MEMORY TESTS FOR USE WITH BRAIN DAMAGED ADULTS IN A MULTIRACIAL GENERAL HOSPITAL : A PRELIMINARY VALIDATION STUDY

by

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ABSTRACT

A battery of three verbal and three visual tests was developed to meet a need for a test of memory functions for use with patients from different racial, cultural, and socioeconomic backgrounds. The test performance of 35 patients with diagnoses implying disorders of the limbic system was compared with that of 35 normal controls matched for race, age, intelligence and sex. Discriminant analysis of the verbal and visual test scores achieved 100% correct classification of the 27 patients with bilateral damage, but 3% of the normal controls were misclassified. There was a clear trend for the performance of the 3 patients with left temporal lobe damage to be impaired on the verbal tests, and the performance of the 5 patients with right temporal lobe damage to be impaired on the visual tests. Race, which tends to be correlated with socioeconomic and education levels, had no significant effect on the test scores of the 34 White, 28 Coloured, and 8 African subjects. Test scores were not significantly effected by age, intelligence or sex. Further studies to achieve cross-validation are indicated.

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SUMMARY

INTRODUCTION

This study arose out of the need for tests which could be used to detect memory defects in patients from a wide range of educational and cultural backgrounds. Groote Schuur Hospital (GSH) serves a multiracial population, and most of the patients, particularly in the Coloured and African groups, are from the lower socioeconomic levels and have limited education. There are no psychological tests available which cover a wide range of memory functions and which have been shown to be valid in detecting organic impairment. Those tests available which tap a limited aspect of memory, eg. the Modified Word Learning Test (Walton and Black, 1959) and the Memory for Designs (Graham and Kendall, 1960) are not suitable for use with the local population.

Requests for the assessment of memory functions constitute a large proportion of the referrals to clinical psychologists. Memory comprises at least three operations: registration, retention and recall or recognition. Disturbances in some of these processes occur in many different clinical conditions. They may be part of a more generalized disturbance of cerebral functioning as in dementia or aging, or may be related to psychiatric conditions such as depression, or may occur in isolation and be indicative of localized brain pathology.

It was decided to develop a test covering a wide range of memory functions and to validate this test on patients with the amnesic syndrome. This syndrome is characterized by a disturbance of memory out of proportion to all other disorders, occurring where there is intact perception, no clouding of consciousness, and adequate intellectual functioning. It is characterized by defective learning and retention of ongoing events and a retrograde amnesia (RA) for a limited period preceding the onset of the syndrome. Depending on the severity of the syndrome and the stage at which it is observed, these patients may also show confabulation and be disoriented in time and place.

The syndrome was first described by Korsakoff in 1887 in association with chronic alcoholism. However, it has since been described in relation to third ventricle tumours, Herpes simplex encephalitis, tuberculous meningitis, posterior cerebral artery occlusion, anoxia, ECT, severe head injury and where there is

bilateral calcification or surgical ablation of the hippocampi. The dense amnesias which followed bilateral resection of the hippocampus for the relief of epileptic seizures (Scoville and Milner, 1957), drew attention to the role of the limbic system in laying down new memories. It is not known whether this system, which is also associated with emotional aspects of behaviour and is linked to the reticular activating system and the cortex, acts as a specific "holding" mechanism, temporarily storing memories in the course of consolidation, or whether its action is nonspecific, ie. creating favourable conditions for coding or for storage and recall (Brion, 1969). Models correlating psychological processes with neurophysiological changes are in a very speculative stage.

Material-specific memory defects have also been reported. The learning and retention of verbal material has been shown to be impaired by left temporal lobe lesions, while the recognition and recall of nonverbal visual and auditory patterns has been shown to be impaired by right temporal lobe lesions (Milner, 1971).

There is no agreement among observers as to which memory processes are impaired in amnesics. In order to determine which processes should be emphasized in testing for defective memory, a review of the experimental literature was undertaken. Experimental findings have been both distorted and clarified by theoretical viewpoints of different interpreters. Talland (1965), concluded from his study of Korsakoff alcoholics that there were defects of both registration and recall and that the underlying problem was one of poor activation and premature closure of search cycles. Milner (1970), as a result of her studies on the patient, H.M., postulated that the defect was one of consolidation and of transferring material from the short-term to the long-term store. A group of workers in Britain have claimed that short-term memory (STM) is normal in amnesics and that the defect is in long term-memory only (LTM), and is related to a failure to inhibit or dissipate material in storage, thus making retrieval difficult (Warrington and Weiskrantz, 1968b, 1970). A group of workers in Boston have published findings showing STM to be impaired in amnesics and have postulated that the basic defect is one of inadequate encoding which leads to inaccessibility of data at the time of retrieval (Cermak, Butters and Goodglass, 1971; Cermak, Butters and Gerrein, 1973).

The experimental literature appears to support the following conclusions about memory processes which are impaired in amnesics:

1. There is abnormal sensitivity to interference from preceding and interpolated experiences. This is accentuated by massed practice or continuous presentation conditions and by the similarity of the intervening material to that which is to be learned. (Cermak and Butters, 1972; Winocur and Weiskrantz, 1976).
2. Learning and retention may be facilitated to near normal levels when the rules governing learning restrain interference, but are otherwise impaired (Warrington and Weiskrantz, 1968a, 1970; Winocur and Weiskrantz, 1976).
3. Encoding is impaired and there is a tendency to use the rapidly decaying acoustic coding rather than the more durable semantic encoding (Cermak et al, 1973; Brooks and Baddeley, 1976). Use of visual image strategies is also impaired (Baddeley and Warrington, 1973).
4. The information processing rate is slower than in normals and multisensory inputs enhance this defect (Talland, 1965; Oscar-Berman, 1973; and Glosser, Butters and Samuels, 1976).
5. Nonverbal material is poorly retained over even short intervals (Milner, 1970; de Luca, Cermak and Butters, 1975).
6. Perceptual-motor skills may be acquired and retained, but often not at normal levels (Milner, 1970; Brooks and Baddeley, 1976).
7. Consolidation in storage may be impaired (Fuld, 1976). This may be related to poor categorization or to a failure of inhibition.
8. Retrieval from storage is impaired (Warrington and Weiskrantz, 1968b, 1970; Fuld, 1976).

Memory tests should utilize techniques which maximize the manifestation of these defective memory processes. This would include using the rapid presentation of materials which are in excess of immediate memory span, which are not easily discriminable, and which call for verbal encoding strategies. Distraction tasks in the same modality as the learning task should be introduced. In retrieval, judgment by context should be required, facilitatory cues minimized, and interference from a range of possible alternatives fostered (eg. as in multichoice recognition). Errors from such interference should be penalized. Delayed as well as immediate recall and recognition should be assessed.

