaviour, the formulation of

explanatory constructs within biochemical, genetic or social theories, is particularly treacherous. Moreover, there has been widespread antipathy toward biologically based theorising among criminologists on the basis of arguments that crime is a social, not an individual, phenomenon. Nevertheless, the effort goes on, and presentations of biochemical and genetic correlates of crime have been plentiful. The relationships, thus far, have been for the most part small, and not useful as more than indicators of future hope. Perhaps the highest correlation reportable in the area is the negative one between the quality of research methodology and provocativeness of results.

Naming Disorders and Semantic Representations.

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The status of semantic conceptual operations in aphasia was investigated in relation to naming disorders in spontaneous and constrained speech production. A battery of 6 tasks was administered to 25 control subjects and 25 aphasics. The tasks were: Spontaneous speech production (from which the percentage of substantives was calculated); Confrontation naming; understanding class relationships (verbal), understanding class relationships (pictorial), understanding thematic relationships (verbal), and understanding thematic relationships (pictorial). The results pointed out the main role of taxonomic abilities for naming while other conceptual operations (e.g. thematic relations) do not seem to play any important role in the process of naming. The results are discussed in terms of internal organization of semantic information.

Evoked Potentials Following Chronic Exposure to Organic Solvents.

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Toluene (methyl benzene) and n-hexane are the principal volatile organic solvents used in adhesives, paints and lacquers. While the

major effect of n-hexane is a peripheral neuropathy, toluene has toxic effects on the central nervous system (CNS). Clinical disorders affecting the CNS have occurred among industrial workers inadvertently exposed to solvents and among young people using the deliberate inhalation of these substances as a means of intoxication, the neurological sequelae depending on the length and intensity of exposure. When dealing with relatively low exposure levels, sensitive non-invasive methods, such as evoked potentials, must be applied to demonstrate early effects on the CNS. The literature contains many case studies showing that the toxic effects on the CNS following chronic toluene exposure are widespread; the complete reversibility of these remains in question. In some of these case studies, abnormal evoked potentials have been reported, and a recent study demonstrated abnormal pattern visual evoked potentials (PVEPs) in 9 of 12 chronic glue (toluene) sniffers. In this study PVEPs and brainstem auditory evoked potentials were recorded from a group of young people involved in chronic solvent abuse and a group of workers following long-term occupational exposure to solvents. The findings were compared to observations recorded from normal subjects in the same age groups.

Response Characteristics of Prepositus Hypoglossi to Vestibular Stimulation.  
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Response characteristics of cells in the Nucleus Prepositus Hypoglossi (PH) to both visual and vestibular stimulation have led to the suggestion that this nucleus may be important in the integration of the vestibulo-ocular reflex. The present study examines the response characteristics (resting rate, gain, phase) of PH cells to horizontal sinusoidal stimulation at frequencies ranging from .02 to .20 Hz. Single neurons were recorded extracellularly in the anesthetized guinea pig. It has been found that in the normal animal PH cells respond predominantly in a Type 11 fashion, similar to Type 11 cells in the medial vestibular nucleus, but stand in a different temporal relationship to the stimulation. PH responses were also studied after

commissurectomy and unilateral labyrinthectomy in order to clarify the importance of vestibular commissures in the function of PH.

Structural Limitations to Interhemispheric Transfer of Tactile Information in the Developing Brain.

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The finger localization task required a subject to indicate which finger(s) was stimulated, by touching the finger with the thumb in the same hand as stimulated (ipsilateral localization, IL) or to touch the corresponding finger(s) with the thumb on the other hand (cross-localization, CL). Whereas CL requires interhemispheric transfer of tactile information, IL can be performed with the hemisphere contralateral to the stimulated and responding hand. Interhemispheric transfer of tactile information improves between 5 and 11 years in line with the sequence and myelination of the corpus callosum during this period as described by Quinn and Geffen. IL and CL were investigated in 5- and 7-year-olds ( $n = 16$  per group) to determine whether CL would improve with finger stimulation. Immediate versus delayed (by 3 sec) responding were also examined. With one finger stimulated, 5-year-olds showed 45% better IL than CL, while 7-year-olds were 22% better at IL, replicating our previous findings. This difference between IL and CL did not decrease across sessions in either age group. Seven-year-olds' overall accuracy of localization (IL and CL) improved across sessions. Five-year-olds showed an improvement in 2-finger localization across sessions but this was restricted to the left hand IL condition. Five-year-olds performed better with an immediate response, whereas 7-year-olds benefited from the delayed response. Since no evidence was found for improved interhemispheric transfer of tactile information (CL relative to IL), but evidence of learning was found for IL, it appears that the unmyelinated fibres of the corpus callosum restrict learning of finger localization to the contralateral hemisphere, and that structural limitations to interhemis-

pheric transfer were not overcome by repeated practice.

The Exploration of a Computer Assisted Operant Colour Discrimination Task Through its use on Normal and Neurological Populations.

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This paper examines the operant discrimination task 'Colour Match Reversal' (CMR), used in the computer based neuropsychological Otago Battery. The test assesses both speed and accuracy of subjects responses to the matching of coloured stimuli with and without discriminative stimuli in the background (i.e. match to sample, and nonmatch to sample). Along with the full Otago Battery, the CMR task was administered to 49 Traumatic Head Injury patients, 40 patients with Space Occupying Lesions and 117 controls presumed not to have central neurological damage. It was noted that CMR was performed less well by the brain injured patients than by controls. Cluster analyses revealed that the CMR variables were clustered differently across the three groups. Despite an intrinsic trade-off between speed and accuracy, these two aspects of the CMR performance did not cluster together. Evidence is also provided which indicates that the CMR variables are not highly correlated with scores obtained through standard assessment techniques. These results suggest that CMR may be assessing a neuropsychological process that is not usually measured with traditional tests.

Replicated Patterns of Age-Related Decline Reflected in Neuropsychological Measures.

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Drawing general conclusions from previous research regarding the effect of age on neuropsychological measures has been hampered by the problem of comparing results across studies which employed different age groups, subject populations, and tests. In this study, Halstead-Reitan Neuropsychological Battery scores were compared across three age groups (16-34, 35-54 and  $\geq 55$ ) in three samples drawn from neuropsychiatric populations: an initial sample of 217 subjects (USA), a within-laboratory replication of 307 subjects (USA), and a cross-national replication sample of 101 subjects (UK). The results showed significant age effects for subtests of the Halstead-Reitan Battery involving problem-solving abilities and motor strength, which were replicated across the three samples. Verbal and perceptual subtests did not show consistent age effects across samples. These results help clarify for which measures the effect of age is consistent. They indicate a need for age-adjusted norms for the Halstead-Reitan Battery and cautious interpretation of results for older individuals. The results also support the notion that age-related cognitive decline is not general, but specific to certain abilities.

