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A MEMORY RETRAINING PROGRAM

FOR THE HEAD INJURED

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Essay submitted in partial fulfilment of the requirements for the Degree of Master of Science in Applied Psychology at the Australian National University
Memory impairment is a common feature of post head injury symptomatology. Moreover memory impairment continues to be complaint for a considerable period following the head injury and hence represents a particular area of concern to professionals involved in the rehabilitation of head injured patients.

There are few reports of programs for remediation of organic memory impairment and this lack is probably a reflection of both the incomplete knowledge of the nature of the memory impairment in the head injured as well as the massive demands on a clinician's time for preparation and delivery of a comprehensive program.

A review of research into organic memory disorders and normal memory function, plus an examination of the features of brain disturbance in a head injury, yielded a number of hypothetical explanations of the nature of the memory deficits in the head injured. Some behavioral factors were considered also.

A program was devised on a cost-benefit basis aimed at improving the over-all memory function of the head injured by tackling as many of the proposed modes of disturbance as practicable. The program was orientated towards improving memory efficiency, so that a patient might remember important things better.

The major exercise involved in the program was the construction of a personal hierarchy of items that
need to be remembered for the head injured patient to cope successfully with his everyday contacts with people. This exercise emphasised the development of active mental processes to reinstate memory function and relied on current knowledge of the limits of human information processing. A good understanding of memory function at both cognitive and behavioral levels was developed.

Guidance on how to use the hierarchy was an integral part of the program and practical exercises to familiarise the patients with the use of the hierarchy were incorporated. Follow-up reappraisal of any difficulties in using the new memory system was seen as essential also.

Clinical use of the program with head injured patients on an individual basis and with a group of temporal lobe epileptics has shown promising results despite the difficulties involved in assessment of the program's effectiveness. Provision of the program material in a form demanding minimal preparation on the clinician's part should make the program viable for widespread use.
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STATEMENT OF CONTRIBUTION

The program presented in this essay represents my own ideas and development.

[Signature]
# A MEMORY RETRAINING PROGRAM
## FOR THE HEAD INJURED

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INTRODUCTION

A period of marked disturbance to memory function is typically one of the most immediate consequences of a head-injury. This period of Post-traumatic Amnesia (P.T.A.) is the most commonly used index of severity of a head injury and correlates well with degree of impairment and recovery time (Russell 1932). Following this period of P.T.A. some impairment to memory persists for a good while, both in the case of a minor head injury (Merskey and Woodforde 1972; Schwartz and Sisler 1971); and even more so in severe head injuries (Brooks 1972). This is of particular concern to the professional involved in the treatment and rehabilitation of the head-injured, since it is the presence of psychological symptoms such as memory impairment which is the most important adverse factor in the recovery of these individuals (Fahy et al. 1967, Lishman 1972).

Whilst there is still some query about the nature of memory impairment in minor head injuries because of the lack of supportive evidence from psychometric assessment, the presence of impairment for more significant head injuries has been validated. Kear-Colwell (1973) has provided a factor-analytic study of the Wechsler Memory Scale (W.M.S.) (Wechsler 1945) for both normal and head-injured subjects. This is most valuable since the W.M.S. is the most frequently used clinical test of memory function. Three factors were isolated. Factor 1: Learning of complex novel information in a visual and/or auditory modality. Factor 2: Attention, Concentration and the processing of verbal non-semantic information. Factor 3: Orientation and the recall of long established information. For the 20-29 years age group there was a difference of more than one standard deviation (S.D.) between the control group and the head-injury group on Factors 1 and 2 and a difference of almost one S.D. on Factor 3. This difference was in favour of the control group.
Brooks (1972) has also found significant memory impairment for a head injured group as compared with matched controls on a wide variety of measures. Not only was initial performance worse for the head injured group, but also tests of longer term memory storage revealed significantly more forgetting. He attributed this to less efficient initial processing but considered that more careful analysis of the nature of the deficits was required, particularly individual examination of the various stages of information processing into memory. This is currently being examined by Bond (1975).

Impairment to memory is a very common feature of a wide variety of neurological conditions other than head injuries. Whilst a number of other conditions can produce more severe impairment to memory - and these will be outlined later - memory impairment subsequent to a head injury does provide a major concern. Firstly the incidence of head injuries is quite high due to the ubiquitous motor vehicle accident. Secondly the individuals who sustain head injuries tend to be of a younger age group than those suffering memory impairment due to neurological conditions. Hence they present a more real prospect for rehabilitation than the typical stroke patient (for example.) Thirdly individuals suffering closed head injuries tend to exhibit greater cognitive impairment than a comparative group of individuals who have experienced penetrating missile wounds (Black 1973). Hence this group provides a real challenge for remediation.

Psychologists have long been involved in the assessment and description of these cognitive deficits as a diagnostic aid to the neurologist and neurosurgeon. The growth of neuropsychology in recent years illustrates the increasing interest in this area (Reitan & Davison 1974). However, much less consideration has been given to the remediation of memory impairment in the brain impaired individuals, despite recognition of the marked limitations of medical treatment for memory impairment in the vast majority of cases.

There have been a few reports of attempts at remediation of memory impairment. Luria (1963) reported the use of a cueing strategy to aid the organisation of recall. Patten (1972)
outlined the use of a mnemonic system proving recall of a list of unrelated items. Jones (1974) reported a visual imagery technique to improve recall of paired associate lists; and quite recently, Glasgow et al. (1977) reported the use of an organisational rehearsal method for improving recall of course work for a student. They also outlined the use of a visual imagery technique to assist an individual having difficulty with recall of the names of people he met frequently.

These few reports belie the wealth of data available on human memory and the degree of interest shown in this field, as evidenced by the multitude of publications devoted to this topic every year. In the clinical sphere there is continued research into the defects of memory (Barbizet 1970) and there is great interest in improving the methods of assessment of memory impairment and also delineating the mechanism of acquired impairment in a variety of neurological conditions.

In the realm of research and experimentation there is continued exploration of the nature of normal memory function and in the development of more fruitful representation of the whole process of memorisation. Factors which interfere with the memory process and conversely factors which enhance the memory process have also provided a great interest to researchers (Klatzky 1975, Norman 1976).

A third approach to the study of memory function is also evident in the field of neurophysiology. Here there is a keen interest in the elucidation of the processes involved in memorisation at a cellular level. The research into the development of drugs that selectively impair certain memory functions has enabled the neurophysiologist to correlate biochemical changes with various aspects of memory function (Kandel & Spencer 1968).

With this wealth of interest in memory function and memory impairment it does seem rather surprising that there has been so little attention given to the remediation of memory impairment. Perhaps one explanation for this might be the prevalence of a common misconception about organic and non-organic conditions. The use of the global word "organicity" to distinguish people who had an organic basis for their problems from those who had no apparent organic basis occupied the attention of many clinical psychologists until quite recently.
The assumption allied with this viewpoint was that if a condition had an organic basis then there was no point in attempting any remediation, whereas if the basis was functional, then there was some hope. This may have been the line of reasoning that led many clinicians to the conclusion that once the memory deficit was attributed to an organic disturbance then nothing could be done about it. The prevalence of this viewpoint is rather surprising, especially as it is directly contrary to the common clinical observation of the brain damaged individual who does show some recovery of function over a period of time. Except in particularly severe cases, compensation for deficits tends to be the rule rather than the exception. Of course this compensation does not make up for the original loss of ability but it is often good enough to confuse a clinician. For example it is widely accepted that the performance of individuals with chronic brain damage on clinical tests such as the Wechsler Adult Intelligence Scale (Wechsler 1955) is quite different from the performance obtained from individuals having acute brain impairment (Matarazzo 1972). There is much less discrepancy between individual subtest scores for those with long-standing brain impairment and this strongly suggests some form of compensation. An alternative explanation might be that the tests used become insensitive. Whilst this may be partly true it is unlikely that it wholly explains the phenomena.

The most plausible explanation for the current lack of involvement in the remediation of "organic" memory impairment could be the sheer magnitude of the task and the obvious huge demands on the therapist's time for assessment of memory impairment, program formulation and delivery of the program. Glasgow et al. (1977) emphasise this time factor as a major stumbling block to widespread usage of remediation techniques.
This paper is a description of a pilot program of Memory Retraining developed to provide some form of comprehensive remediation of memory impairment for individuals who have suffered mild to moderate head injuries. The magnitude of this task has necessitated a strict cost-benefit analysis of what might be achieved in the limited time available.

An examination of current requirements suggested that a program for the remediation of generalised memory impairment would prove immediately useful without precluding subsequent development of specific programs for the more modality specific impairment. Hence the program was limited to overall remediation of memory impairment.

Secondly the area of greatest need in these head-injured patients was examined with a view to finding a common area where all the patients experienced difficulty. Interview data strongly suggested that the area of social discourse proved to be the most demanding situation for these patients and it was here that they were acutely aware of their impairment.