There are few tests available which assess different aspects of memory and which have been shown to be valid in detecting organic memory impairment. The Wechsler Memory Scale (Wechsler, 1945) is in wide clinical use, but assesses only limited aspects of memory. Data on its efficacy in detecting organic impairment are mostly negative or controversial (Cohen, 1950; Howard, 1950; Parker, 1957; Kljajic, 1975), although it has a better record with severe amnesics (Victor, Talland and Adams, 1959; Drachman and Arbit, 1966). The Guild Memory Test (Gilbert, Levee, and Catalona, 1968) is an adaptation of the Wechsler Memory Scale and includes measures of delayed recall. However, it is still in the standardization stage. Like the WMS, it has no theoretical basis as a test for impaired memory functions.

The Williams Scale for the Measurement of Memory (1968) measures different aspects of an individual's memory, eg. immediate recall, nonverbal learning, verbal learning, and delayed recall; but only the delayed recall subtest has been found to differentiate organics from nonorganics (White, Merrick and Harbison, 1968). Barbizet and Cany (1968, 1969) have developed a battery of memory tests which assess a wide range of verbal and visual memory functions and which include measures of immediate recall, learning and retention. They have published the mean scores obtained by patients with right and left hemisphere lesions, alcoholics, and dementias, but adequate normative data are lacking.

Cronholm, Ottosson and Molander have developed three tests which use words, pictures of common objects, and drawings of people combined with fictitious data about them, to obtain measures of immediate registration and of retention. Evidence of validity and reliability has been provided through studies on patients receiving ECT. Cultural loading makes this test unsuitable for local use.

Selection of tests for the present battery

Criteria imposed for the selection of tests included that the test or the principle on which it was based should have been empirically shown to detect memory impairment; that it should be possible to hypothesize which aspects of impaired memory the test was assessing (construct validity); that the tests should be either verbal or visual so as to allow for differences in left versus right hemisphere impairment (Milner, 1971); and that the tests should

be relatively "culture-free" and interesting to do. On the basis of these criteria, three verbal and three visual tests were devised.

A. Verbal Tests

1. Lion Story: (Adapted from Barbizet and Cany, 1969). Immediate and delayed recall of stories has been shown to be impaired in amnesics (Talland, 1965; Drachman and Arbit, 1966), and in individuals with left temporal lobe lesions (Milner, 1958). It is postulated that amnesics will not be able to integrate the material on immediate recall, and that they will show more confabulation and greater forgetting over a delay interval than with controls.

2. Shopping List: Multitrial learning of lists of words has consistently been shown to be impaired in amnesics (Fuld, 1976), particularly when distraction is introduced (Cermak et al, 1971) or when delayed recall is required (Talland, 1965). It is impaired in patients with left hemisphere lesions (Barbizet and Cany ,1969; Milner, 1971). This test incorporates several principles which should elicit memory defects. It is postulated that amnesics will show less learning over trials; defective clustering of items by category; more confabulation, and greater forgetting over a delay.

3. Digit Span and Supraspan Digits: Digit span is not impaired in amnesics (Zangwill, 1943; Talland, 1965) but multitrial learning of supraspán material is (Drachman and Arbit, 1966). Performance on the task is impaired in patients with left hemisphere lesions (Barbizet and Cany, 1969; Milner, 1971). Amnesics should be sensitive to interference from the similarity of the material and it postulated that there will be perseveration of learning from list a to list b.

B. The Visual Tests

1. Continuous Recognition of Recurring Figures: (Adapted from Kimura, 1963). Impaired recognition of shapes and a high incidence of false positive recognitions has been found in amnesics (Milner, 1970; de Luca et al, 1975). Kimura (1963) has shown performance on this test to be impaired by right temporal lobe lesions. It is postulated that amnesics will have slower increase in correct recognitions and a slower decrease in false positives over trials and that they will be impaired on both geometric and nonsense figures.

2. Faces: Amnesics have been found to be deficient in their recognition of faces (Warrington, 1974) and Milner has found this to be a specific deficit in right temporal lobe lesions (1968). It is postulated that the multichoice recognition technique will result in more false positives for the amnesic patients.

3. Spatial Span and Supraspan Block Tapping: Some authors have reported normal nonverbal span in amnesics (Drachman and Arbit, 1966), others have reported impairment (de Luca et al, 1975). Multitrial learning of supraspan sequences has been found to be impaired in amnesics (Drachman and Arbit, 1966). Cumulative learning of block sequences has been reported to be impaired in patients with right temporal lesions (Corsi, Milner, 1971). Amnesics should be sensitive to interference from the similarity of the material and it is postulated that there will be perseveration of learning from list a to list b.

Aims and Hypotheses

The aim of the study is to develop a battery of verbal and visual tests which will detect memory impairment in people from different cultural backgrounds.

I Criterion Validity: Hypotheses under this heading predict that the scores obtained on the verbal and the visual memory tests will be significantly lower in the patients with bilateral temporal lobe damage than in the controls. Subsidiary hypotheses predict that performance on the verbal tests will be impaired in patients with left temporal lobe damage, while performance on the visual tests will be impaired in patients with right temporal lobe damage.

It is postulated that test scores will not be significantly affected by age, intelligence, sex or race.

II Construct Validity: These hypotheses are concerned with the aspects of memory measured by the tests, and the extent certain theories of memory impairment can account for performance on the tests. The rationale of these hypotheses was mentioned above.

1. Lion Story: The patients will be unable to integrate the two halves of the story; will show more "forgetting" (immediate-Delayed Recall), and have more confabulations than the controls.

2. The Shopping List: The patients will have a slower increase in their rate of learning over trials than will the controls; will be less able to cluster items by category; will have more confabulations, and will show more "forgetting" (List 5 - Delayed Recall).

3. Digit Span and Supraspan Digits: Digit span will not be significantly different in patients and controls. More patients than controls will show perseveration of supraspan list a in their learning of list b than will controls.

4. Continuous Recognition of Recurring Figures: The patients will have a slower increase in correct recognitions and a slower decrease in false recognitions over trials, for both nonsense and geometric figures than will controls.

5. Faces: Patients' strategies will be less efficient than those of controls and they will recognise more false positives.

6. Spatial Span and Supraspan Block-Tapping: Spatial span will not be significantly different in patients and controls. More patients than controls will show perseveration of supraspan sequence a in their learning of sequence b.

III Reliability: Split-half reliability coefficients will be calculated for the Story, Supraspan Digits, the Faces, and Supraspan Blocks. Interscorer reliability on the story will be calculated.

METHODOLOGY

The research sample consisted of 70 subjects: 34 Whites, 28 Coloureds, and 8 Africans. It comprised 35 patients with diagnoses implying disorders of the limbic system who were individually matched for age, race, sex and intelligence with 35 control subjects who had no such cerebral pathology. The brain damaged group was subdivided into 27 patients with bilateral limbic lobe damage, 3 with left temporal lobe damage and 5 with right temporal lobe damage.