Encoding Processes, Memory Strength and the Korsakoff Amnesic Syndrome.

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The role of memory strength in Korsakoff's syndrome was examined. The performance of Korsakoff amnesics' on free recall tasks was compared to that of control subjects' performance on the same tasks, at the same and longer retention intervals. When control subjects were matched for age, their performance was similar as retention delay increased and was quantitatively different from that of the Korsakoff amnesics. Unmatched controls had a different performance pattern and showed different effects of delay, indicating a qualitative difference. The effects of other factors indicate the fragility of delayed retention as a means of equating memory strength.

An Assessment Aid: The GFW Auditory Skills Test Battery.

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As the prevalence of surviving patients with closed head injuries increases, more attention is being given to assessment. The GFW Auditory Skills Test Battery, a group of 12 independent tests normed on subjects from 3 to over 80 years of age, is being used to measure deviance and recovery in non-aphasic closed head injury patients. It includes tests of selective attention, discrimination, memory, sound-symbol relationships, and grapheme-to-phoneme and phoneme-to-grapheme translations. It can be a useful addition to the collection of neuropsychological tests used with this population and with others who are likely to have difficulty in any of these areas of auditory verbal processing. (Earlier versions of some of these tests were useful in this investigator's research comparing several types of dialysis in patients with kidney failure. The accumulation of toxins in the system resulted in cognitive processing changes which could be detected before medical signs of toxicity could be detected.) Comments on its potential usefulness with English-speaking Australasian patients will be invited. Potential usefulness would be dependent upon the development of appropriate norms.

Some Properties of a Model of the Cerebellar Cortex.

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The cerebellar cortex appears to be qualitatively very similar from one species to another an (unlike the cerebral cortex) also appears to be uniform in its structure from one region to another. Knowledge of the anatomy and physiology of the cerebellar cortex is more complete than that for any other region of the central nervous system, but the complexity is such that it has not proved possible to deduce how the cortex operates. The model described was developed

as a tool to assist in understanding the operation of the cerebellum and to try to demonstrate the functional implications of the known details of the structure. The model has been simulated on a digital computer and represents a uniform sheet of cerebellar cortex divided into a large number of compartments, each of which corresponds to an area of cortex containing about 60 Purkinje cells and their associated interneurons. (The Purkinje cells are the largest neurones of the cerebellar cortex, and their axons provide the only output pathway from the cortex). So far the model has mostly been used to study the steady-state pattern of output produced in response to a spatially patterned input. These investigations have shown that the form of the output pattern can change very markedly with changes in the parameters of the model which represent the relative strengths of the synaptic connections between the different types of neurones. Changes in the output pattern can also be produced by alterations in the arrangement of some of the neuronal connections. The connections involved are those for which the available anatomical data are insufficient to determine unequivocally what their true arrangement is. Parallel anatomical and physiological studies are in progress to provide information on which it may be possible to determine which of the modes of operation of the model most closely mimics the working of the real cerebellum.

Dorsal Septal Inhibition of LH Release in Cat.

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We have previously reported a direct monosynaptic excitatory pathway from the dorsal septum (DS) to the medial preoptic area (MPO) in cat and that the MPO cells excited by septal stimulation are also excited by fornix stimulation. Fornix stimulation is known to block the luteinising hormone (LH) release evoked by amygdalar stimulation and there is evidence that this interaction takes place in the MPO. We have therefore examined whether concurrent DS stimulation will block luteinising hormone release evoked

by amygdalar stimulation. In these experiments cats were anesthetized with intravenous "Althesin" and stimulating electrodes were implanted in the DS and medial nucleus of the amygdala using stereotaxic coordinates. After the experiment the electrode placement was confirmed by passing a lesioning current through the electrodes and examining the lesions after the brain had been removed, fixed, frozen and sectioned. Stimulating pulses of 750  $\mu$ amp and 0.2 ms were applied to 60 Hz and 30 sec on and off for 30 min. Blood samples were taken every 10 min before, during and after the stimulation and later analysed for LH using a radioimmunoassay. Our initial experiment indicated that DS stimulation reduced the effects of amygdalar stimulation by about 50% but further experiments will be needed to confirm the finding.

#### Electrophysiological Evidence for a Projection of Prefrontal Cortex Neurons to the Medial Preoptic Region of the Cat.

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Stimulation of the medial preoptic region (MPO) with concentric bipolar electrodes (macrostimulation) causes antidromic invasion of medial prefrontal neurons but the possibility of current spread to lateral structures was not ruled out. To prove that axons from prefrontal neurons lie within the MPO we have employed the technique of microstimulation. In five anesthetized cats a glass-insulated tungsten microelectrode (microstimulator) was stereotaxically placed in the MPO. Constant current pulses of up to 200  $\mu$ A were applied to this electrode while antidromic single neuron responses were searched for in medial prefrontal cortex with 2M NaCl filled micropipettes. Antidromic responses were recognised by collision test and/or fixed latency and absolute refractory period less than 5 ms. Threshold/depth curves were constructed for antidromic responses by moving the stimulating electrode up or down in 25 or 50  $\mu$ m steps and measuring the threshold-current at each step. Conduction velocity was calculated in all cases, and chronaxie calculated for some neurons.

Threshold/depth curves were obtained for 15 (out of 41) antidromically invaded medial prefrontal cortex neurons; 4 had a minimum threshold of less than 10  $\mu$ A, the lowest being 0.45  $\mu$ A. For 7 low threshold neurons the curves yielded current-distance relationships of 1.0-7.1  $\mu$ m/ $\mu$ A (mean  $2.6 \pm 0.59$  SE, median 1.5  $\mu$ m/ $\mu$ A), and calculated current spread at 200  $\mu$ A of 0.2-1.5mm. Conduction velocities ranged from 0.6-2.1 m/s (median 1.4 m/s). Chronaxies for 11 neurons ranged from 0.18-0.38 ms, mean 0.23 ms. These steep threshold-depth curves, slow conduction velocities and long chronaxies are consistent with the activation of small diameter axons, possibly terminal branches, within the MPO.