Thus the program was further limited to facilitating memory function in the situation where the patient was conversing with another individual without the option of using any physical aids such as notes, diaries, etc. Improving function in this far from ideal situation where optimum performance is unlikely was seen as an attempt at tackling the real memory problems the patient faced, not the problems that might be elicited in a clinical setting.

As a basis for tackling this now somewhat circumscribed task, a review of the current status of human memory function is necessary. This will be explored firstly from a clinical neuropsychology viewpoint incorporating clinical data from related fields where appropriate. Subsequently the contributions of experimental research into normal memory function will be considered. These two approaches should provide guidelines for the construction of a suitable program and a rationale for decisions made. Finally, some consideration will be given to delineating other factors that might contribute to generalised memory impairment in head injured patients which from a purist view would not be classed as memory dysfunction. Hence the term memory impairment is used to cover professed memory problems rather than clinically determined memory dysfunction, and the focus will be on defective memory performance throughout.
A. Clinical Neuropsychology

An understanding of the clinical presentation of memory disorder draws on data from a wide variety of fields. Hence neuropsychology represents a focus for this data, a point of confluence rather than the source of the information itself. Clinical research in the realms of neurology, neurosurgery and psychiatry have provided massive contributions to the knowledge of clinical manifestations of memory disorder.

Memory dysfunction occurs in conjunction with other cognitive deficits in the presentation of Dementia. In fact one of the most useful diagnostic criteria in deciding whether dementia is present is the occurrence of major deficits in long term memory for new material coupled with marked impairment in short term memory function (Miller 1973). The association of memory impairment with a fall-off in other cognitive abilities is hardly surprising since memory is a sophisticated intellectual function. However the more informative and enlightening features of memory disorders are discernable via the study of impairment to memory without accompanying generalised cognitive deficits, although focal deficits may be present. These will now be summarised.

(1) AXIAL AMNESIA

Axial Amnesia refers to major deficiencies in memory function associated with damage to the "axial" structures of the Limbic system and its related structures and connections. Damage is typically found in the region of the Mamillary Bodies and/or the Anterior Thalamus in the Korsakoff (Alcoholic) axial amnesia and in the Post-encephalitic type, damage is usually in the region of the Hippocampus (Walsh 1978).

Both of these principal forms of memory dysfunction are characterized by a gross defect in recent memory resulting in an almost complete lack of permanent new learning or registration of everyday events. Some disturbance to previously stored information also occurs, however performance on immediate recall is relatively unimpaired, although not completely intact.

There are differences between the Alcoholic and the Post-Encephalitic amnesia. The Alcoholic amnesiac lacks awareness of his memory deficit and exhibits a generalised difficulty with conceptual tasks (Talland 1965). Also the problem tends to be one of retrieval with some storage actually taking place as evidenced by the improved performance when cues are given.
Conversely the Post-encephalitic amnesiac is very aware of his deficit and tends to perform better when there is a logical/conceptual structure in the material to be remembered. However cues provide no benefit at all, indicating the deficit is one of storage.

Whilst these labels - Alcoholic and Post-Encephalitic - refer to the most frequently encountered profound memory disorders according to their aetiology, similar forms of axial amnesias can occur with quite different aetiologies. Bilateral Ablation of the Temporal Lobes yields the Post-encephalitic type of amnesia and in fact any condition which provides bilateral Hippocampal damage can produce this type of Axial Amnesia. Ischaemia in the region of the Hippocampus is another well documented precipitant (Boudin, Brion, Pepin and Barbizet 1968). Similarly conditions producing chronic Vitamin B deficiency will mimic the alcoholic amnesia.

In considering the factors that are the key to the memory problems observed in Axial Amnesia, two major factors have been discerned (Cermak and Butters 1972):

(i) An increased sensitivity to inference effects
(ii) A failure to verbally encode new information. This is a performance failure since the axial amnesic is still capable of verbal encoding.

2. FRONTAL AMNESIA

A deficit in "recent memory" is a frequent consequence of frontal lobe damage particularly when the damage is bilateral. There is some query in actually defining the problem as a memory deficit and it probably is best considered as one of the many manifestations of the disturbance to abstract thinking, planning and general intellectual organization (Luria 1965, Benton 1968, Barbizet 1970) that characterizes frontal lobe impairment.

Lhermitte et al. (1972) have illustrated the benefit of a provision of a program in improving the recall of the complex figure of Rey (Rey 1959) in the case of a patient with frontal lobe impairment. This attests to a disturbance of memory organization in the case of frontal lobe impairment rather than a "pure forgetting" syndrome.

A second form of memory disturbance is seen in patients with mesial frontal lobe damage in the form of lack of initiative and spontaneity producing a fall-off in memory function. Once again this is not regarded as a discrete memory disorder, although performance on memory tasks is impaired.
3. SPECIFIC (CORTICAL) MEMORY DISORDERS

The selective impairment of verbal memory with left temporal lesions is widely recognised (Milner 1962, Meyer and Falconer 1960). A less definitive but still well accepted view is that right temporal lesions selectively impair visual memory. These generalisations whilst largely accepted are still the subject of controversy since some more recent research has suggested that memory impairment in these conditions is modality specific rather than material specific (Luria and Karassera 1968, Warrington and Shallice 1969).

Nevertheless if material is selected that is very hard to verbally encode rather than just non-verbal then the distinction between the right and left hemisphere roles in memory is clearer. Memory performance on this material via both visual and auditory modalities is impaired with right temporal lobectomy (Kimura 1963, Milner 1968).

A specific impairment in audioverbal memory, that is, an inordinate rapid decay of the initial memory trace is a feature of lesions in the region of the middle temporal gyrus (Luria, Sokolov & Klimkovsky 1967). Warrington et al. (1971) refer to a similar study of this type of disorder and cite it as prima facie evidence of impairment to a short term memory store.

Besides the specific disorders outlined to date, Luria and Simernitskaya (1977) have reported a comparative study of patients with posterior left hemisphere damage and patients with posterior right hemisphere damage. Both groups were inferior to a control group on the two tasks: (1) Active Memorisation of a list of ten words; (2) Passive Memorisation of a list of ten words. Passive Memorisation consisted of performing an extraneous task such as counting the number of letters in the word or the number of words with the letter "K". The left hemisphere group were significantly worse than the right on the active memorisation task and significantly better than the right on the passive memorisation task. Luria interpreted this result as indicating that the left hemisphere is primarily involved in volitional learning or intentional memorising and the right primarily involved in incidental recall. This is a largely unexplored area, but it does indicate the multiplicity of approaches to the delineation of types of memory dysfunction and their relation to cerebral pathology.
One result of the dominance of verbal memory in intellectual functions is that other discrete memory functions may remain undetected in a clinical memory assessment. Hence the difficulties in correlating professed memory impairment with clinical assessment in the case of minor head injuries may be a result of this lack of discrete testing. However the exploration of the nature of memory impairment in head injuries will be deferred until a review of the contribution of experimental research into human memory function and the proposed models of memory.

REVIEW OF HUMAN MEMORY FUNCTION

B. Research and Theory

Fig. 1. Information Processing in Human Memory.

The above figure represents a summary of the information processing in human memory based on Greeno and Bjork (1973) and Shiri and Atkinson (1968).

A. Sensory Registers

These are peripheral stores of stimulus traces which can hold the item up to three seconds. The items are stored here exactly as they were received and physical features of the items provide a basis for recall from here, that is, spatial location, size and colour in the case of visual input, and voice characteristics in the case of auditory input (Sperling 1960, Morton 1970, Coltheart 1972).
B. Short Term Store—Primary Memory

This storage facility is distinguished by its verbal coding characteristics although visual and semantic coding can occur. Generally items are stored in verbal form on a holding basis for a short time. The difference between storage at this stage and at the previous sensory registers is that the items in Primary Store are no longer pre-categorical but have passed through the stage of pattern recognition in which contact with their Secondary Memory representations has been made (Klatzky 1975). Certain activities must be carried out to transfer data into the permanent store of Secondary Memory.

Primary Memory has typically 2–3 items capacity (Watkins 1974) although these items may represent complex units, for example sentences (Glanzer & Razal 1974). This flexibility of unit suggests that Primary Memory might be better described as "working memory" or Operational Memory (Posner 1970).

Hence Miller's (1956) delineation of the limits to information processing of 7 items was in relation to a measure of human short term memory performance not the capacity of this Primary Memory store. Clinical tests of Short Term Memory can actually draw on any or all of the stores unless specialised techniques are used to control the contribution of certain stores e.g. "The Peterson and Peterson Technique" (1959).