The sample was shown to be representative of the population for whom the test is intended with regard to racial representation, socioeconomic levels, educational levels, and age range.

Subjects were matched for I.Q.s on the Standard Progressive Matrices (Raven, 1960). The Experimental Memory Battery (EMB) was administered to all subjects by the same examiner in a separate testing session in a non-sound-proof office. The mean time for administration was about an hour and 15 minutes.

EMB Tests:

A. Verbal Tests:

1. Lion Story: This was read to the subject. Immediate recall and delayed recall at the end of test battery were recorded.

2. The Shopping List: was presented a total of 5 times. A 30 second counting task intervened between each presentation and attempted recall. Delayed recall at the end of the battery was recorded.

3. Digit Span and Supraspan Digits: Basic digit span was established by presentation of three lists of digits at each length until the subject failed all three. Two supraspan lists of 10 digits were presented until a criterion of two perfect recalls had been reached, or a total of 10 trials on each had been given.

B. Visual Tests:

1. Continuous Recognition of Recurring Figures: (After Kimura, 1963. Designs from Dr. Brooks, Glasgow). The subject is shown a pack of cards, 8 of which recur randomly on each of the next seven trials, intermingled with 12 new cards on each trial. For each of these 140 cards the subject is required to say "old" if he has seen it already, or "new" if he has not seen it.

2. Faces: The 12 photographs of Set I are shown to the subject who is then required to pick them out from amongst the 25 photographs of Set II, after the Spatial span and block tapping task.

3. Spatial Span and Supraspan Block Tapping: Basic spatial span was established by tapping out three sequences at each length until the subject failed all three. Two supraspan sequences of 8 block-taps were presented until a criterion of two perfect reproductions had been reached, or until a total of 10 trials on each had been given.

RESULTS

The research hypotheses were largely confirmed. The scores obtained on the verbal tests by the patients with bilateral damage were significantly lower than those obtained by their controls (Hotellings $T^2 = 313,23$; $F = 42,17$; $df = 6, 21$; $p < 0,001$), as were their scores on the visual tests (Hotellings $T^2 = 192,15$; $F = 32,52$; $df = 5\ 21$; $p < 0,001$). There was a clear trend for patients with left temporal damage to perform poorly on the verbal tests and for patients with right temporal damage to perform poorly on the visual tests. Discriminant analysis achieved 100% correct classification of patients and controls as "brain damaged" or "normal" on the verbal tests, and misclassified only one control on the visual tests.

Discriminant scores on the verbal and the visual memory tests were not significantly

affected by age, I.Q., sex or race. Most of the hypotheses related to construct validity were confirmed.

1. Lion Story: As predicted, the patients were unable to integrate the two halves of the story; showed greater relative forgetting of what they had learned, and more of them introduced confabulations, particularly on the delayed recall.

2. Shopping List: The patients had a significantly slower increase in their rate of learning over trials; were less able to cluster items by category; were more prone to confabulate items; and showed greater relative forgetting of their learning on the Trial 5 list.

3. Digit Span and Supraspan Digits: Digit span was not significantly different for patients and controls. More patients than controls showed perseveration of their own version of list a in learning list b.

4. Continuous Recognition of Recurring Figures: Contrary to what was predicted patients did not show a slower rate of increase of recognitions nor a slower decrease in false positive recognitions over the trials. Their performance was inferior to that of the controls on both the geometric and nonsense designs.

5. Faces: The procedure of insisting upon a choice of 12 faces made it difficult to determine whether the poor performance of the patients was due to a failure of correct recognitions or an excess of false positive recognitions. Both types of error seemed to be operative.

6. Spatial Span and Supraspan Block Tapping: In contrast to what was predicted, the patients were slightly but significantly inferior to the controls on the spatial span. More patients than controls showed perseveration of their own version of sequence a in learning sequence b.

Reliability: Adequate split-half reliability coefficients were obtained for the story, and the two supraspan tests. The Faces had a negative reliability coefficient, but this was thought to be related to the small range of scores possible.

DISCUSSION AND CONCLUSION

The validity of the Experimental Memory Battery as a test of memory impairment receives confirmation from its success in differentiating individuals with

diagnoses implying limbic lobe disorders from those without such disorders. These individuals came from the White, Coloured and African racial groups which tend to vary widely in regard to cultural, educational and socioeconomic factors. Race was not found to exert any significant influence on the test results, however; but it should be noted that the sample of Africans was too small to permit generalizations about the usefulness of the test with this racial group to be made with any confidence. The variables of age, sex and intelligence were also not found to have any significant affect on test results.

The verbal and visual memory tests seem to have the potential to differentiate individuals with left or right temporal lobe lesions, but further investigation (bearing in mind the limitations of this approach) is needed to substantiate this.

Hypotheses on the construct validity of the various tests in the battery were generally confirmed. Patient performance on the Shopping List and the Continuous Recognition provided support for theories postulating a failure of encoding in amnesics (Cermak et al, 1973). Patients generally showed a tendency to use and perseverate inappropriate strategies for problem solving (as postulated by Talland, 1965). This was particularly evident on the Supraspan Digits and Blocks. There was some evidence for poor integration and consolidation of material, as postulated by Talland (1965) and Milner (1970) on the delayed recall of the Lion Story. Support for the theory that amnesics are abnormally sensitive to interference from previous learning or experience (Cermak and Butters, 1972), particularly where material is poorly discriminable and judgment by context is required (Huppert and Piercy, 1976), was provided by the patients' performance on Continuous Recognition and Faces; and by their confabulations on the Lion Story and Shopping List. Interference from perseveration of previous learning was particularly evident on the Supraspan tests. Limitations in retrieval strategies were evident on the Lion Story, and on the Shopping List and Faces, where patients tended to "give up" prematurely. It cannot be determined whether this impairment is attributable to inadequate coding at input, or premature closure of search cycles.

Indications for future research with the EMB include investigating its usefulness with individuals in whom brain damage is not limited to the limbic system, and with psychiatric patients. It is necessary to develop an alternate form

to establish the reliability of the battery, and it may be desirable to attempt to shorten it at the same time. The most immediate need, however, is to standardize the EMB on a larger sample of Africans and to have it cross-validated by workers in other settings.

CHAPTER 1

INTRODUCTION

This study arose out of the need for tests which could be used to detect memory defects in patients from a wide range of educational and cultural backgrounds. Requests for the assessment of memory functions constitute a large proportion of referrals to clinical psychologists. Memory comprises at least three operations: registration, retention, and recall or recognition. Different aspects of memory may be disturbed in different clinical conditions and an accurate assessment of where the defect lies and whether impairment is objective or subjective is important in diagnosis.