#### The Effect of Priming on Auditory-Related Potentials.

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According to the priming hypothesis, a cerebral hemisphere may be primed, that is, aroused or activated prior to the presentation of information to be processed, and this primed hemisphere then assumes control of the processing. It is possible that appropriate instructions to the subject, and the presentation of separate blocks of verbal and nonverbal stimuli, would 'prime' the left and right hemispheres, respectively, thus producing a clearer indication of hemispheric asymmetry in auditory event-related potentials (AERPs) than the presentation of an interspersed sequence of verbal and nonverbal stimuli. The latter procedure would be expected to produce minimal 'priming', since the subject cannot know from trial to trial whether the stimulus will be verbal or nonverbal. Experiment 1 compared the effect of blocked and interspersed presentation of verbal and nonverbal stimuli on NIP<sup>2</sup> amplitude in AERPs recorded simultaneously from left- and right- hemisphere temporoparietal regions in male right-handers. As predicted, there was a significant difference in the laterality effect between these conditions, the effect reaching significance only for the blocked but not the interspersed condition. Experiment 2 again compared blocked and interspersed presentations but subjects

were instructed to count the occurrences of particular stimuli. It was expected that counting would optimize the priming effect, especially in the blocked condition. Although the laterality effect was again demonstrated there was no significant difference between the blocked and interspersed conditions.

Evoked Potentials in Reading Disabled Boys.  
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This study compared visual evoked response potentials (ERPs) of specific reading disabled (SRD) boys (reading age one or two years below their chronological age,  $N = 7$ ) with a control group of boys ( $N = 9$ ) of similar age (10 years) and intelligence. Language and non-language stimuli were presented in an S1, S2, RT paradigm. S1 was presented foveally and S2 randomly ( $p = 1/3$ ) either foveally or to left or right visual half fields (VHF). Behavioural data indicated that the performance of the two groups did not differ significantly on the non-language task. However, the SRD group was less accurate but had faster RTs than controls on the language task, suggesting a speed/accuracy trade-off in this group. RTs to VHF stimuli were shorter than to foveal stimuli in the SRD group but not the control group, indicating that the SRD group may have had greater difficulty in processing stimuli when both hemispheres were involved. To examine group, task and hemisphere effects on the ERP prior to S2, ERPs were averaged according to task only. For the language stimuli, the control subjects had a substantially larger N230 over 01 than 02, but the SRD subjects had virtually identical N230 over both hemispheres. For the non-language stimuli, N230 was slightly larger over 02 than 01 for the SRD subjects but not for the control subjects. However these findings should be treated with caution as the interaction was only significant when the amplitude of N230 was measured at specific latencies (220 to 240 ms). One interpretation of the lack of an effect on peak amplitude is that the effects on N230 are due to superimposed negative components rather than to changes in N230 amplitudes.

The second positive component after S1 (P340) had a longer latency over the right hemisphere than over the left in the SRD group, whilst the reverse pattern occurred in controls. The morphology of the contingent negative variation (CNV), following P340 differed in the two groups. The CNV in the SRD group peaked around 200 ms prior to S2 then flattened out whereas the CNV in the control group continued to increase in amplitude up to 100 ms after S2.

The Effect of Age, Sex, and Laterality on Performance on a Battery of Computerized Sensory-Motor Tests.

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A battery of 15 computerized tests has been developed for quantification of upper-limb sensory-motor function, with particular attention given to applications where neurological impairment may be involved. The tests comprise 3 pursuit tracking tasks (preview-random, step, combination) for measurement of integrated function and 12 tests which aim to break tracking into its various sensory, perceptual, and motor component functions (visual resolution, object perception, static and dynamic visuospatial perception, joint position sense, range of movement, grip and arm strength, reaction time, gross speed, static and dynamic steadiness). Single and multiple session adult normal trials ( $n = 36$  and  $n = 12$  respectively) were carried out to determine the extent to which age, sex, and laterality influence performance. Increase in age over the 20-72 year range had no significant linear effect on strength or steadiness but adversely affected visuospatial perception, reaction times, speed, and all forms of tracking. No significant gender difference was found on acuity, perceptual, reaction time, and steadiness tests, but males were superior to females on all strength, speed, and coordination tests. The dominant arm (right) was superior to the nondominant arm on strength, speed, and combination tracking but marginally inferior to the latter's component random and step tracking when performed separately.



### Long-Term Potentiation and Feed-Forward Inhibition in the Dentate Gyrus.

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The functional properties of interneurons in the dentate gyrus are less well understood than those of the principal cells, granule neurones, although they are suspected of contributing to inhibitory interactions. Previous experiments have demonstrated that high-frequency stimulation of the perforant pathway, the major input to the dentate gyrus, results in a long-lasting change in the evoked potential which involves complex changes in the relationship between the population excitatory post-synaptic potential (EPSP) and the population spike. We show that when long-term potentiation (LTP) of the EPSP was reduced or blocked by concurrent activation of the contralateral hilus, a long-lasting reduction in the apparent granule cell excitability was observed. In a second experiment, this change was shown to be analogous to the short term effects imposed by inhibition. Both effects therefore may be attributable to the same inhibitory interneurons. Finally, we have recorded from putative inhibitory interneurons in the dentate gyrus and have studied their activation by perforant path and commissural inputs. The results suggest that granule neurones may receive inhibitory input through a feed-forward pathway, and that the synapses in this pathway may also demonstrate some degree of LTP.

### Angiotensin II Sensitivity of Units in the Rat Lateral Septum *in vitro*.

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The rat lateral septum has the highest Angiotensin II (ANG II) binding activity of any part of rat brain. Moreover ANG II containing nerve fibres and terminals have been localised there by immunohistochemical means. Microelectrophoretic studies confirm that ANG II excites units in this region. In

the present investigation single units were recorded by conventional means from 300  $\mu\text{m}$  slices of rat septum *in vitro*. Of the 124 units exposed to ANG II, in concentrations between  $10^{-7}$  and  $10^{-13}\text{M}$ , 45 units were excited, 32 inhibited and 47 did not respond. The lowest effective concentration was  $10^{-11}\text{M}$  and the units were all localised in the dorso-lateral portion of the lateral nucleus. These results indicate an extreme sensitivity to ANG II and strongly support a transmitter role for the peptide in the lateral septum.

### Abnormalities of Attention and ERPs in Somatization Disorder.

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Event related potentials to rare and frequent auditory stimuli were recorded from 15 patients with somatization disorder, 15 schizophrenics, 10 patients with anxiety disorders and 60 normals. The most consistent and intriguing finding was that the somatization group had significantly larger NI amplitudes in response to the frequent tones (which subjects had been instructed to ignore) at the FZ, CZ and PZ sites compared with all the other groups. In addition, within the somatization group there was no difference in NI amplitude to the two types of stimuli. All other groups had significantly larger NI amplitudes to the rare tones (which subjects had been instructed to attend to). The differences between the somatization and control groups were most pronounced frontocentrally. These results are interpreted to suggest that somatization disorder is associated with a defect in sensory input regulation which is manifest as an impaired capacity to selectively inattend to relatively meaningless afferent stimuli. This in turn may be related to a subtle dysfunction of frontal and possibly subcortical activity, and may help explain why somatization is a long-standing condition characterized in large part by a multiplicity of physiological disturbances.