C. Secondary Memory—Long Term store

This store of potentially unlimited capacity is characterised by storage via semantic coding and other forms of coding. Organization is the key here. Models of Secondary Memory have described its structures as a network of associated bundles of information (Anderson & Bower 1973); Quillian 1968; Rumelhart et al. 1972) or as sets of information (Meyer 1970) or as bundles of meaningful features (Rips et al. 1973) or as a collection of nodes (Shiffrin & Schneider 1977). Tulving (1972) has suggested a demarcation into Semantic Memory—the information that we need in order to use language—and Episodic Memory which holds temporarily coded information and events, information about how things appeared and when they occurred. This episodic memory is in a constant state of change. The organisation of items for Secondary Memory is carried out by the Executive Control.
EXECUTIVE CONTROL

This facility covers a wide range of functions and relies on automatic brain mechanisms as well as stored data for the completion of its functions. These functions include:
1. The analysis of initial stimuli.
2. The direction of attention to specific inputs and modalities.
3. The activation of rehearsal.
4. The control of the flow of data from the Sensory Registers to Primary Memory.
5. The development of codes for the transfer of information from Primary Memory to Secondary Memory.
6. The control of retrieval from Secondary Memory including the setting up of cues.
7. The formulation of decision criteria.
8. The initiation of responses.
Section Three
MEMORY IMPAIRMENT IN HEAD INJURED PATIENTS

Having briefly explored human memory function, we must now consider the head injured patient and the mechanisms associated with the memory impairment of these individuals. Before exploring these mechanisms, a brief discussion of the sorts of brain impairment associated with closed head injury would be in order.

In a closed head injury much of the disturbance to brain function is brought about by the stress and strain due to rapid acceleration and deceleration. These stresses, particularly the sheering stresses can produce quite widespread damage. However there are certain sites of predilection where these stresses tend to produce damage independent of the site of impact. The anterior poles of the temporal lobes and the basal regions of the frontal lobes are particularly sensitive to sheering stresses and to laceration because of their position relative to the bones of the skull. Hence damage to these regions is very common in head injured patients, although it will vary in degree a good deal. Besides these common sites of injury there are also injuries associated with the site of impact, especially if there is a skull fracture or if a secondary haematoma or haemorrhage occurs. Also the incidence of a contro-coup injury, that is an injury to the brain opposite the site of impact, is a well known clinical feature as well. Hence a history of the mode of head injury does not necessarily provide a complete picture of the actual brain disturbance and this must be obtained via a neurological and neuropsychological examination and from neurosurgical data also.

It is very likely that there will be a multiplicity of syndromes associated with specific, localised cortical deficits, and thus the profile presented by these patients can often be a little confusing and perhaps contradictory. The response of the brain to cerebral insult in the form of cerebral oedema can be a lingering one, with oedema present even as long as six months after the injury. Hence delineation of the problems provides a real challenge to a clinician and certainly the memory impairment presented by these individuals may be the result of a variety of focal deficits as well as
the generalised changes accompanying any head injury. There are more detailed descriptions of the problems resulting from head injury in Walker Caveness & Critchley (1969).

Zangwill and Whitty (1977) have described the memory difficulties following a head injury as: 1. An impairment in memory for current events. 2. A lowering of the general efficiency of memory. 3. Some deficiencies in recall of information that has been stored for some time. They go on to cite examples of the difficulties shown by head injury patients and say "They have difficulty remembering the names of people whom they have met recently, they forget to carry out instructions and often forget their own intentions, and overall show an excessive degree of absent mindedness." These features are considered part of the post-concussional syndrome (Symonds 1962). However the resolution of these difficulties does not occur within the same time span as the other post-concussional features.

Let us now consider some of the explanations that may be proposed for the presence of memory impairment in head injured patients. These explanations are by no means exclusive or even exhaustive and obviously many are linked together, both from a behavioural and site of disturbance viewpoint. Since the program is aimed at professed memory impairment, the scope of these possible modes of disturbance to memory function will be even wider, since they will include functional explanations.

A. SLOWING OF THE RATE OF INFORMATION PROCESSING

The development of specific tests designed to quantify the rate of information processing for use in the assessment of recovery from head injury attests to the ubiquitousness of this feature in the cognitive functioning of the post-head injury patient. Gronwall (1974) has developed the PASAT Test (Paced Auditory Sequential Addition Task) to chart recovery in terms of improvement in processing time. Memory function would obviously be degraded by slower overall processing rates, because the amount of information available to Secondary Memory would be lessened.
B. LOWER SIGNAL TO NOISE RATIO

A common sequel to head injury is an increased sensitivity to noise (Walker et al. 1969). This change may represent the result of an increase in the level of internal noise in the system which enhances the disruptive effect of external noise. Whilst this is most evident in auditory processing, it may well be a feature of all modalities. The persistence of oedema is a physical occurrence which might well be responsible for these lowered signal to noise ratios.

A generalised increase in noise in the system would reduce the "hold time" in the Sensory Registers and could well lessen the duration of storage of an item in Primary Memory simply because it would take less time for the signal strength to decrease to a level where it was absorbed in the noise. These changes would significantly degrade the probability of successful processing into Secondary Memory.

C. DISTURBANCES TO EXECUTIVE CONTROL

Probably the most likely site for the production of generalised memory impairment would be at the level of Executive Control. Because of the complexity of the tasks carried out by this "module" it is prime locus for disruption. Neuropsychological findings re the role of the frontal lobes in the organization and control of behaviour (Luria 1973) plus neurosurgical findings concerning the frequency of laceration and damage to the frontal lobes referred to earlier, provide a strong basis for considering the disruption of Executive Control as a major factor in the manifestation of generalised memory impairment.

The disturbances to executive control would have impact at all stages of human memory function.

1. Attention and Initial Analysis

Impairment to the analysis of an initial stimulus would lead to omission of important input data. The long recognised difficulty of dividing attention amongst concurrent events (Sternberg et al. 1971) raises the issue that disturbances to attention may constitute a significant part of the professed memory impairment in head injury patients. The switching of attention being slowed would produce complete inattention to some information. Also there might be a less appropriate
distribution of attention, to the extent that features of the input direct attention. For example, intensity of the stimulus may determine the focus of attention rather than more higher level rational decisions.

2. **Rehearsal Activation**

A slowing down of the onset of initiation of rehearsal would diminish the likelihood of retention of an item and subsequent transfer into Secondary Memory.

3. **Data flow to Primary Memory**

Slowed pattern recognition would disrupt the control of data flow into Primary Memory.

4. **Deficiency in Coding**

One likely deficiency would be in the area of code development and organization of information for the transfer into Secondary Memory. This form of disturbance is already clearly established in research into Korsakoff’s disease. The reliance of Korsakoff-Amnesic patients on organization via old established codes (Winocur 1976) is a key example of this form of deficiency. The finding that Korsakoff patients have the same ability as normals in the storage of individual items for random retrieval (Fuld 1976) reaffirms that their memory problem is at the executive control level in that they cannot utilise new codes or new forms of organization which are at their disposal. Hence the memory impairment of head injured patients may be a product of weak coding. This may take the form of the use of old codes which are more readily subject to confusion or simple codes, unsuited to permanent storage, e.g. coding on acoustic parameters of the stimulus. This explanation is in accord with the findings of Brooks (1972) who noted that long term recall was more significantly impaired than immediate recall in head injured patients. Perhaps the commonly used codes were reasonably effective with immediate recall but were not suitable for permanent storage, hence producing more distortion and decay.

5. **Retrieval Dyscontrol:**

The disturbance to retrieval control would have a marked effect on the overall efficiency of memory. This form of disturbance is very evident in Korsakoff patients who show high levels of Proactive Inhibition. (Cermak & Butter 1972).
The selection of appropriate responses and the discrimination between different sets of items stored is a function of retrieval control, and disturbance to this function would have profound effects on the accuracy of recall.

6. Decision Criteria.

Decision criteria play a part in all facets of memory function. Disturbances to these criteria would significantly degrade the efficiency of memory since they are set for optimum results in the face of multiple competing demands. Bernbach (1967) has shown that confidence of the accuracy of a memory trace does not reflect the strength of the trace but rather it is an all-or-none phenomenon.

Besides the possibility of changes to Decision Criteria degrading memory performance, it is also quite possible that lack of change in decision criteria contributes significantly to memory impairment. That is, disturbances to executive control may disrupt the ongoing appraisal of decision criteria leading to fixation of these criteria.

This is a particularly pertinent issue in that lack of appropriate modification of decision criteria would produce a generalised memory impairment close to what is actually observed in head injured patients. Also changes in function at any or all of the possible sites of disturbance enumerated so far would necessitate changes in decision criteria, so the need for criteria change is extremely likely and most probably the degree of required change is greater than at any other point in the patient's life. The fact that this need occurs at a time when intellectual functioning is compromised only enhances the likelihood of this specific disruption.