Disturbances of memory may occur as part of the normal process of aging, in psychiatric conditions such as depression, as a function of disease affecting the brain indirectly, and as a symptom of cerebral disease. They may be part of a more generalized cerebral dysfunction such as dementia, stupor or coma, or they may occur as the predominant and perhaps the only feature of the disorder. This amnesia in isolation implies localized rather than generalized brain pathology.

The cerebral changes of old age and dementia may result in poor registration and recall of recent events, although memory for remote events is relatively well preserved. However, this deficit in memorizing ability is usually part of a more general decline in intellectual abilities along with a reduction in interest, attention and alertness (Whitty, 1966). Complaints of memory disorders by the aged, though, may well be associated with depression rather than with any objective evidence of impairment (Kahn, Zarit, Hilbert and Niederehe, 1975).

Memory defects in the depressive states are in concentration and learning (ie. registration) rather than in retention and improve with response to treatment (Sternberg and Jarvik, 1976). In contrast, the major impairment of memory following treatment with electroconvulsive therapy (ECT) is in retention (Cronholm and Molander, 1957; Cronholm and Ottosson, 1961) and disappears within several weeks (Squire and Chace, 1975).

A specific amnesic syndrome is characterized by a distrubance of memory out of proportion to other mental disorders, occurring where there is intact

perception, no clouding of consciousness and adequate intellectual functioning. It is characterized by defective learning and retention of on-going events and a retrograde memory loss for a limited period preceding the onset of the syndrome.

Neurologists and psychologists distinguish between loss of memory for events preceding the trauma (retrograde amnesia, RA), loss of memory for events in the transient confusional state that may ensue (post-traumatic amnesia, PTA), and an impairment of memory for recent events and new information that may persist (anterograde amnesia) (Newcombe, 1972).

Retrograde amnesia may be very variable in duration, lasting from minutes to 20 or 30 years preceding the trauma, and may shrink, although not totally disappear, with recovery (Symonds, 1966). Post-traumatic amnesia, is also limited in duration and covers the period until continuous memory is reestablished (usually continguous with regaining orientation in time and place). The length of the PTA tends to be correlated with the length of RA and with the severity of memory disorders for ongoing events (Jennett, 1972; Brooks, 1972).

The anterograde amnesia may occur in all degrees of severity varying from an almost total loss of memory for day to day events and a profound inability to learn, to conditions in which the patient merely has an unreliable memory for recent events and a slowness in learning new material (Warrington, 1971). Remote memory for past personal events is relatively intact, except for the period covered by the limited retrograde amnesia.

These descriptions give some idea of the types of memory disorder a psychologist may be asked to assess. Remote memory is usually assessed by taking a case history, but current memorizing ability is assessed by psychological tests.

This study arose from a two-fold practical problem:

1. There are no psychological tests available which assess a wide range of memory functions and which have been shown to be valid in detecting organic impairment. (See Review of Current Memory Tests, p. 48).

2. Those tests which are available and which assess a limited aspect of

memory with some validity are not suitable for use with patients of limited education and from cultural backgrounds different from those populations on whom the tests were standardized.

Consultations at Groote Schuur Hospital's In- and Out-patients Departments exceed one million per year. Most of the patients come from the lower socio-economic groups as hospital services are specified as available only to those whose family income is under R240 per month. Exceptions are made where an emergency exists or where facilities for investigations and treatment do not exist privately. The patient population is multiracial: 60% of patients are Cape Coloureds, 30% are Whites, and 10% are Africans. (Statistics from the Groote Schuur Hospital Annual Report, 1975). (For description of these population groups see Appendix A).

Psychological tests for "brain damage" in wide clinical use in South Africa which tap a limited aspect of memory, although they do not claim to be memory tests, include the Modified Word Learning Test, MWLT, (Walton and Black, 1957, 1959; Walton, White, Black and Young, 1959) and the Memory for Designs, MFD, (Graham and Kendall, 1960). However, using these tests together in the hope of thereby covering a wider range of memory functions, for example verbal versus visual, is not justifiable because of differences in the principles on which they were based and their validation procedures. The MWLT is based on the principle that the speed of acquisition of new learning is impaired where there is general cortical damage. The test has stood up well in cross-validation studies and correctly classifies around 80% of brain damaged patients. The MFD was based on the loosely defined notion that reproduction of designs from memory would be associated with "organic" impairment. The scoring system is not related to memory (omission of forgotten designs is not scored) but is empirically based upon specific distortions in reproduction that discriminate between the brain damaged and the non-brain damaged. The initial cut-off points were conservatively chosen so as to avoid false positives and resulted in detection of from 40 to 50% of the brain damaged standardization samples. Later studies have adjusted the cut-off points to detect higher percentages of the brain damaged population, but this has also resulted in an increased misclassification of normals (eg. McManis, 1974).

Both the MWLT and the MFD tend to make more errors in classification of patients with low intelligence. This restricts their use with local patients from the

lower socio-economic groups (mostly Coloureds and Africans) as, perhaps because of deprivation and limited education, these patients tend to achieve low scores on intelligence tests. The new words taught to patients on the MWLT are graded to their vocabulary level, but the task still seems too linguistically sophisticated for unlearned people to allow 'brain damaged' scores to be interpreted with any degree of confidence. (Perhaps they have fewer linguistic associations available; certainly, for example, they have no Latin-root associations to help them). It is common to be told that the task is too difficult or "Ek praat nie sulke hoër Afrikaans taal nie."

Studies have shown that lower class Coloured children are impaired in their performance on design copying tests (Friend, 1974), and this is before a memory factor is introduced as on the MFD. Several studies have shown that perceptual-motor processes in Africans are not the same as those of people of Western-technological cultures (McFie, 1969) and that even Western-educated Africans, eg. nursing staff and medical personnel, may obtain scores in the brain-damaged range on tests involving such skills (Egnal, 1975, Egnal and Daneel, 1975).

Faced with these practical problems, it was decided to attempt to develop a test which would detect memory impairment in people with limited education and from widely different cultural backgrounds. It was not planned to design a 'culture-free' test, but merely one that would be suitable for use with local population groups. As this was to be a test of 'memory' and not of more generalized cognitive functioning it was decided to validate the test on patients who were free from diffuse cerebral pathology, but who had limited lesions producing a disproportionate interference with memory functions: that is, patients with the amnesic syndrome.

Amnesic Syndrome: History and Clinical Picture

Description of an autononous syndrome characterized by a marked memory disorder in which other mental functions are relatively intact, is usually ascribed to Korsakoff who published papers on it from 1887 onwards (Talland, 1965). Korsakoff noticed it in association with peripheral neuropathy and found a common cause in chronic alcoholism. In the acute phase of their illness, his patients showed irritability, poor concentration and confusion, but as this general derangement cleared, the memory disturbance became prominent: The

patients were able to appreciate their surroundings and reason correctly, but had no knowledge of events during their illness and could not remember what they had just experienced or learn anything new. Korsakoff's other observations included lack of volition, the stereotyped application of routines acquired prior to the illness, the tendency to place memories outside their temporal context; lack of insight as to their impairment, and the operation of Ribot's law of regression (ie. recent memories tend to be recovered before remote ones and habits are the last to be affected). (Talland, 1965).