### P300 Latency as a Means of Diagnosing Dementia.

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The P300 component of event related potentials is thought to reflect aspects of the cognitive processing of stimuli; its latency seems to relate to the time taken for this cognitive processing. A P300 which is abnormally delayed may therefore provide evidence of cognitive slowing, which is a cardinal symptom of dementia. In this study the P300 component was elicited by use of an auditory "oddball" (tone discrimination) paradigm in 20 patients with dementia, 15 schizophrenics, 10 patients with anxiety disorder, 17 depressives and 61 normals. An abnormally delayed P300 was defined as one which occurred more than two standard deviations away from the predicted latency in normals of the same age. Sixty three percent of the demented, none of the normals and 14% of the psychiatric patients were thus identified as having abnormally delayed P300's. The overall false negative rate for identifying cases of dementia according to this technique was therefore 37%, and the overall false positive rate was 6%. The topographical distribution of delay in P300 latency is elucidated in colour maps of brain electrical activity and methodological procedures which may enhance the diagnostic accuracy of the ERP technique are discussed.

### EEG Topographical Analysis of Mental Imagery.

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Theories of cortical localisation usually assume that mental imagery is a function of the right hemisphere. The evidence for this

assumption is equivocal, however, and clinical cases of imagery loss and commissurotomy suggest a left hemisphere involvement. This study investigated mental imagery in a normal sample of volunteers using electroencephalograph (EEG) topographical analysis. Subjects were pre-selected for high and low scores on the Vividness of Visual Imagery Questionnaire (VVIQ Japanese version). The EEG was recorded from 12 needle electrodes, referenced to linked earlobe electrodes, while the subjects were engaged in visualisation of VVIQ items, mental calculation (serial subtraction), and rest. All EEG data were recorded on magnetic tape and, following digitisation, were carefully screened in four-second epochs prior to the construction of maps based upon the square roots of power spectra. Average amplitudes at points between electrode sites were obtained by interpolation using the unbiased polynomial interpolation method ( $n = 12$ ,  $m = 3$ ). Field maps were constructed and displayed on a colour CRT with 16 colour levels and a radius of 63 points as described by Ashida, Tatsuno, Okamoto, and Maru. Alpha attenuation maps (rest minus imagery and rest minus calculation) specified areas of activation brought about by the two experimental tasks. Marked individual differences occurred in the cortical activation produced by imagery and calculation. Differences in the imagery activation were related to the subjects' imagery vividness score: vivid imagers showed more widespread activation than non-vivid imagers. Generation of vivid visualisation involves the co-activation of several cortical regions including right frontal, occipito-parietal and left temporo-parietal cortex. These results have been corroborated by recent studies of imagery using positron emission topography.

### Changes in Dentate Recurrent Inhibition and "Inhibition Failure" Following Perforant Path Kindling.

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Recent papers by Maru and Goddard, and Tuff and colleagues have presented evidence

suggesting that the excitability of the ipsilateral dentate granule cells decreases and the synaptic inhibitory processes in the ipsilateral dentate area are strengthened following the perforant path or dentate kindling. In Experiment I, the changes in the granule cell excitability and the recurrent inhibition in bilateral dentate areas were examined following the daily perforant path kindling with use of field potential recording in freely moving rats. The excitability of granule cells decreased after the first few kindling trials not only in the ipsilateral but also in the contralateral dentate area. The recurrent inhibitions measured at an interpulse-interval of 30 ms in bilateral dentate areas were strengthened even by the first kindling stimulation and then became stronger with further kindling trials. In Experiment II, the sustaining power of dentate recurrent inhibition during a kindling stimulation at a frequency of 100 Hz for 2 sec was examined following the perforant path kindling. The excitatory post synaptic potentials (EPSP's) and the population spikes were rapidly depressed by recurrent inhibition during a repetitive stimulation in the first few kindling trials. As kindling progressed, small EPSPs and the sharp negative spikes began to reappear after a short depression phase (150-200 msec) during a kindling stimulation of 100 Hz.

#### Acalculia Following Subcortical Infarction of the Dominant Hemisphere.

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Acalculia with aphasia has generally been the result of cortical infarction of the parietal region of the dominant hemisphere. We report a 59 year old hypertensive right-handed woman with acute onset of speech disorder and confusion. On recovery she complained of memory impairment and inability to calculate. CT scan demonstrated infarction of the left caudate nucleus and anterior internal capsule. Neuropsychological assessment revealed global deficits. Prominent amongst these was acalculia with impaired perception of the categorical structure of numbers and confusion of arithmetical operations. She has slight expressive aphasia and impaired

visuospatial perception. It has been increasingly recognised that subcortical structures participate in cognitive processes.

#### Differential Diagnosis Using Qualitative Neuropsychological Data.

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A probabilistic, pattern-matching procedure has been proposed by McFarland to aid differential diagnosis in neuropsychology. The present study examines its use when only qualitative data are available for diagnosis. In essence the method involves the derivation of sets of indices from the cross-tabulation of observed and expected symptom patterns. These indices reflect the likelihood that the observed profile pattern matches one (or more) of the profile patterns to be expected if particular predefined cognitive-behavioural functional systems are impaired. The latter profiles are typically called syndromes. In the present study differential diagnosis was made on two occasions (separated by at least 12 months) for thirty brain-impaired patients (aged 5-18 years) in relation to ten syndromes defined in terms of behaviour patterns across some 200 qualitative signs. The diagnoses made were then evaluated in relation to the patients' test-retest performance and neurological data about the locus and type of incurred lesions. The results support the conclusion that the profile matching procedure provides an effective and valid use of qualitative data for the diagnosis of impaired functional systems.

#### Separate Projections from the Septum to the Hilar and Granule Cells of the Dentate Gyrus: Preliminary Results.

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Stimulation of the medial septal nucleus produces evoked potentials distributed throughout the dentate gyrus. Previous work has shown that negative potentials recorded in the region of the granule cell layer result from the activation of granule cells and that

negative potentials recorded in the hilar region result from activation of hilar neurones. Latencies of activation of granule and hilar cells were different suggesting the possibility that the two responses result from activation of separate groups of septal neurones. The experiments to be reported are from a preliminary mapping study in which site of stimulation in the septum and site of recording in the hippocampus were systematically varied. The results obtained suggest that stimulation sites which produce activation of dentate granule cells also produce activation of hilar neurones. However, some stimulation sites located in anterior portions of the septum appeared to produce activation of hilar neurones in the absence of activation of granule cells. These results, if confirmed, suggest that there are two classes of neurones, located in or passing through the medial septum, projecting separately to the granule cells and hilar cells of the dentate gyrus. Alternatively, if two collaterals of a single class of neurones are involved, their septo-temporal distribution within the hippocampus must be different for granule and hilar projections.