The feature of increased noise in the system outlined earlier would produce a lessening of the gap between the Signal Mean and the Noise Mean using Signal Detection Theory framework. (Coombs Dawes & Tversky 1970). Consequently the decision criterion of the individual, maintained at its previous setting relative to Signal Intensity would produce an increase in false positives - errors of optimism (See Fig. 2).
Fig. 2. The effect of Changes in Noise Levels on the efficiency of a set criterion

In this example a criterion that previously generated twice the number of correct responses for every incorrect response, is now producing more incorrect responses than correct ones. This example is quite realistic in that the setting of decision criteria according to signal intensity is certainly the most useful method of regulating criteria.

E. DISRUPTION OF SECONDARY MEMORY

Almost certainly some disturbance within Secondary Memory also occurs. The very existence of Retrograde Amnesia and Post Traumatic Amnesia readily supports this notion. Whilst recall of long established memories is typically less impaired than current memory function in head-injured patients, psychological test results attest to some impairment. For example, scores on the information subtest of the W.A.I.S. tend to be depressed a little in head injured patients, and this subtest is solely a measure of acquired information (Matarazzo 1972).

The disturbance to Secondary Memory could take the form of disruption of organization and hence a loss of access to certain items or groups of data. This would make the task of executive control even harder in that it could no longer assume an exact knowledge of the nature of what is stored. Hence decision criteria would have to be altered further.

F. DISRUPTION TO AUTOMATIC PROCESSING

Shiffrin and Schneider (1977) have recently suggested a further distinction in memory function that warrants consideration at this point. They have divided memory processing...
into two categories - controlled and automatic. They consider that controlled processing is very demanding on attention, serial in nature, relatively easily established, altered, reversed, and performance here is dependent on the task load. Conversely they consider automatic processing as a well learned activity stored in long term memory. Attention is only required when a target stimulus is presented, processing is parallel and largely unaffected by load, but it is very difficult to alter, ignore or suppress the activity once it is learned.

This model of memory function has empirical support from experimentation. Also it seems to tie in with the picture presented by the head injured patient. The persistent memory impairment may represent a disruption to automatic processing, whereas controlled processing is much less disrupted, especially once some time has elapsed since the injury. Disruption to the automatic processing would be difficult to correct, especially from the individual's viewpoint since he is largely unaware of this aspect of his mental activity. It is difficult to change the automatic processing, hence it would be very difficult to reinstate that processing.

The model of Shiffrin and Schneider includes the concept that the long term memory stores contain learned sequences of information processing. Hence damage in the frontal region leading to disruption of learned sequences of events would explain the disruption to information processing. Hence the difficulties exhibited by head injured patients could be viewed as the result of assuming a certain automatic function is operating when it is not and this is in accord with the behavioural presentation of the head injured patient.

**BEHAVIOURAL FACTORS**

Having examined the various modes of disturbance in the memory system, the possible behavioural contributions of memory impairment must now be considered. These may be viewed as prime factors in themselves or alternatively secondary effects precipitated by one or more of the disturbances outlined previously.
19.

(1) CATASTROPHIC REACTION:

Having passed through the acute phase of the post head injury symptomatology an individual may be so overwhelmed by the changes in cognitive status that he gives up all hope of regaining function and hence puts no effort into the re-establishment of effective memory function. This reaction is often determined by certain misconceptions about memory function. There is a common belief that memory is an automatic process with little voluntary control. Hence memory impairment is either irreversible or any improvement in unrelated to active effort. This reaction would certainly enhance memory impairment because it would reduce effort at a time when the demand for effort was probably higher than ever before.

(2) OVERCOMPENSATION

A more strong-minded individual might react quite differently following a head-injury. Mindful of the deficits in his memory via his own observations or more likely through comments of those around him, he could set out to improve his memory through exercising it, trying to remember everything he can. The results of this could be devastating. Faced with an inexhaustable supply of information that could be remembered he would find that he really has not solved his memory problems and in fact he may have added to them by clogging up his memory with tons of relatively useless information.

This result could thus precipitate a Catastrophic Reaction and this reaction would be rewarded by relief from the encumbrance of memory exercises, plus the fact that this memory function may seem to improve simply because he has stopped clogging it up. Clinicians have balked at the magnitude of the task of memory reconstruction, it is quite understandable therefore that the individual with the impairment would react the same way.

(3) LACK OF CONFIDENCE

Even if the Catastrophic Reaction is avoided, a generalised lack of confidence in memory function is a likely feature of the post head injury patient. The impact of retrograde amnesia and post traumatic amnesia is often unrecognized. Yet this clear
cut sign of disturbance to memory can be much more significant than day to day forgetfulness. At least some things are remembered amid the daily forgetfulness but the amnesic periods constitute a massive loss of information and experience which continues to challenge the integrity of the individual’s cognition. People can understand omission of some information but not a complete gap.

This loss of confidence in memory can lead to all too ready acceptance of fault when miscommunication occurs. The head injured person becomes resigned to the fact of his impairment but because of this he assumes responsibility for errors automatically even though he may not be at fault. On a probabilistic basis he may be more likely to be at fault overall, but this does not mean that in considering one particular instance of miscommunication he is at fault. In reality there tends to be an initial phase where the head injured patient strongly resists the notion that he is at fault. Repeated instances of initial resistance to the assignation of fault followed by confirmation of the fact that fault lies with him by a third party eventually humbles the patient into ready acceptance of fault.

(4) LACK OF UTILISATION

This assumption of fault can enhance memory impairment in that the patient becomes uncertain about almost everything he recalls and relies on his memory less and less. With fewer demands on memory the efficiency of function must decrease. Thus a destructive cycle of assumption of impairment and subsequent lack of use leading to further impairment can be set up. The lack of reliance on memory ensures that future reliance would be prone to disappointment.

(5) SCAPEGOATING

The ubiquitousness of memory impairment may encourage the attribution of difficulties to this form of disturbance when in fact other forms of impairment are present. An individual suffering receptive difficulties may explain his problem in terms of "I don't remember what you said" when in fact he did not comprehend what was said and therefore had
no possibility of remembering it. This compensation can occur without any awareness on the individual's part.

Alternatively a person with expressive difficulties would find it easier to say "I don't remember" than to say "I don't know how to express what I remember" and once again the subtle distinction between these two statements may escape the awareness of the individual (and the clinician).
To date we have listed most of the plausible explanations for generalised memory impairment in head-injured patients. It is an impractical task to attempt to distinguish which explanations fit a particular individual but in considering head injured patients as a group the most constructive move would be to develop a program that has an impact on as many as possible of these sources of impairment given the constraints of time and effort required.

The two most productive sites of intervention seem to be at the levels of Executive Control and behavioural adjustments. These account for most of the sources of impairment. So we must now examine what changes can be made of strategies introduced to effect intervention at these levels. Let us examine what can be done at each site of disturbance.

**STRATEGIES OF INTERVENTION**

(1) **Attention - Initial Analysis**

If switching is slowed then new rules outlining what to attend to are required so as to streamline the process. Obviously, the reduced facility must be recognized and adjusted to. Inappropriate switching of attention can also be corrected via a new set of rules. What must be recognized is that more time is required for these processes now, if they are to be carried out correctly. This requires a release from pressure to process quickly and at a behavioural level it requires the head-injured patient to attend for a longer time to input than on previous occasions.

(2) **Slow Rehearsal Activation**

This deficiency does not appear to be correctible. However adjustment to this state of affairs may be achieved via lessening the demands on rehearsal, so that items that are rehearsed, can be dealt with adequately for the required time and thus Primary Memory would not have so much information arriving for rehearsal that each item is rehearsed incompletely.

(3) **Slow Data Flow to Primary Memory**

Again this cannot be directly altered but the changes in control of attention and the lessening of input into Primary Memory described already may remove bottlenecks that enhance this slow data flow.
Having already reduced the amount of information arriving in Primary Memory it may now be possible to introduce changes to the Coding procedures. One of the reasons for the tendency to use simple codes such as acoustic similarity may have been the overload at Primary Memory and this simple coding was a means for transferring data quickly out of there, even though the degree of error was enhanced considerably. So reducing the pressure to process allows the individual more time to devote to the organization of input for permanent storage. Fredericson (1975) has shown that the acquisition of semantic information from discourse is dependent on an appropriate adjustment to the conditions of information overload during the acquisition of information. Conversely the recall processes are much less crucial.

Actually research by Craik & Lockhart (1972) and Mistler-Lachman (1975) has indicated that deeper levels of processing that is higher level coding, does not necessarily take longer. Now whether this is still true for head injured patients or not, the utilisation of more stable higher level coding is essential if the degree of distortion and decay is to be reduced at the individual item level. Thus emphasis can be placed on accurate storage of a reduced amount of data. Certainly coding or organization is seen as the basis for almost all long term storage of data. (Atkinson & Shiffrin 1968, Broadbent 1971, Baddelly 1966, Glanzer 1967).