Bönhoffer in 1901 distinguished the four cardinal elements of the alcoholic psychosis that have come to form the modern conception of the Korsakoff syndrome: defective registration of new impressions, loss of the chronological order of events, retrograde amnesia, and confabulation (Barbizet, 1970). There followed a large number of publications outlining the characteristics of the memory disorders observed in chronic alcoholics and reporting the occurrence of the syndrome in other conditions (eg. cerebral tumours, encephalitis, etc. See Aetiology, p.9). Whereas the memory disorder has usually been regarded as central to the syndrome, opinion has been divided on the importance of the other features described, particularly that of confabulation.

Confabulation, defined as a factually incorrect statement other than intentional deception, fantastic fabrication, wild guessing, gibberish or delusion, (Talland, 1965) occurs frequently in the acute stages of the amnesic syndrome, whatever the aetiology, but is exceptional in the chronic, stable period, and may never occur at all (Victor, Herman and White, 1959). In the early stages confabulation is related to the disorientation and impaired perception of the global confusional state, and in the convalescent stage it seems to be related to the loss of the temporal sequence of events. Talland (1965) regards confabulation as secondary to the amnesic derangement and as occurring when memories are unavailable or lacking in structure and points of anchorage. The patient confuses memories of actual experiences, second-hand information, and ideas. He transposes information from earlier in his life, and condenses and distorts without awareness either of his deficit or of the confabulatory process. In the stable stage of the amnesic disorder, as the patient gains insight into his condition, he is far more likely to hesitate or admit ignorance than he is to confabulate.

So-called 'pure' amnesic syndromes in which the memory defect appears in the absence of disorientation, confabulation and denial of disability, have also been reported. Such syndromes follow bilateral surgical removal of the hippocampi (Scoville and Milner, 1957), and have also been reported after meningitis and encephalitis (Zangwill, 1966). (As disorientation and confabulation have also been observed as sequels to these latter conditions, the clinical picture presumably depends on the extent of the brain involved).

Most authors use the terms Korsakoff's syndrome, Korsakoff's psychosis, and the amnesic syndrome interchangeably and regard the derangement as varying according to the degree to which it is present and the stage at which it is observed. It should be noted that the learning disorder itself can clear: in a study of 104 alcoholics with the Wernicke-Korsakoff syndrome, 21% made a complete recovery, 25% a significant recovery, 28% a slight recovery and 26% no recovery (Victor, Adams and Collins, 1971).

A severe and persistant amnesic syndrome without confabulation is produced by bilateral surgical resections of the hippocampi. This operation was devised by Scoville as a treatment for psychosis. Some 30 operations were done before the postoperative amnesia of H.M., an epileptic patient, disclosed the risk to memory of this procedure. The case of H.M. will be described in some detail as it illustrates how incapaciting the syndrome can be, even though there is no impairment of intellect. H.M. has been intensively studied over the years and experimental findings are incorporated into the review section on the nature of amnesic impairment.

H.M. (Summary of Case Reports from Milner, 1966; Isaacson, 1972)

Birth and early history were uneventful, except for a mild head injury when he fell off his bicycle at age 7. Minor epileptic attacks began one year later and at the age of 16 he began to have generalized seizures which increased in frequency and severity until he was unable to work. At the age of 27, in 1953, he submitted to a mesial temporal bilateral resection performed by Scoville. Prior to the operation he had had no obvious memory disturbance, having passed high-school examinations without difficulty and become a motor-winder by trade. Following the operation, he no longer recognised the hospital staff, could not relearn the way to the bathroom and seemed to retain nothing of day to day happenings. He had an extensive though patchy retrograde amnesia, such that he did not remember anything of the period in hospital before the operation or the death of a favourite uncle some 3 years before. His early memories seemed vivid and intact and there was no disturbance of speech or social and emotional responses.

This picture has remained largely unchanged over the years. The retrograde amnesia has shrunk, but the anterograde amnesia persists. The family moved after the operation, but after many years H.M. has not learned the new address and cannot find things around the house. Although he mows the lawn regularly, he has to ask his mother each time where the lawnmower is kept. Given sheltered employment, he was able to do the work, but could give no description of the nature of his job, place of work, or the route taken to get there. He does the same jigsaw puzzles day after day and rereads the same magazines without finding their contents familiar. He does not know the names of his neighbours and treats them as strangers when he meets them. Conversely, he will invite in total strangers thinking they must be friends whom he has failed to recognise.

As this last example shows, he is aware of his memory difficulty and will state that his answers will be guesswork. He does not remember things he has been told a few minutes earlier, but uses cues available and will not, for example, mistake the season of the year, although he may mistake the year. He does not appreciate the passage of time, and will consistently underestimate his age. He does not remember emotionally toned events either. Told of the death of his uncle, he was very upset, but from time to time thereafter would ask when his uncle was coming to visit them and would show the same intense distress each time he was retold of his death.

There is no intellectual fall-off. In fact, his Wechsler intelligence quotient (I.Q.) of 118 in 1962 compares favourably with that of 104 reported in 1953, and is attributed to his having fewer seizures than before. He has always been placid and there is no significant personality change.

He is usually described as retaining nothing since the operation, but a few observations refute this. For example, when shown a Kennedy half-dollar, he could remember Kennedy and his assassination (1963). He was dimly aware of his father's death and could also remember the death of Pope John and recognize the name of an astronaut. He is able to draw a floor plan of his house and recognizes his home when a few blocks away.

On verbal learning tasks, digit span (6 forwards, 5 backwards) is normal and improved from preoperative level. He is able to retain small pieces of information for several minutes provided his attention is not distracted. Once distracted, he has no recollection of the task. He demonstrates motor-learning and some perceptual learning, and shows retention of these tasks although he has no recollection of having done them before.

Material-Specific Memory Disorders

In contrast to the global amnesia that follows bilateral damage in the hippocampal zone, certain material-specific disorders have been shown to follow upon left or right anterior temporal lobectomy in epileptic patients. These effects vary according to the side of the lesion. Thus left temporal lesions in the hemisphere dominant for speech selectively impair the learning and retention of verbal material (Meyer and Yates, 1955; Milner, 1958), whether this material is seen or heard (Blakemore and Falconer, 1967; Weingartner, 1968), and whether a recall or a recognition technique is used (Milner, 1971). The deficit is evident pre-operatively, but is far more marked post-operatively (Meyer and Yates, 1955; Milner, 1958). It is still quite striking a year after the operation, and has been found to persist for about three years and thereafter recover slowly (Blakemore and Falconer, 1967). This verbal memory deficit has been found to be proportional to the amount of hippocampus removed in the left-temporal lobectomy and does not occur following right temporal lobectomy (Milner, 1971).