**Hippocampal "Theta" Rhythm Generated by Reticular Stimulation: Common Effects of Barbiturates and Benzodiazepines.**

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Rhythmical slow activity is a striking feature of electrical recordings from the hippocampus. The frequency of this nearly sinusoidal "theta" rhythm (5-12 Hz in the rat) is controlled by pacemaker cells in the medial septum. Anxiolytic drugs, septal lesions and hippocampal lesions have similar profiles of action across a wide range of behavioural tasks. Gray has proposed that this commonality results from the interference produced by anxiolytic drugs with the septal control of theta rhythm — an effect which has been shown to be frequency dependent and reproducible by manipulations of noradrenergic input to the hippocampus. We will present data obtained with a variety of anxiolytic

drugs (amylobarbitone, chlordiazepoxide, diazepam, alprazolam, buspirone) and non-anxiolytic drugs (haloperidol, chlorpromazine) to show that the anxiolytics as a class interfere with the reticular control of hippocampal "theta" in a way which is neither frequency dependent nor reproducible by manipulation of monoamines. These data are consistent with Gray's suggestion that the common effects of anxiolytic drugs and septal and hippocampal lesions result from interference by the drugs with hippocampal "theta" rhythm. However, they imply an additional site of action to that postulated by Gray. Given the failure of noradrenergic lesions to reproduce all of the drugs' behavioural effects, this second site of action may be as, or more, important than that demonstrated by changes in septal control of "theta".

**On the Relationship Between the Striatum and the Cerebral Neocortex During Associative Learning.**

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The author has previously suggested: (i) that the cerebral neocortex is the primary site in the forebrain for acquisition of memory dependent on signal contiguity; and (ii) that the striatum is the primary site for reward- and punishment-mediated learning. Since striatum and neo-cortex are richly interconnected both on the afferent and efferent side of the striatum, a variety of other more complex phenomena of learning or performance can be explained as properties of a combined cortex-striatum model. Those to be discussed in this paper include the following: (i) "Latent learning" and sensory preconditioning; (ii) the fact that lesions or temporary disablement of the striatum may disrupt performance of a newly-acquired task, while an overtrained habit is invulnerable; (iii) the fact that striatal lesions commonly cause perseveration when extinction or reversal procedures are scheduled; (iv) the serial reversal learning effect; (v) the fact that Parkinsonian patients may lose their performance disability under circumstances of extreme sensory activation.

The Striatum and Instrumental Conditioning: What are the Rules for Synaptic Modification?

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Hebb's proposal concerning the conditions under which synapses might be modified during learning is well known. The proposal applies primarily to the paradigm of learning involving stimulus-stimulus association. Far less attention has been given to formulating rules of synaptic modification which might underlie instrumental conditioning (learning mediated by reward or punishment). The author has made preliminary suggestions as to the conditions under which synapses might be modified during instrumental conditioning, and has produced arguments in favour of the striatum (caudate-putamen) being the primary site in the forebrain where such a variety of learning occurs. The suggested rules for synaptic modification are, however, incompatible with three features of the biology of the striatum: (i) The sign of direct synaptic links from the cortex to the striatum output neurones is exclusively excitatory. (ii) Lesions of the striatum tend to cause locomotor hyperactivity, the same effect as is produced by activation of the dopaminergic nigrostriatal pathway — the presumed "reward" pathway. (iii) Striatal neurones normally have a very low level of "spontaneous" neural activity. In view of these three facts the original suggestion for rules of modification of striatal synapses are modified to resolve the incompatibilities.

Effects of Thyrotropin-Releasing Hormone on Evoked Responses and Long-Term Potentiation in Dentate Gyrus of Rat.

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Thyrotropin-releasing hormone (TRH), a neuropeptide with multiple neuromodulatory functions, has been receiving examination for clinical relevance in epilepsy. In order to investigate the neurophysiological properties of anticonvulsant action of TRH, its effects on the evoked responses and long-term

potentiation (LTP) of the perforant path input to the dentate gyrus were examined in anesthetized rats. Intracerebroventricular microinjected 80  $\mu$ g TRH increased the relationship between the amplitude of the population spike and the slope of the EPSP, and reduced LTP of the EPSP by approximately 30% compared with saline control. The TRH, however, slightly increased the amplitude of the population spike. These effects of TRH on LTP were confirmed in a dose-related manner. The results obtained indicate that TRH may have two independent effects in the dentate gyrus, an increase in cellular excitability and a decrease in synaptic plasticity. The latter may be related to the previously reported anticonvulsant effects on kindling.

The Length of Parallel Fibres in the Rat Cerebellar Cortex.

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The architecture of the cerebellar cortex appears to be qualitatively very similar in all mammals investigated. Two types of afferent fibre, the mossy fibres and the climbing fibres, bring information to the cerebellar cortex while the efferent projection is made up entirely of the axons of the Purkinje cells. The mossy fibre to granule cell to Purkinje cell pathway has been investigated quantitatively in the cerebellum of the adult rat in order to obtain reliable information on the numerical synaptic relations between the parallel fibres (the axons of the granule cells) and the Purkinje cells. The parallel fibres form synapses on the spines covering the terminal branches of the Purkinje cells dendritic tree. To discover how many Purkinje cells the average parallel fibre makes contact with, it is necessary to establish the average length and the number of contacts on Purkinje cell spines made by each individual parallel fibre. The length of the parallel fibres in the rat cerebellum has been estimated from their density in electron micrographs of the molecular layer. An average length of 4.93 mm has been calculated. This is considerably

greater than the length of 0.9 mm proposed for the rat by Smolyaninov. Calculations have shown that an average parallel fibre length of 4.93 mm in the rat is consistent with known space limitations in the molecular layer. It has been estimated, by two different methods, that each parallel fibre forms an average of 656 synapses with Purkinje cell dendritic trees. From the known density of Purkinje cells in the rat cerebellum and an estimation of mean dendritic tree thickness, it appears that each parallel fibre makes synaptic contact with 65-75% of the Purkinje cell dendritic trees it passes through.

Timing of Zygote Division, Physical Development and Cognitive Skills in Monozygotic Twins.