The coding techniques should take an abstract logical form since this best approximates normal memory storage of complex information. (Kinitsch & Monk 1972). Meaningfulness must also be emphasised since this tends to be the key to long term recall (Marton 1976). Also the use of imagery has been shown to increase retention (Paivio 1969).

A hierarchical coding strategy should be within the capabilities of the head injured patients. Herriot (1972) has shown that retarded adults can improve their recall via the use of such a coding strategy hence it is likely to be quite useful with the head injured.
(5) Retrieval Dyscontrol

The problems at the point of retrieval should be alleviated partially by the reduction in information storage produced by the measures already outlined. However one important contribution to the reduction of error here would be the use of multiple associations in storage to improve the access to previously stored information when retrieval is required.

A second constructive step would involve facilitating the production of cues that could be present at both presentation of data and at retrieval. Research by Tulving & Osier (1968) and Herrint (1972) has emphasised the importance of having cues available at both junctures since this significantly enhances recall. The presence of cues just at presentation or just at retrieval contributes very little improvement to recall.

Also consideration must be given to encoding constancy and not just encoding specificity. Postman (1975) has emphasised the importance of coding as variations on a theme rather than the development of new themes.

(6) Decision Criteria

It is essential that changes be made to decision criteria firstly in the light of the obvious changes in the cognitive functioning of head injured patients but also to facilitate and adjust to the new situation presented by the changes already decided upon. In fact all the changes require an alteration in the current decision criteria. One major decision is to accept the slowed processing and adjust to it rather than to fight it. Another key decision is to actively disattend to some input or alternatively actively avoid introducing mechanisms to enhance the permanence of that item. Hence there must be a decision to devote more time and effort to less input, thus storing some information well and the rest not at all, instead of storing a bit of everything.

The only way this sort of decision criteria can be introduced however is on the firm basis of clear guidelines on what determines that which is to be concentrated on and that which is to be ignored. These guidelines will thus form the core of the memory retraining program.
(7) Behavioural Adjustments

Catastrophic Reaction

Emphasis will have to be placed on the control every individual has over memory function and hence even though memory impairment is present in head injured patients this just means control has been disrupted. Thus control can be regained - with guidance - as long as certain readjustments are made. These include recognition of the inherent variation in memory function. This makes adequate memory ability a subjective evaluation rather than an objectively measurable phenomenon. Also the fact that a program designated memory retraining is available to them serves to counter the automatic reply that "nothing can be done."

Overcompensation

The importance of appropriate exercise in any form of skill development can be highlighted for those who strive to improve memory through persistent testing and strenuous effort. The fact that only one outcome can result from this can be used to lead into a look at appropriate exercises - as contained in the program. The release from all that extra effort can serve as an immediate positive gain in this situation as well as placing those who have overcompensated on the same footing as those who have catastrophised.

Lack of Confidence

Recognition of the concern engendered by R.A. & P.T.A. and the subsequent loss of confidence can be used to introduce the notion of the individual's contribution to his own problems. The acceptance of fault can be discussed and the principle of increased confidence being based on increased control can be raised.

Lack of Utilisation

The self-destructive cycle of lack of use can be exposed as a second means by which the individual contributes to his own impairment. Also the future increased utilisation of memory can be expressed as simply the introduction and use of the memory program, rather than some non-specific direction which the head injured patient find impossible to carry out because of his problems.
5. Scapegoating

The importance of correctly defining the nature of problems can be emphasised. It is easily recognised that hearing and comprehension are essential prerequisites for the storage of verbal communication for later retrieval. Problems here can be differentiated and the implications of these deficits can be explored.

Plan

Hence the following memory retraining program will aim at providing a system of cues to be available at both the stages of acquisition and retrieval. Secondly it will reduce the demands on information processing to optimise the performance within a limited sphere, and thirdly it will tackle the behavioural components and develop more appropriate mechanisms of adjustment.
1. The Decision "What to remember"

All head injury patients accept that they retain some memory function. Their ability to utilise this function is the most troublesome issue. They accept that they can remember some of the things they want to remember and some of the things they need to remember. Also they readily acknowledge that forgetfulness in the area of items they need to remember is their greatest difficulty and constitutes the criterion by which they measure their memory impairment.

Hence the answer to "what to remember" can be stated as simply: "What you NEED to remember." However this sort of definition is prone to circular thinking and tautology. "What you need to remember" might be paraphrased as "what you are forgetting but shouldn't be." This definition intrinsically provides no gains whatsoever for the head injured patient since he at least is quite well aware of the fact that what he needs to remember is the important things he has forgotten! To escape from this destructive cycle, description of what each person needs to remember must be taken out of the context of forgetting and listed a priori.

Now it is impossible to generate a single memory program suitable to everyone's needs first off. Hence the individual must be involved in the process of development of the program to provide for the idiosyncratic aspects of each person's memory requirements.

The involvement begins with the introduction of the concept "Need to remember" to the group of head injured patients and a clear statement of the large contribution the individual must make in the development of his own memory program. This is already a challenge to the misconception of no control being possible but no effort is made to attack this view directly, at this stage.

Instead some of the situations in life where it is readily apparent that what a person needs to remember varies considerably, are introduced and discussed. Then some of the bases for
differentiation of "need" or importance are drawn out. Here issues such as social etiquette, giving the impression of competence and feeling at ease with company are raised and there is already some communality of problems apparent to everyone. In fact there seems to be a common misconception of singularity, each head injured patient considers he is the only person with this sort of memory problem. This is probably a result of the lack of confidence aspect, the individual has assumed he is at fault, therefore everyone else is fine. It is quite a relief for all patients to find that everyone in the group has much the same problem and that they are not alone. This tends to initiate the development of renewed confidence but this development is quite slow and a significant change is unlikely to occur before the new program is operational.

2. Construction of a Hierarchy

Discussion of the various situations which modify the need to remember leads to the selection of what constitutes the most demanding situation. The decision that social discourse is most demanding on memory function is soon reached, and it is readily accepted that the program should concentrate on this area of need.

The concept of a simple hierarchy of situations is then introduced. The discrimination between situations is clarified according to people rather than places. So a situation would be defined in terms of "talking to John" rather than "talking at the Pub." Having clarified this principle it is quite obvious that a program would not function if every possible social contact was treated individually. So a personal grouping of each patient's contacts is seen as the next step. This usually presents some difficulty to the group until a suitable level of abstraction is reached. A grouping such as: Marriage Partner, Close Friends, Friends, Acquaintances and Others, tends to be quite common although the use of a special category for work associates is often included. The labels may vary a little as well. This variation is encouraged since the program is to be designed for each individual in the group, not the group as a whole.
Basic concepts relating to the restrictions on human processing are introduced here, partly as a familiarisation process but also to convey the fact that a good deal is known about memory function and that this program is based on the reality of what is known, not supposition. This is also an attack on the "no control" misconception because control is clearly dependent on knowledge.

Limits on processing are used to reinforce the notion of parsimony. The lower the number of groups in the hierarchy, the more manageable will be the program, provided there are enough groupings to cater for all the individual's contacts.

When the initial form of grouping is decided - and this is just a starting approximation, subject to modification as experience with the program is gained - then the patients are instructed to list above each group what they consider they need to remember. There is general recognition that what "needs to be remembered" for the groupings "Acquaintances" and "Others" is considerably less than that for "Marriage Partner" and "Close Friends." But specific description of what "needs to be remembered" is very difficult for all group members.

At this juncture the members are exhorted to make some sort of attempt by spending considerable time dwelling over the hierarchy during the coming week, and returning with their "attempt" at the next session. The advantages of this move are firstly that this action reiterates the principle that most of the effort will have to come from the individual. Secondly in attempting this task they are forced to examine their own rules quite closely since it is their rules that produce the first draft. Thirdly recognition of the magnitude of the task makes them more receptive to hints and suggestions given in future sessions. Also the fact of their memory impairment necessitates overexposure and active involvement to compensate for the tendency to forget. Finally this manoeuvre provides a means to establish the current status
of each individual in the group. The amount of understanding gained, the degree of motivation and the resourcefulness of each person will be mirrored in the product that constitutes their first attempt. Often sessions are recorded on tape for the group members to take home and replay. This reduces members' worries about how much they will remember about the session, and obviates the need for copious note-taking which makes the sessions more relaxed and enjoyable affairs.

At the second session each member is asked to report on his difficulties during the week in formulating the first draft. These problems are discussed at length and each draft is examined critically for weaknesses of various forms.

These weaknesses may take the form of:
1. Tautology: If there is a description of an item on a list that is prefaced by the word "important" then the individual is asked to explain what it means to him and more appropriate terminology is sought. On a program devoted to the description of what is needed to be remembered, that is, what is important, it is quite pointless to have an item described as important ______. It is quite absurd to have a list of importance with descriptions such as "important" items. Of course they must be important, to be on the list! What the program must do is differentiate items by recognisable features that decide importance, and these features constitute the body of the hierarchy.