Conversely removal of the right nondominant temporal lobe impairs the recognition and recall of visual and auditory patterns that do not lend themselves easily to verbal coding. This deficit seems to be less marked than the verbal memory impairment produced by the left temporal operation, but statistically reliable differences between the performance of the left- and right-groups upon these perceptual tasks have consistently been found. Thus the right group are impaired in comparison to the left group on the recognition of recurring nonsense patterns (Kimura, 1963), the recognition of photographs of faces, the delayed reproduction of the Rey-Osterieth figure, and of designs from the Wechsler Memory Scale, and on the recognition of familiar tunes (Milner, 1968). The deficit is not seen on the comparison of tones, flashing lights and colour shades where there is a delay of up to 20 seconds and Milner considers that it applies only to complex, patterned stimuli which are too rich in detail to be rapidly described verbally. Stylus maze learning is impaired, whether it is visually or tactually guided, as is learning of the position of a cross on a line following distraction, and the cumulative learning of recurring sequences on a spatial block-tapping task (Milner, 1971). It has been suggested that these deficits of non-verbal memory may persist a year or more after the right temporal lobectomy (Taylor, cited Milner, 1968), but no long term follow-up seems to have been carried out.

CHAPTER 2

AETIOLOGY

Korsakoff observed the amnesic syndrome in association with peripheral neuropathy and found a common aetiology in chronic alcoholism. In 1912 Chaslin separated the mental disorder from the polyneuritis (Barbizet, 1970). Amnesia following head-injury and carbon monoxide poisoning was recorded in casualties in the Franco-Prussian and First World Wars (Talland, 1965). Tuberculous meningitis (Williams and Zangwill, 1953), viral encephalitis (Conrad, 1953, cited Talland, 1965), and tumours of the 3rd Ventricle (Williams and Pennybacker, 1954) were all reported in association with amnesia. The dense amnesias which followed bilateral resection of the hippocampus for the relief of epileptic seizures (Scoville and Milner, 1957; Penfield and Milner, 1958) sparked off interest in the role of lesions in the circuit of Papez (hippocampus, mamillary bodies, thalamus and cingulate gyrus) in producing amnesia.

Disorders causing amnesia are discussed more fully below (after Brion, 1969) with some of the anatomical data available:

1. Nutritional deficiency

The Wernicke-Korsakoff syndrome in which the memory disorder follows episodes of encephalopathy results from thiamine deficiency, commonly though not invariably in association with alcoholism. Bilateral lesions of the mamillary bodies have been reported in several studies (eg. Brion, 1969), but there are also cases on record in which lesions of the mamilary bodies were found without any evidence of memory disorder (Victor, Adams and Collins, 1962). This latter group of investigators have stressed the importance of lesions in the medial diencephalon, particularly the medial dorsal nuclei of the thalamus, in producing the memory disorders (Adams, 1969).

2. Cerebral tumours

A disproportionate amnesic disturbance is usually related to bilateral and deeply set tumours in the septal or frontal regions of the cingulum or on the floor or the walls of the third ventricle (Williams and Pennybacker, 1954). The fornices, mamillary bodies and anterior thalamic nuclei are

usually affected. Craniopharingiomas constitute two-thirds of the cases. (Brion, 1969).

3. Neurosurgical lesions

Surgical ablation leads to amnesia if the medial and inferior parts of both temporal lobes are excised (Scoville and Milner, 1957) or if one is ablated in the presence of disease in the other (Walker, 1957; Penfield and Milner, 1958). Bilateral dorsomedial thalamic coagulations cause variable and transient memory defects; bilateral partial cingulectomies produce a transient amnesic syndrome with rich confabulation; and coagulation or bilateral transection of the fornix may produce an enduring amnesia (Brion, 1969; Barbizet, 1970). It is disputed whether incidental damage to the periventricular structures did not produce these latter amnesias, however (Whitty and Lishman, 1966).

Lesions placed in the vicinity of the anterior thalamic nuclei for the relief of Parkinsonism have also been noted to produce transient memory disorders (Barbizet, 1970).

4. Trauma

Amnesia has been reported following severe head injuries (Russell, 1968) and following concussion (Fischer, 1966). Russell stresses primarily the limited period retrograde and post-traumatic amnesias (RA and PTA), but a continuing deficit in day to day memory is often one of the most severe complaints following head injury (Newcombe, 1972). Memory disturbance is related to the length of the coma and the PTA (Symonds, 1966; Russell, 1968; Brooks, 1974). Anatomical verifications are few, but both brain stem and cortical-subcortical areas are implicated (Whitty, 1966).

Penetrating wounds causing lesions in the hypothalamic-hippocampal and 3rd ventricle areas produce amnesia (Barbizet, 1970). Teuber, Milner and Vaughan (1968) have reported a case of persistent amnesia following a stab wound of the basal brain.

5. Intracerebral infections

Acute Herpes Simplex Encephalitis often leaves a disorder of memory that

exceeds other cerebral deficits (Adams, 1969). Damage is greatest in the orbito-frontal cortex, the medial parts of the temporal lobe, and the cingulate gyri (Oxberry and MacCallum, 1973).

Amnesia has been reported following limbic lobe encephalitis in association with bronchial carcinoma (Barbizet, 1970). There are inflammatory and degenerative changes in the temporal parts of limbic grey matter. An amnesic syndrome following tuberculous meningitis has been reported (Williams and Smith, 1954) and gross memory disturbances in association with lesser impairment of other cerebral functions have been reported in patients with cerebral abscess formations in the temporal lobe (Whitty and Lishman, 1966). A transient amnesic syndrome has also been observed after typhoid fever, epidemic mumps encephalitis, herpes zoster encephalitis, and meningococcal meningoencephalitis (Whitty and Lishman, 1966).

6. Vascular Causes

A relatively rare cause of amnesia is bilateral infarction of the medial temporal lobes from atherosclerotic or embolic occlusion of the posterior cerebral arteries. Amnesia following degeneration of the limbic structures from infarcts elsewhere in the brain has also been reported (Brion, 1969). Vascular insufficiency of the temporal lobes is assumed to be the basis of attacks of transient global amnesia, which may progress to a more persistent impairment of memory (Matthew and Meyer, 1974). Benson, Marsden and Meadows (1974) reported 4 cases of amnesia, in 2 of whom the disorder was permanent, following left-sided infarction.