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Monozygotic (MZ) twins result from the splitting of a single egg 0-14 days after fertilization. Form of placentation is indicative of division; one third of MZ twins split in the first three days and have two placentas, chorions, and amnions (Di-Di). Most others split between days four and eight and have one placenta, one chorion and two amnions (Mo-Di). Many, of the latter type experience an arteriovenous anastomosis, leading to large weight disparities between the donor and recipient twin. The donor may also experience anemia and oligohydramnios, and the recipient polycythemia and polyhydramnios. The effects on brain function of this transfusion syndrome and of the cleavage of the developing embryo are unclear. A noticeable weight difference may distinguish the Mo-Di from the early splitting Di-Di MZ twins where such a difference is unlikely. MZ boys aged 7-15 years from the Latrobe Twin Study were compared on several measures from the study's test battery. The tests selected reflect to some extent hemispheric differences and bilateral asymmetry — motor laterality, two verbal tests (Peabody Picture Vocabulary Test and Forward Digit Span) and two spatial tests (British Ability Scales Block Design and Knox Cube). Two aspects of these results are

discussed. (1) The extent of intra-pair differences which are larger for verbal (left hemisphere) tests in the Mo-Di group; and 2) The comparison of pair means where the Mo-Di group scored lower on the spatial (right hemisphere) tests. This work adds further doubts to the validity of any assumption of developmental equivalence between MZ twins and the general population. If zygote division after the start of neural division produces atypical lateralisation, then left-handedness and other asymmetries in MZ twins may have an etiology uniquely different from that of the general population.

Variation in the Neurological Development of Preterm Infants Revealed by the Brainstem Auditory Evoked Response.

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Infants born before term are at higher risk for later neurological handicaps. However, it is uncertain whether this outcome is related to prenatal or postnatal influences on the development of the nervous system. We have examined the neurological development of infants born <35 weeks gestation by recording brainstem auditory evoked responses (BAERs). The intervals between peaks I and V, and II and V of the response (brainstem conduction time, [BCT]), were used as objective measures of neurological status. Infants who had clinical intraventricular haemorrhage or birth asphyxia were excluded from the analysis. In 36 small for gestational age infants (SGA, <10th percentile for weight) the mean BCT in the period 30 to 36 weeks post conception was significantly shorter than that for infants of the same age who were appropriately grown for their gestational age (AGA). In 6 multiple births, the SGA sibling had the shorter BCT in the preterm period. BCTs for SGA and AGA infants were similar at term and during the next year. Twenty-eight of the SGA preterm infants were born to mothers with hypertensive disease of pregnancy (HDP). However, the BCTs of 19 preterm AGA infants born to mothers with HDP were not significantly different from the

BCTs of AGA, non-HDP infants. Thus, maternal hypertension per se or the drugs used to treat the condition are probably not associated with the abnormal BCTs in the SGA infants. In AGA infants, neither maternal smoking (>10 cigs/day, n = 20) nor chorioamnionitis (n = 40) was associated with abnormal BCTs. A separate study by Kesson and colleagues showed that the development of peripheral nerve conduction velocity was similar in AGA and SGA preterm infants. Failure to grow *in utero* may indicate a prenatal 'stress' which results in disruption of central neural development during the third trimester which may underlie the poor neurological outcome. BAERs with poor form and poor reproducibility were also recorded in 7 SGA and AGA infants born to heavy consumers of alcohol. Such functional abnormalities in the newborn may also be associated with the poor neurological outcome in infants exposed to alcohol *in utero*.

#### Electrical Stimulation of Regenerating Nerve.

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If a rat sciatic nerve is crushed just above the branch point in the thigh, it will regenerate so that the toe-spreading reflex is restored in  $10.4 \pm 1.7$  (mean  $\pm$  SD) days. If the nerve is electrically stimulated for 15 min to 1 hour at the crush site, just after the crush occurs, the toe-spreading reflex becomes observable again  $4.14 \pm 1.6$  (mean  $\pm$  SD) days after the crush. Stimulation is most effective in accelerating regeneration if it is delivered immediately after the crush, but it can be delayed up to an hour and still cause significantly faster regeneration. If the two stimulating electrodes are placed just proximal to the crush, stimulation has no effect on regeneration rate. If both electrodes are placed just distal to the crush the acceleration is observed. This suggests that the effect is on conditions local to the injury, not on the cell bodies of the regenerating axons. One possible mechanism for the effect is that stimulation speeds up the degeneration of the distal segments of injured axons and the

conversion of their Schwann cells to a nerve-growth-promoting mode. Preliminary electron microscope studies show that myelin degeneration begins slightly earlier in the distal segment of stimulated crushed nerves. Stimulation may be clinically useful in cases of nerve injury.

#### Thyroid Hormone Induced Maturation of Peripheral Nerve.

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Morphological and functional recovery of crushed sciatic nerve in adult male Wistar rats was examined following treatment with triiodothyronine ( $T_3$ ). A dose of  $T_3$ , 20ug/kg per day was given. Full functional recovery had occurred in all rats by day 21 with no significant difference between treated and placebo groups as assessed by the vestibular placing reflex. Electronmicroscopy revealed a significant increase in the amount of myelin present in  $T_3$ -treated animals as indicated by the longer myelin spiral length, longer outer fibre perimeter and larger total nerve fibre area. Axonal membrane length was also significantly increased. Taken together these results suggest that  $T_3$  enhances the synthesis of myelin and axonal membrane.

#### Human Motor Unit Recruitment During Static and Dynamic Contractions.

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T6G2H7.

Spike triggered averaging (STA) was used to determine the apparent recruitment order of 147 motor units in the first dorsal interosseous muscle (FDI) of 4 subjects during static contractions in 3 directions: Flexion and abduction of the index finger, and flexion of the index finger coupled with abduction of the thumb. A similar procedure was used for the abductor pollicis brevis muscle (APB) using abduction and opposition movements of the thumb while recording from 48 units in 2 subjects. Finally, the actual recruitment order of units in both FDI and APB was

determined by recording the temporal relationship between 12 pairs of units during repeated scissor movement by 2 subjects. These data show that the recruitment of motor units during static contractions of both FDI and APB in various directions is strictly ordered; the units with the smallest twitch tensions (2-3 NM) firing at the lowest static forces (5% of a maximum voluntary contraction [MVC]) and those with the highest twitch tensions (175-215 NM) firing at the largest static forces (78% MVC). The temporal relationship between unit pairs of APB and FDI was also very ordered as in 12 unit pairs the unit with the smallest twitch tension was recruited first and derecruited last. Thus it appears from these data that for FDI and APB muscles the size principle adequately describes motor unit recruitment for both static and dynamic contractions.