2. Vagueness. When an item is described in vague terms clarification is sought - what was really meant. If an item is defined loosely then it will be subject to greater error and the aim of the program is to virtually eliminate error in a defined area of memory function. If the person cannot define the item sufficiently then it is eliminated or perhaps incorporated within another description.

3. Long windedness: Descriptions of categories must be succinct. If there is a three or four word description, this will be harder to remember itself and may enhance error. Also the brevity of the category name, the easier it will be to recognise a feature pertaining to that category.
4. Lack of Progression: Sometimes a first draft will contradict the progressive build up of important items from the group "Others" to "Close Friends." This must be brought to the attention of the individual concerned and the alternatives considered. Either the ordering of the groups is altered, a somewhat difficult task given the previously established conceptual framework, or some of the items in the aberrant group are sacrificed in the interest of consistency. However minor changes in order do occur more frequently when the placement of the group "Work Associates" has to be considered. As long as an adequate rationale for positioning can be established by the individual himself then the hierarchy will stay as it was formulated.

5. Lack of Categorisation: The use of categories to describe features rather than the name of the feature itself is encouraged. The over-specifying of items tends to make the program inflexible and consequently less useful. Where categorisation is lacking the group works together to formulate category labels that are discrete, clear and acceptable to the individual concerned. The labels must cover what the individual meant not what the group interpreted the items to mean.

6. Overinclusiveness: There is a frequent tendency to produce quantity rather than quality in the specification of categories. This may reflect too simple a level of abstraction and the group discussion referred to earlier can be utilised here to assist the individual in reducing the number of items. However often there is just too much data in the hierarchy and a complete reappraisal of what really is important is necessary. Once again the limits of processing need to be reiterated and the importance of having a hierarchy that is comprehensible and manageable is stressed.

Generally individuals have little idea of what is important to store in memory and they can omit from the hierarchy things that are important because they already remember them! The completeness of this reappraisal of memory function must be emphasised. The program will not be an aid to memory function it will be the person's memory function, to a large extent. The totality of the change required tends to be glossed over. If it is not recognized then the program will not function successfully, and there will be the comment
"I forgot to use it."

The appraisal of first drafts may occupy more than one session especially when a number of the first attempts represent about ten minutes work just prior to the session by the less motivated group members. Alternatively the less endowed members may take longer to comprehend the principles involved and the systematic examination of first drafts serves to highlight the principles quite specifically, and enable them to make a worthwhile attempt at their own particular hierarchy.

3. The need to forget.

At this stage a second key concept is introduced - the need to forget! All people with memory impairment and in fact the great majority of those with intact memory function, view forgetting as a malfunction of memory - a symptom of lack of control. Now if this criterion of dyscontrol is maintained then the group members will never gain control of their memory function because they will always forget things just like everybody else. So to change this counterproductive conclusion, forgetting must be seen in a different context. The limits on processing can be used to highlight the need to forget. Without forgetting there is no certainty of remembering, because the choice of what "needs to be remembered" must be matched with a complementary choice of what needs to be forgotten.

This point needs considerable emphasis and repetition at later sessions since it represents a marked cognitive restructuring. However despite its novelty this concept is accepted by head injured patients as a reasonable one, especially if there are tangible examples of the working of this concept available to them. Faced with a massive amount of information in every day of our lives it is readily obvious that we choose to forget a great deal. Perhaps different words are used - such as "I chose to ignore that" but recognition must be paid to the fact that in choosing to ignore something, we may have already processed the event partially hence the choice to forget must have been made.
Bjork (1972) provides a comprehensive review of directed forgetting. Also Rakover (1975) has distinguished that voluntary forgetting is achieved by choosing not to use organizational imagery to transfer items into long term storage, hence it is an active process.

The introduction of the concept of needing to forget is thus fundamental to the maintenance of parsimony in the hierarchical structure, and complements the need to remember principle. One advantage of this approach is that via this concept, forgetting is no longer an index of dyscontrol but paradoxically another measure of control. Hence it further erodes the no-control assumption and promotes further confidence. Forgetting because one chose to, is in no way reinforcing impairment. However this cannot be used to glibly rationalise away the head injured patient's memory problems. The choice to forget must occur at its appropriate time and place.

During this second session, the grouping "Others" is given special attention. This grouping covers more than 99% of the people one meets hence it is a crucial area of the hierarchy. Individuals tend to place only six items or so in this grouping but even this may represent a major information overload. Since there are so many people included in this group there should be as few items as possible listed as "what needs to be remembered."

Generally two to three items are adequate, namely:
A. One unique personal detail.
B. One interest.
C. How to contact

Of course these categories must be discussed at length so that each group member is completely aware of what constitutes each category.

Once this grouping is formulated, emphasis must be placed on remembering these items only! There is always the temptation to take in a few more details. The time spent taking in a little more could be utilised much more appropriately by making sure the three key items are permanently stored. Methods of achieving this constitute a later part of the program. After successfully dealing with the grouping "Others" each grouping is dealt with in turn.
At the third and fourth sessions, redrafts (and first drafts) of each member's Hierarchy are examined critically; using the criteria discussed previously. There will have already occurred some swapping of ideas during the group examinations of the individual hierarchies. However this process is encouraged further by the dissemination of hierarchies of those in previous groups plus copies of each of the current group members' hierarchy. This represents the final opportunity to modify the hierarchy before utilisation begins.

The issue of recall of names is always subject to much discussion. Most individuals say they should remember names but they recognise the difficulty of the task by the fact that they do not achieve it. On a strict basis of importance names are often not that crucial, the forgetting of names if an acceptable social faux pas and not really a general criterion for excommunication of an individual from a social group. When given the alternative of remembering a personal detail or a name, the former has distinct advantages. What needs to be appreciated is the lack of information value in names. The proportion of new names is quite low and a name gives little insight into the person and even less to talk about. Hence group members generally agree that names only become important above the level of acquaintances. And even then it is the lack of knowledge of a name that is the issue. There is very little satisfaction in knowing you recall a friend's name, but perhaps considerable embarrassment if you don't.

The hierarchies are set out in a standard format with groupings along the X-axis and the categories listed above each group like a histogram. The groups are ordered left to right with diminishing items, so typically "Marriage Partner" is at the extreme left and "Others" at the extreme right. (See Figure 3).
Further examples of hierarchies (see Appendix Pages 57-59) illustrate both the inherent uniformity and the inherent diversity in each individual hierarchy. Overall this process of hierarchy construction takes four to six sessions.

4. Utilisation of the Hierarchy

Putting the now developed hierarchy into effect presents the biggest challenge of all. The applicability of each person's hierarchy soon becomes apparent as it is put to work. Certain principles are elaborated at this point to the group members.

(1) Attention: To evaluate the relative importance of information, attention to the relevant input must be maintained. This requires a choice at the outset to attend to one input totally and not at all the other input (in its simplest form). It is better to store a little information properly than a lot of information partially. This manoeuvre must be seen as a rational decision not a measure of impairment.

However the appropriateness of one's decision must be evaluated critically in terms of the long term benefits and costs. If this evaluation indicates that there was a sacrifice
of important information for which the alternative information gains did not compensate, then new decision criteria for the distribution of attention have to be formulated. In simple terms, if the decision was made to listen to the joke one of the workmates was relating, rather than listen to the foreman's instruction and the outcome was marked criticism from the foreman because a job was not done, then the future decision criteria might have to be altered to: Listen to the foreman first of all. This requires a recognition of the choice factor here so that when queried the explanation must be "I wasn't listening" rather than "I don't remember."

2. Comprehension: There is no point in trying to remember something that is not understood. Even if storage in memory is achieved this does not signify a gain. Whilst attending to the storage of this information other important data may have been overlooked. Also the effort required to store an item that is not understood is significantly greater, and considering the fact that one cannot benefit from information that is not understood the effort is wasted. Perhaps the only thing that needs to be remembered is that an instruction was given that was not understood.

3. Information: Only new data needs to be stored. Just because something is important does not mean you should automatically set about processing it into long term storage. You may already know it! Examine the question "Is it information?" right after the question "Is it important?" By definition, information incorporates the principle of novelty. The examination of whether the input constitutes information is another means of saving wasted effort and because of the hierarchical setup, can be accomplished very quickly. Thus it can leave the individual free to attend to data he might otherwise have missed.