Florid amnesic syndromes with confabulation have been reported following subarachnoid hemorrhage, and defective memory (rather than total amnesia), has been found in association with subdural haematoma (Whitty and Lishman, 1966). These syndromes are usually transient.

7. Toxic and Metabolic Disorders

Any severe systemic infection or metabolic disturbance such as hepatic or renal failure may produce amnesia as part of a global impairment of cerebral functioning. Substances such as arsenic, lead, manganese, mercury and carbon disulphide, and sedatives such as bromide taken in excess

or over prolonged periods have all been reported to produce selective memory deficits. The defect of memorizing is usually reversible, but permanent changes may occur when the toxin has acted for long or in heavy doses, producing stupor or coma. These agents are thought to act at a cellular level by interfering with enzyme systems. This is speculative, however, and these conditions do not contribute to knowledge about parts of the brain affected in memory disorder. (Whitty and Lishman, 1966).

Lipoid Proteinosis (Urbach-Wiethe's disease), a rare hereditary disorder with predominantly dermatological, oral and neurological manifestations, has been reported to produce progressive recent memory loss in several cases. In some of these there has been radiological evidence of hippocampal calcification. (Gordon, Gordon, Botha and Edelstein, 1971; Newton, Rosenberg, Lampert and O'Brien, 1971).

8. Cerebral Anoxia

Memory disturbances, usually transient but which persist beyond other mental changes, have been ascribed to anoxia or hypoxia following anaesthesia, temporary cardiac arrest, electrocution, haematemesis, carbon monoxide poisoning and flying and climbing at low oxygen levels (Whitty and Lishman, 1966). The amnesic effects of carbon monoxide poisoning may also be long-lasting and severe and may occur several weeks after exposure (Konstamm, 1917, cited Talland, 1965; Newcombe, 1972). The amnesic syndrome may also be produced by status epilepticus (Symonds, 1966; Newcombe, 1972).

9. ECT

After ECT there is always some degree of retrograde amnesia as well as anterograde amnesia. The retrograde amnesia usually shrinks fairly rapidly, but a retention defect may persist for some weeks after ECT. The defect is related to the strength and duration of electrical stimulation and to the duration of the seizure (Cronholm and Ottosson, 1963; Williams, 1966; Dornbush, 1973), but the mechanism is obscure.

10. Epilepsy

Retrograde amnesia for the period of the seizure and a variable period of

post-ictal confusion occurs in epilepsy. Amnesia for behaviour occurring without loss of consciousness, eg. automatisms or fugue states, is related to discharges from the medial temporal lobes (Penfield, quoted Whitty and Lishman, 1966). Defects of memory, but not a dense amnesia, are commonly reported in temporal lobe epileptics (Glowinski, 1973).

11. Aging and Dementia

A progressive loss of learning and memory occurs along with other features of decline in both these conditions. A high incidence of electroencephalographic abnormality in the region of the temporal lobes, more marked where learning ability is deficient, has been reported in the elderley (Whitty and Lishman, 1966).

Impairment of memory occurs in all dementias, but may dominate the clinical picture in the thalamic form of Jacob-Creutzfeldt disease (Brion, 1969) and in Alzheimer's disease (Brion, 1969; Miller, 1975). Pathological changes predominantly involve the hippocampus, the thalamic nuclei, the mamillary bodies and the frontal cortex (Brion, 1969; Corsellis, quoted Miller, 1975).

CHAPTER 3

THE NEUROPSYCHOLOGICAL BASIS OF MEMORY DISORDER

The discovery that any one of these disease processes can produce a failure of the capacity to form new memories combined with the loss of memories formed prior to the illness (RA) has been of importance in the study of the physiology of man's cerebral mechanisms. The anatomical substrate of the amnesic syndrome has emerged from comparisons of pathological cases of varied aetiology and involves a bilateral lesion of structures within the limbic system, in particular the hippocampal formations, the mamillary bodies and certain thalamic nuclei within the diencephalon. The role of the cingulum is still poorly defined and that of the fornix is a subject of controversy (Brion, 1969). See Figure 1 below.

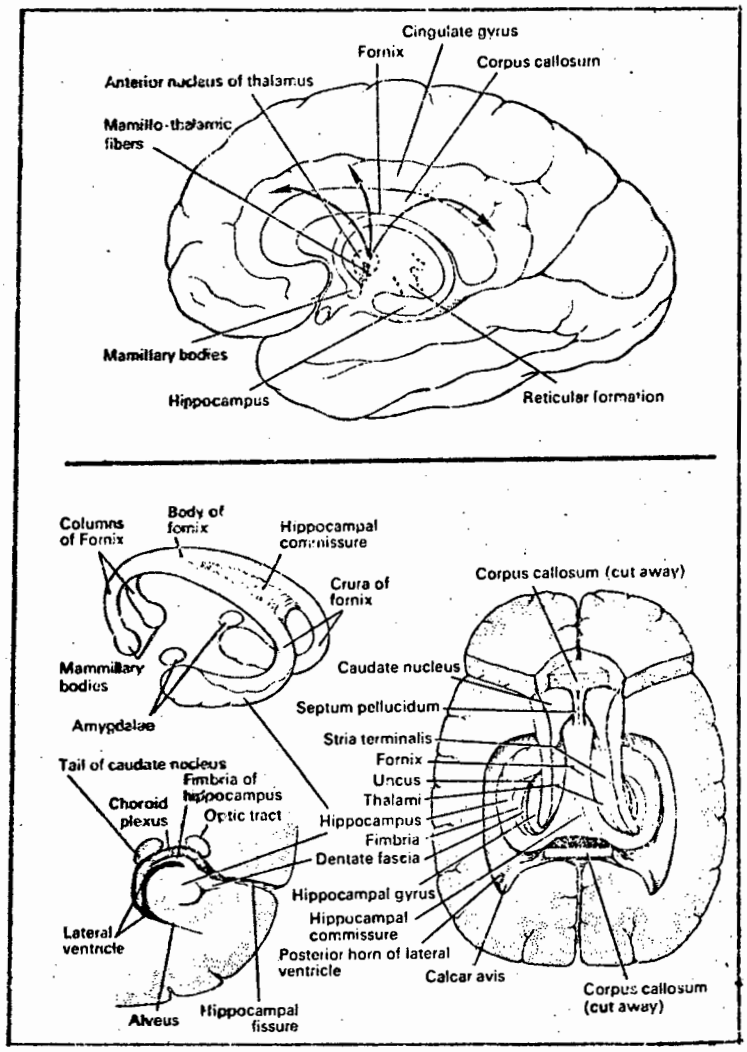


Figure 1: The Limbic System and its Connections.
From Barbizet: Human Memory and its Pathology, 1970, p. 34.