The Effects of the Arrangement, Sequence and Practice in the Performance of a Computerised Motor Task.

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The arrangement of hand, (left, right) and screen (left, right) in the learning of a computerised pursuit tracking task is examined for a group of sixteen post-stroke hemiplegics and a group of sixteen elderly controls. Four different arrangements (hand and screen) and four different sequences of these arrangements in a latin square design were compared. The last arrangement was repeated to examine the practice effect. Results demonstrate a treatment effect but not an order effect in the acquisition of this task.

Event-related Evoked Potentials During Automatic Detection and Controlled Search.

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The present experiment represents one part of an ongoing research programme designed to build a bridge between psychological and physiological theories of attention. Subjects participated in a visual-memory search task in which they were required to decide rapidly

whether or not a target item appeared on a previously memorised set of items. The task was arranged so that some subjects always searched for targets from one stimulus category (letters, for example) against the background of distractors from another category (digits, for instance). For the other subjects, the relationship between targets and distractors was inconsistent. As expected from previous literature, the consistent group developed automatic responding (their search times were unaffected by the number of members of the memory set or the number of distractors), while the inconsistent group did not. Switching the relationship between targets and distractors slowed the automatic group but not the others. Event-related potentials were recorded from several scalp areas throughout the experiment and were later averaged and analysed using multivariate techniques. These analyses indicated that several evoked-potential components (N1, N2, and P3) were differentially related to various aspects of the task and experimental conditions. Some components were sensitive to the size of the memory set others to consistency of targets and distractors.

Analytic Processing of Mental Images.

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In Experiment 1 the subjects classified as same or different two successive letters. In the Perceptual Condition the first letter was actually presented, whereas in the Imaginal Condition it was generated by the observer. In both conditions, response latencies for different decisions decreased with increases in degree of difference and same decisions were faster than the fastest different ones. It was concluded that a mental image preserves enough detail to allow an analytic comparison. Experiment 2 replicated the Imaginal Condition of the previous experiment but the subjects were not allowed enough time to form a suitable visual image of the first letter. Same responses were again faster than different responses, however this time the latter were not affected by the degree of difference. This suggests that when the observer cannot



generate a visual image of sufficient clarity, the comparison takes place on the basis of the "name" of the letters.

**Concurrent Electrical Stimulation of the Medical Amygdala and Fornix Blocks the Expected Post-stimulation Amygdala Rise in Plasma LH in the Anesthetized Cat.**

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We have been studying in the anesthetized cat the neurophysiology of limbic system connections with the medial preoptic region (MPO) and have identified an input from the medial amygdala (AME) to the MPO which is inhibited by concurrent stimulation of the fornix (Fx). MPO-limbic system connections are known to modulate luteinizing hormone (LH) release and electrical stimulation of AME in rats, rabbits, pigs and cats has been reported to modify LH secretion. We have studied in Althesin anesthetized male cats, which had been castrated for 1-6 months to induce an active gonadotrophin releasing hormone (GnRH) system, the effect of electrical stimulation of AME or [AME + Fx] on plasma LH. Serial blood samples were taken before during and after a 30 min period of stimulation and the LH determined by a radioimmunoassay. Plasma profiles were drawn for the experimental periods and the areas under the curves measured. Plasma LH was not significantly changed during the 30 min of electrical stimulation of AME but it was significantly increased during the period 5-30 min post-AME stimulation. In 7 comparisons the ratio of the area profiles for plasma LH, post-AME stimulation: during-AME stimulation, ranged between 1.5 and 5.5, mean = 2.7; SD = 1.4. The shape of the profile of the post-AME plasma LH peak was similar to that seen after intravenous injection of GnRH. In 2 experiments the period of AME stimulation was followed 1 to 1½ hours later by concurrent stimulation of [AME + Fx]. No plasma LH peak was observed after concurrent stimulation of [AME + Fx]. The ratio of the areas post-[AME + Fx]: post-AME were 0.47 and 0.66.

**Memory Retraining Using "Spaced Retrieval": A Case Study.**

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A recent study reports the utility of a spaced retrieval technique in the remediation of memory disorder. This represents a departure from the traditional, more demanding techniques involving relatively complex mnemonic strategies. The subject in the current study was a 21 yr old male who had sustained a severe closed head injury 3 yr 6 mo previously. Spaced retrieval was evaluated as a means of improving his impaired memory function. Stimulus characteristics such as name, occupation and hobby, were assigned to sixteen slides of human faces. Treatment and baseline conditions were alternated daily within a random stimulus design. Treatment involved rehearsal of stimulus characteristics at increasingly long temporal intervals following initial slide presentation. Time elapsed between slide presentation and recall of characteristics was identical in both baseline and treatment conditions. Improved recall of stimulus characteristics was observed during treatment sessions only. The implications of these results and indications for future research are discussed.

**The Recovery of Neural Activity in the Deafferented Vestibular Nucleus Following Unilateral Labyrinthectomy.**

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Following unilateral labyrinthectomy, we have found a striking reduction in neural activity in the ipsilateral vestibular nucleus (IVN). Type I cells, normally abundant, become extremely difficult to find and have unusually low resting rates. However, over a period of time, Type I activity returns and the IVN begins to function in a more normal way; Type I cells become easier to find and their resting rates are higher than immediately after the labyrinthectomy. This paper compares the response characteristics (resting rate,

gain, and phase) of Type I cells before, immediately after and 4-12 months after ipsilateral labyrinthectomy. Single Type I cells were recorded extra-cellularly in the anesthetized guinea pig during horizontal sinusoidal acceleration at 0.2 Hz. Possible explanations for the renewal of neural activity will be discussed.

#### Neuropsychological Studies of Multiple Sclerosis.

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We have investigated some of the neuropsychological correlates of Multiple Sclerosis and examined their relationship to neurological findings. Twenty-one Multiple Sclerosis subjects and twenty-two normal control subjects underwent a neurological examination and were subsequently tested on the Otago Battery of computer assisted neuropsychological tests. Compared with controls, Multiple Sclerosis subjects demonstrated poorer performance across several neuropsychological dimensions, including verbal memory, abstracting ability and choice time. For example, Multiple Sclerosis subjects were not able to recall as many words as control subjects on a verbal recognition task; they completed fewer categories on the Wisconsin Card Sorting Test; and they had difficulty learning and discriminating new rules. The results of these neuropsychological tests however, correlated poorly with neurological findings. This was an unexpected result, since physical impairment is generally assumed to affect psychomotor performance. However, when a cluster analysis was performed on the neuropsychological data and on some of the neurological data, three subgroups emerged. These differed in overall severity of disability, length of active disease, and pattern of neuropsychological deficits. These findings suggest that there may be several forms of progression of the disease.