4. Time: In essence all memory impairment can be viewed as a problem of time constraints. In everyday life there are examples of how we remember "too late." Hence utilisation of the hierarchy must be constantly in the reality of time constraints and most decision criteria must be based on this
parameter. ("I could remember that but I don't have the
time.") There is not enough time to remember everything we
want to remember but we must ensure that there is enough time
to remember everything we need to remember. The consistent
recognition of time constraints enhances the reaction time
to input - ("I don't have time to remember that = forget")
and ensures that there is appropriate time to deal with
important data. The fact that the hierarchy tends to list
the minimum means that there is an increased chance of
remembering all those items.
5. Multiple Coding: Given that enough time has been allowed
to store an important (new) item which is comprehensible, how
can permanent storage be best achieved? The use of multiple
means of coding for storage does lower the error rate. Consider
the data in Table 1.

<table>
<thead>
<tr>
<th></th>
<th>Normal</th>
<th></th>
<th>Head Injured</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Recall</td>
<td>Probability</td>
<td>Recall</td>
<td>Probability</td>
</tr>
<tr>
<td>Item One</td>
<td>0.82</td>
<td>0.82</td>
<td>0.60</td>
<td>0.60</td>
</tr>
<tr>
<td>Item Two</td>
<td>0.77</td>
<td>0.96</td>
<td>0.50</td>
<td>0.80</td>
</tr>
<tr>
<td>Item Three</td>
<td>0.74</td>
<td>0.99</td>
<td>0.40</td>
<td>0.88</td>
</tr>
<tr>
<td>Item Four</td>
<td>0.60</td>
<td>0.99</td>
<td>0.20</td>
<td>0.90</td>
</tr>
</tbody>
</table>

In the section headed "Normals" the first column gives
data based on the probability of recall in a serial position
curve (Atkinson & Shiffrin 1971). This provides a workable
picture of the probability of recall for the first four
successive items in a lengthy series. The second column gives
an alternative measure. Instead of attempting to recall a
number of items, only the first item is attended to and the memory
capacity that otherwise would be utilised on separate items is now used to enhance the recall of the first item. This yields a cumulative probability as memory capacity is devoted more and more to that one item. After devoting three items capacity the probability of recall is 0.99.

Considering the Head-Injured Group, these are entirely fictitious figures that hopefully reflect what we would implicitly expect of this group. There are lower probabilities of recall and an accelerated drop-off in probability of recall for later items. Hence Probability of recall of the first item is set at 0.60 (c.f. 0.82 for normals). However in examination of the Cumulative Probability Column, here the use of the memory capacity of four items to enhance the recall of the first item has produced a probability of recall of 0.9. This is better than the normal probability of recall for the first item in the normals. Whilst these figures can only be used as models, they support the value of multiple coding of one item in returning individual item performance to normal levels, although capacity is diminished of course.

Using this example the value of making multiple associations/comparisons/link-ups can be illustrated and the reality of return to normal memory function within a circumscribed area can be demonstrated. Of course the selection criteria for the item to be remembered become quite crucial now, hence the time spent in hierarchy development.

6. **Deep Coding**

Emphasis is also placed on appropriate associations, effective linking, especially via the use of semantic rather than physical or acoustic aspects of the items. The more meaningful and to some extent conceptual the association the more likely is its retention. Some forms of comparison will be used preferentially by certain individuals. This is quite acceptable. The important thing is to use deeper levels of processing as much as possible, given all the other constraints.

Other aids to coding can be discussed here including imagery, but mnemonic techniques such as the place loci method (Bower 1970, Norman 1976, Posner 1973) and other specific techniques are inappropriate in this context because the emphasis is on a comprehensive memory system—not specific
techniques to be used as an adjunct to normal memory function. Besides, the learning of those specialised techniques may represent an insurmountable task to the head injured patient. However those techniques and other techniques as outlined in Norman (1976) may represent a useful adjunct to the generalised memory retraining process in specialised cases.

7. Reliance

The head injured patient must be encouraged to rely on his memory program in every day usage, otherwise it will quickly fall into disrepair and disuse and consequently will be of little advantage. Probably the biggest task facing the patient is the large amount of practice required before the program is largely autonomous. As with any other skill, practice is the key, and certainly complete familiarity with the hierarchy and utilisation of the program will provide the most favourable situation for memory improvement. With sufficient level of practice the program may then function without much conscious direction and hence it will occupy very little of the individual's attention, leaving him free to tackle the actual task of memorisation in a more confident and self assured frame of mind. As his confidence in the system develops he will be further optimising his chances of recall.

Once these principles have been elaborated then the group members can initiate practice with their own hierarchy in the group setting. To facilitate practice, tapes of conversations can be used and played for short intervals with each group member listening to the tape utilising their hierarchy. Different situational demands can be incorporated into this practice by defining the person talking on the tape as in a particular category (according to the group members' categories). For example, sometimes the person talking on the tape can be viewed as an "Other" or perhaps sometimes as a "Friend" or an "Acquaintance," and so on. Given these different categories the group members can then adjust the requirements for memorisation and practise the use of the hierarchy in a flexible way. This practice forms the conclusion of the first stage of the program and when the individuals are largely familiar with their hierarchy and comfortable with its use, then the stage is largely complete.
STAGE 2: FOLLOW UP AND REAPPRAISAL

Some follow up is obviously essential with the program and this can occur at a set time, say two to three months after completion of Stage 1, or at an earlier time if problems arise for a particular individual. At these follow up sessions the individual or the group members provide some feedback on the use of the program and any difficulties that have arisen. If one member says that the program is just not working at all then other group members can give examples of how their program is working, and perhaps provide some insight to the group member why his program is not functioning at present. Sometimes the program can actually be working but the individual is unaware of it because it has become largely automatic in function. So if a comparative evaluation of his previous memory performance and current memory performance is carried out and indicates some improvement, then this may provide some evidence that the program is functioning.

If some group members have specific problems in a confined area of their program then these can be dealt with in a group format as well. Certain principles may have to be re-iterated at this point, and perhaps some changes to the original hierarchy are required in some cases. The emphasis is on flexibility. The program is for personal use and it is quite appropriate to change it given a sound basis for the change. Because it is always possible to modify the program, the individual cannot argue that there is nothing more that can be done about his memory difficulties.

Depending on the composition of the group, further follow up may be necessary or advisable. This can be usually left to the group members themselves - if they feel that further follow up is necessary it can be arranged, and the option of further assistance can be given, to be taken up at any point in the future.
Section Six

CLINICAL USE OF THE PROGRAM

This program has been used in a clinical setting on an individual basis for a period of two years. However concurrent with its usage was a gradual refinement of the program and a continued examination of its suitability and any problems associated with its use. However use on an individual basis, whilst an advantage in the formative stages of the development of the whole program, became rather a burden and somewhat unwieldy with continued use over a long period of time.

Comments from patients who were involved in the memory retraining program tended to be quite constructive and supportive of the use of the program but it is often difficult to distinguish whether improvement is a result of a program or part of the natural recovery process anyway. Sometimes the program was initiated but as time went on it became apparent that the individual was really not all that interested in devoting a great deal of effort to the improvement of his memory function and when confronted with this the individuals usually agreed that they felt the effort was not worth it.

This is an important factor since lack of motivation may seriously cloud the actual benefits of the program because of apparent lack of improvement in a number of individuals. After all many individuals have adjusted to their memory impairment and when faced with the choice of devoting a good deal of effort to changing it or accepting the status quo, they opt for the latter alternative. The program is designed to help those with professed memory impairment, but a further rider should be added to this phrase - the individuals must be seeking an improvement in their memory function, mindful of the costs involved. Like those with normally functioning memories the prospect of improved memory function is a pleasant one. However the time and effort involved in achieving the improvement may make the proposition quite unattractive. This can be easily seen in the case of the normal individual who has potentially available a wide variety of specialised memory techniques but their use tends to be the exception rather than the rule. So the program like most other rehabilitation programs must be based on a desire by the individual with the impairment to improve his situation.
Feedback on the value of the program when using an individual format included the following comments:

1. "It was good to find out that everyone forgets. That was an important understanding. I wasn't the only one with the problem."

2. "It was good to understand the relationship between remembering and forgetting. I hadn't looked at it that way before."

3. "Even if you don't use the program it does work. You learn it and you find it automatically happens."

4. "It was good using the tapes. You see the value of the program straight away."

5. "Yes, my memory is better - I utilise it better."

Section Seven

USE OF THE PROGRAM IN A GROUP FORMAT WITH EPILEPTIC PATIENTS

The fact that there is a natural recovery of function in head injured patients makes it difficult to evaluate the program's effectiveness. In an attempt to provide a more controlled appraisal of the program a small group of non-head injured patients was selected. The patients were all temporal lobe epileptics with onset of the epilepsy in the late teens or early twenties. To some extent they matched up with the head injury group who were largely young men, but of course they really cannot be considered an equivalent group.

The epileptic group members all had complaints of memory impairment over a considerable period of time and hence expressed interest in joining a memory retraining group. The group was run along the lines of the format as outlined and three months after the program the group members got together to give feedback on their progress and comments on the program. The three group members' programs are illustrated in Figures 4, 5 and 6).
Fig. 4. HIERARCHY OF PATIENT G.S.
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<td>Tasks and Messages (either given by someone or given to someone.) Interests: work</td>
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</tbody>
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Fig. 5. HIERARCHY OF PATIENT J.T.
Fig. 6. HIERARCHY OF PATIENT B.M.
Of the three group members, all stated that their memory had improved since the inception of the program, although one group member attributed this improvement to other situational aspects rather than the use of the program itself. The other two group members explained situations where they had coped much better with the demands on their memory along the lines outlined in the program. In many instances their comments referred to a choice of not remembering something, and this seemed to be the most useful principle they had grasped, namely that in choosing not to attempt to memorise something they were freed from the discomfort of forgetting involuntarily.

Of these latter two group members, one member had been rather reluctant to formulate any sort of hierarchy in the actual group sessions, constantly complaining that the program did not fulfil his needs. However, towards the end of the group sessions he did devise a more simple program than the other members and in fact was quite pleased with this. (Fig 6.) At the reappraisal three months later he was quite positive about the improvement due to the utilisation of this program and clearly showed a mastery of the principles involved. This suggests that even if the program is utilised in a very simplistic way with quite a spartan hierarchy the results can be rewarding. Most of the hierarchies tend to be fairly comprehensive and perhaps simplicity may be considered to be a further important feature of development of the memory program.

A further important feedback from the individuals involved in this group program was the importance of practice. They appreciated most of all the use of tapes and the chance to try out the program and get immediate feedback on where they were doing things wrong or right. This contradicts the impression that there is a lack of motivation on the part of people trying to recover memory function. Rather it suggests that there is a big gap for these individuals between the development of a suitable program and the effective use of it, and if the actual use of the program can be dwelt upon at great length then significant achievements can be attained.
The partial success of this program with these individuals with temporal lobe epilepsy augers well for the use of the program with head injured patients. The head injured patients tend to have a lot more going for them in that there is a natural improvement and often they are not taking any form of medication which may disrupt memory function, which is not necessarily the case for the epileptic. At any rate there was no obvious expectation of improvement with the temporal lobe epileptic patients, yet the individuals reported definite gains. This highlights the earlier comment that an organic basis for memory impairment does not preclude the use of a remediation program.

Section Eight

DISCUSSION

This memory program does seem to make some impact on memory impairment in head injured patients. One important feature of the program is the emphasis on informing the patient about his own deficit, and highlighting what is known about memory impairment, and consequently what can be done. The informed patient must be at an advantage over the uninformed patient, and perhaps the memory program can accelerate recovery simply by showing the person who has suffered a head injury what he has to adjust to.

One of the difficulties of using this program is that results must be largely gleaned from the patient's own observations rather than any sort of test measures. The program does not aim to improve performance on clinical tests of memory. Although some improvement may occur, the lack of improvement would not argue against the utility of the program. However this lack of validation does not seem so crucial an issue when there are even greater problems facing the use of clinical memory tests anyway. The most commonly used test of memory function in a clinical setting is the Wechsler Memory Scale. This test has come under criticism for a variety of reasons. It is shown to be a rather poor test of brain
damage (Prigatano 1977). This is not surprising since the term "brain damage" is such a catch bag of various problems, and of course the Wechsler Memory Scale was not designed for this sort of test anyway. The scale has also been criticised because of its norming on rather small samples and subtest selection as well (Ivison 1977). So even if the program did show some improvement on the Wechsler Memory Scale for these patients, criticism might still be well justified that this may not represent what it is purported to represent. Until there are quite well established tests which distinguish the various sorts of memory impairment in different sorts of conditions and can validly measure the changes in memory function over time for those conditions where memory changes are well known, then the use of a clinical test to validate the program will remain suspect. In the situation of memory impairment the clinician can only confirm the individual's complaints, he cannot really disconfirm them.

The memory program as outlined does still present some problems to effective usage. Firstly it requires the clinician delivering the program to be thoroughly familiar with a multiplicity of aspects of memory function and be able to lucidly explain distinctions and important principles and this can be quite difficult without an underpinning of a good deal of background knowledge. Hence to use the program what must go with it is a good deal of background reference data which can be drawn upon by a clinician who wants to use the program to fill in the gaps in his own knowledge of the various aspects of memory function.

Secondly the delivery of the program involves a good deal of learning on the part of the clinician as well and hence the time involved before actually being able to deliver the program is considerable.

Thirdly, the program does involve a reasonable amount of the clinician's time in his actual delivery, although this is probably well within any realistic cost benefit analysis, especially if the program is delivered in a group format. Other clinical groups such as occupational therapists, can be closely involved in the delivery of the program, hence lightening the burden somewhat.
Probably the most viable form of delivery of the program would be via the use of videotape facilities. The use of videotape to record details of delivery of the program would lessen the demands on all clinicians and make it only really essential that one person understand the material to a great extent. If the program can be put into a video format then, the workload on the clinician will be largely reduced and his role then would be as an adviser to the individuals involved in the program, when some points of contention or lack of clarity occurs. This would mean that only the actual delivery time of the program would be the cost involved, in terms of the clinician's time. Furthermore, the use of videotape facilities would enable the recording of a large variety of situational scenes to provide the multitude of practice that is obviously required to become familiar with the program and its appropriate usage. The use of this format of presentation would enable due consideration to be given to the concentration abilities of the patients and their span of attention, and it would also enable material to be repeated a number of times, simply by replaying the same tape.

As a further development of this general memory retraining program consideration can also be given to the development of specific programs aimed at helping people with allied modality specific memory difficulties. For example, people with verbal learning difficulties can be coached to use various techniques such as imagery in a very specific way to help them cope with their particular impairment. Conversely, individuals who have difficulty remembering faces and visual information can be trained to attend to non-visual aspects of stimuli, and the development of these specific memory retraining sub-programs can be seen as a further adjunct to the recovery of the head injured patient.

Some of the criticisms that could be raised against utilisation of the memory retraining program include the question of whether it is the actual program that is helping the patient, or merely the clinical contact, or perhaps the group experience. Certainly the therapeutic contributions of clinical contact plus the feeling of "I'm not alone" engendered by the group
experience could well contribute to the positive outcome of the program. However it is very unlikely that these explain improvement entirely, since these are quite commonly used methods of therapeutic intervention yet they have never been held up as a method of improving memory, and surely if these aspects were responsible for the improvement they would have been noticed some time ago. Rather it is the lack of any consistent remediation program for memory difficulties that suggests that these aspects themselves whilst constructive, really make little impact on the memory problem.

Another criticism might be that the program is a little insubstantial in that it does not define exactly what items should be included in what particular category, and what category should be included for what class of people and so on. This lack of definition is a very real factor, but it may not warrant the criticism. Perhaps the converse is true. Perhaps in looking for a simple, comprehensive widely applicable memory remediation program we have searched for a common denominator which was rather insubstantial in itself. Being insubstantial would explain why it has not been found. One of the advantages of this program is that it is for the individual rather than the group. Its aim is to help the individual develop some new program for memory function that is better than what he currently has. This takes into account the reality of the variation in memory function in the populace, and the wide variety of differing needs and abilities. In a sense the program is aimed at lessening the gap between what the individual desires for himself according to his own criteria and what he is achieving, and since these criteria will vary from individual to individual, the elucidation of a common factor may actually be erroneous, like the reasoning that because many people die in hospital, hospitals are dangerous. The description of a common factor does not necessarily mean that we have latched on to a cause or even a suitable parameter for explanation.
CONCLUSION

This memory retraining program aims at informing the head-injured patient about his current intellectual status and subsequently what can be done about specific problems in the area of memory. It aims at removing confusion, lessening misunderstanding, and providing some hope for the patient. Involvement in the program on the patient's part is quite active and is a learning situation. At the same time it directly confronts many of the psychological maladjustments that can occur in association with memory impairment.

The program is aimed at providing individual help although it does draw on a group format. The program itself and method of delivery and rationale are clearly set down, and are far removed from the generalised rules of thumb that are often given to supposedly assist individuals with impairment. Special emphasis is placed on putting what is learnt into action rather than just learning and understanding it.

Clinical use of the program has shown some promising results. Nevertheless more widespread use of the program will provide the most critical test of its usefulness. One major development that is necessary is provision of the program in a more suitable format, such as videotape. This will not only make the program viable from a cost benefit point of view, but should also enhance the effectiveness of the program in a number of ways.

The exact nature of memory impairment exhibited in head-injured patients is still a moot point. Nevertheless this program is formulated to tackle the memory impairment in the light of proposed explanations of the nature of memory impairment in the head injured patient. Perhaps further modifications will be necessary as better understanding of the nature of the memory impairment is gained. However, the use of a program such as this may in itself provide a good deal of insight into what constitutes the memory impairment in the head injured patient.
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