#### Short Latency Somatosensory Evoked Potentials in Peripheral Nerve Lesions.

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The use of Somatosensory Evoked Potentials (SEP's) in the diagnosis of brachial plexus lesions will be discussed including original observations made in cases with thoracic outlet syndromes and plexus metastases, and the contribution to be made in cervical spondylosis will be indicated. Their use in meralgia paresthetica and with intrinsic and extrinsic nerve tumours will be illustrated. The correlation of SEP's with clinical signs will be made, to show how dysaesthesias of organic origin may be separated from those of hysterical nature. Finally, the problem of the recovery in damaged nerves will be addressed with original clinical investigations presented to show how recovery rates may be measured by sensory recovery which is often delayed. This is an important observation in a situation where the methods used in experimental work often cannot be applied in the human setting.

#### Abnormal Brain as an Electrical Generator.

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The use of electroencephalography (EEG) for diagnostic purposes in conditions of current scientific interest is presented and will be illustrated where appropriate, by examples of the associated morphological changes found in the tissues. Specific diagnoses may be indicated by EEG in conditions such as dementias (Alzheimers, Picks, Jakob-Creutzfeldt and Laforas diseases; and in multi-infarct dementias including the vasculitides), with generalised hypoxic or hypoglycaemic insult: in encephalopathies associated with uremia, hepatic failure and renal dialysis; with drug effects (Lithium and Haloperidol); in concussion and trauma with alpha-coma and lastly with periodic lateralised epileptiform discharge due to deep seated lesions. Correlation between specific EEG changes and pathology in the same patient will be discussed. This summary is based on 24 years of experience including observations of over 60,000 EEG's.

### Measuring Handedness as a Continuous Variable.

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Handedness is an important variable in many investigations of lateralization of cerebral function. Handedness needs to be considered as a continuous variable in some cases, and multi-item questionnaires such as that of Crovitz and Zener are popular, despite a paucity of data on their reliability and validity. This study reports data obtained on 176 subjects who completed the Crovitz and Zener questionnaire twice, and on 60 subjects who performed the tasks involved. The samples included 40 and 20 left-handers respectively. A report of generally lower reliability and validity for left-handers was not confirmed. Comparison with other questionnaires shows that the general format of this questionnaire is suitable for measuring handedness as a continuous variable. However some items were found to be unsatisfactory and an alternative inventory is proposed.

### Scholastic Ability in Left-handers.

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The question of differences in cognitive abilities and school achievement between left- and right-handers is a controversial one. The Australian Studies in School Performance measured basic numeracy and reading skills in approximately 6000 10-year-olds and 6000 14-year-olds attending normal schools. For the four age by sex groups, overall analysis indicated no differences between left- and right-handers at age 10, but left-handed 14-year-olds obtained lower scores on reading tests, the differences being significant for males ( $p < .02$ ) but not quite significant for females ( $p < .06$ ). Left-handers were found to be significantly over-represented in some subgroups of low-achievers, and an excess of left-handers in groups with problems was a general trend. For 14-year-olds, left-handers'

scores tended to be more variable than right handers'. However left-handers were not over-represented among high scorers. An explanation of conflicting results from previous studies is suggested: Left-handers may be in excess among low achievers and in clinical samples, yet the mean of a large unselected sample may not be lowered. Patterns of abilities may show different distributions between handedness groups and these may also be related to maturational factors.

### Topography of Theta Activities in Mental Calculation.

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Brain mechanisms which produce theta activities have not yet been elucidated, though they have been observed in various situations such as calculation, meditation, drowsy states and under drug administration (e.g. Ketamine).  $Fm\theta$  is one of the well known theta bursts which appears along the midline in the frontal area especially in concentration during continuous addition. In this report investigation using a mapping method of various indices is introduced, which includes phase analysis and amplitude. Subjects were healthy student nurses aged 18-20. Eight subjects were selected; 4 good calculators and 4 poor. Calculation tasks were continuous subtractions for 1 min, for example: 1) 100-7, 93-7, 86-7, . . . ; 2) 105-7, 98-7, 91-7, . . . ; 3) 200-7, 193-7, 186-7, . . . ; 4) 205-7, 198-7, 191-7, . . . EEG was recorded from 12 locations; Fp1, Fp2, F7, F8, C3, C4, T5, T6, O1, O2, Fz, Pz, referenced to linked earlobes. Average reference was also used. Twelve bit A/D conversion was performed at a sampling rate of 250 Hz. FFT was done for 4 sec blocks (resolution .25 Hz). Maps were drawn using Unbiased Polynomial Interpolation. Investigations of amplitude topography indicated that good calculators generally showed increased theta activities on the map but the areas were different among the subjects; whereas poor calculators showed a widespread decrement of theta activity except for a small increase in the narrow front-polar region. Phase study of Fp1 and Fp2 recordings revealed that both sides showed similar

quadrant phase advance or delay to that of the average reference.

#### Recovery Sleep at Different Times of the Night Following the Loss of the Last Four Hours of Sleep.

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The sleep of 8 17-year-old women was restricted to the first half of the night for one night on two separate occasions. On each occasion this resulted in a heavy loss of Rapid Eye Movement (REM) (64%) and Stage 2 (60%) with only a relatively light loss (20%) of slow wave sleep. The purpose of the present study was to investigate whether or not the circadian timing of recovery sleep would affect the response of the sleep system to the differential loss of the sleep stages. Recovery sleep commenced at 20.00 hrs (i.e. after a normal 16 hrs of wakefulness) and was either continuous or split into two 4 hour periods (i.e. 20.00-24.00 and 04.00-08.00 hrs). Thus

the second 4 hours of recovery sleep occurred between either 12.00-04.00 hrs or 04.00-08.00 hrs, two periods of the night normally associated with low and high levels of REM sleep respectively. As the appearance of REM sleep is believed to be strongly influenced by circadian factors it was predicted that the second 4 hours of recovery sleep would contain more REM sleep if it occurred between 04.00-08.00 hrs than if it occurred between 24.00-04.00 hrs. The composition of recovery sleep was found to be relatively unaffected by circadian factors. The amount of REM sleep in the first and second 4 hours of recovery sleep was the same as during the first and second 4 hours respectively, of baseline sleep. Thus none of the lost REM sleep was recovered. However, all of the lost Stage 4 sleep was replenished in a one-to-one fashion. It is suggested that the response of the sleep system to loss of sleep is largely determined by Stage 4 debt and that obtaining a daily Stage 4 quota acts as the primary drive mechanism of the system.