In addition to its function in memory, the limbic system is associated with emotional aspects of behaviour and the visceral responses accompanying these emotions. It is linked to the reticular activating system, thalamic nuclei and cortex, in particular the temporal and parieto-occipital regions. The cortical system has been proposed as a storehouse of memory with some degree of localization of certain categories of memory (Whitty, 1966). The studies of Penfield and others showed that stored memories could be evoked by electrical stimulation of the cortex and by spontaneous epileptic discharges. Some of the elicited memories were of experiences "forgotten" to normal recall (Whitty, 1966). Relatively limited lesions in specific parts of the cortex may produce specific loss of memories, eg. for words or visual orientation (Adams, 1969) and the "split-brain" studies show that skills learned by one hemisphere cannot be elicited by stimuli applied to the other hemisphere (Zaidel and Sperry, 1974). However, no simple equation of the engram of a particular experience with a given cell or cells can be supported: the correlation is more likely to be with a complex pattern of neuronal activity (Whitty, 1966).

The mechanisms of integrative memory processes are not understood and it is not known whether the defect in recording and retaining new experiences is one of storage or retrieval (they are not operationally separable) or is in some common underlying mechanism such as coding. Attempts have been made to explain the discrepancy between the amnesic's poor memory for recent events and his relative preservation of remote events by postulating different sites of storage for the two types of memory: storage taking place initially in the limbic system and later becoming neocortical. It is not known, however, whether the limbic circuit acts as a specific 'holding' mechanism, temporarily storing memories in the course of consolidation, or whether its action is nonspecific, ie. creating favourable conditions for coding or for storage and recall (Brion, 1969).

Models correlating psychological processes with neurophysiological changes are in a very speculative stage:

Symonds (1966) postulates that a hippocampal activating system opposes the normal bias towards decay (forgetting) of memory units. These memory units, based upon structural modifications registered in vast numbers of neurones, are the more vulnerable to decay the more recent their establishment. In

the post-traumatic period, this hippocampal system would be inactive, so no lasting memories would be formed (PTA), and there would be fading of memories stored before the brain damage (RA). This fading is postulated as a gradual process, proceding to erasure; but if activation is restored, memories in a zone decayed to a nonfunctional level could recover their function. (This would explain the shrinking of RA, and the persistance of some RA in cases where there is no ongoing defect of memorization). If activation is not restored, then there is an ongoing defect and a limited retrograde amnesia.

Other theorists, eg. Kimble (1969) have postulated from their work with animals that hippocampal lesions result in the defective inhibition of previously learned responses. Isaacson (1972) considers this form of the inhibition-deficit hypothesis to be too limited to explain experimental contradictions and puts forward a more liberal hypothesis which regards the hippocampus as imposing inhibitory control over ongoing, motivated cognitive and behavioural sequences. Disruption of the functioning of the system produces a failure of inhibition.

The decay theorists, eg. Broadbent (1969), regard forgetting as an autonomous process of decay, occuring unless the information is rehearsed in a limited capacity system concerned with perceptual processing,or is recirculated into a storage system. Whether fading implies annihilation of traces, ie. the reversion of structures in the brain to their previous condition, or merely an increasing inaccessibility, is a matter of speculation (Talland, 1965). The interference theorists postulate interference with the consolidation of traces from new incoming stimuli (proactive inhibition) and interference at the retrieval stage due to competition of responses in storage (ie. a failure in discrimination in recall and recognition).

Pribram (1969), as a result of his work on monkeys subjected to selective brain operations, has developed a model of input-processing in which the sensory-specific posterior association cortex reduces the redundancy of cells available to excitation (so increasing the density of information in the input channel), whereas the frontolimbic system operates to enhance redundancy, making more cells available. This presumably is accomplished by inhibition and disinhibition of ongoing interneuronal regulatory processes within the afferent channels. Such a model implies that nonrecovered cells (those still excited from prior inputs) will act as a context or short-term memory buffer

against which current input is matched. The 'occupied' cells form a matrix of uncertainty that determines the selection of input signals that may or may not occur. The normal functions of the posterior cortex would be to increase the complexity of this context, while those of the frontolimbic systems would simplify and thus allow readier registration and parceling.

Lesions of the frontolimbic region disrupt delayed alternation behaviour in which the correct response on any trial is dependent upon the outcome of the previous response. Such lesions thus appear to disrupt the process by which the brain achieves temporal organisation. Anatomically the memory trace is distributed within a neural system by means of an encoding process while as a function of decoding the engram is reassembled, ie. remembered. Thus what is remembered and whether it is remembered depends on how it was coded. A model stressing defects in input-coding at least has the advantage of being able to explain retrograde as well as anterograde amnesia as this would result in a disorder of retrieval as well as one of storage.

Talland (1965) regards amnesics as having an abnormally rapid fading of traces and a failure to sustain the searching cycles necessary for normal remembering. Other theorists regard amnesics as being abnormally sensitive to interference, either at the input stage (eg. Cermak and Butters, 1972) or at the stage of retrieval from storage (eg. Warrington and Weiskrantz, 1970).

CHAPTER 4

THE NATURE OF MEMORY IMPAIRMENT IN AMNESICS: a review of experimental findings

Memory implies several processes: the experiencing or registration of sensation; the retention of some part of the process, which may involve coding or categorization for storage; and retrieval through recall or recognition.

There is no agreement among observers as to which memory processes are impaired in amnesics. The controversy derives in part from the fact that the patients investigated have differed in the degree to which they were affected and the stage at which they were studied; that data has been largely anecdotal and psychometric data has been incomplete or entirely absent, and that analyses of the memory disorders have been made in epistemological contexts as dissimilar as structural associationism, Gestalt theory, psychoanalysis, Pavlovian inhibition and Jacksonianism (see Talland's 1965 review). Recent experiments on amnesics have been more in line with those used by psychologists in studying normal memory processes. These experimental findings, the interpretation of which is disputed, will be reviewed in some detail in order to determine which processes are impaired and should therefore be emphasized in a test battery. (See Summary and Implications for Memory Test Techniques, p. 44 to 47).

Overview of Theoretical Positions

The work of Milner and associates on bilateral hippocampal lesions seemed to support theories proposing two separate systems of memory, a short-term one (STM) with a limited storage capacity from which material is rapidly displaced, and a more durable long-term system (LTM) with far greater storage capacity (Warrington, 1971). (STM and LTM must not be regarded as equivalent to recent and remote memory as both refer to hypothetical systems in recent, ongoing memory). Milner (1970), observing that H.M. could retain small chunks of information for several minutes, but forgot everything once his attention was distracted, postulated that the defect was one of consolidation and of transfering material from the short-term to the long-term store. The difficulty with such a theory is that it does not account for the high incidence of intrusion errors from previous learning seen in amnesics (eg. Talland, 1965; Winocur and Weiskrantz, 1976), nor does it account for retrograde amnesia, ie. the loss of memories that were already stored at the time of onset of the disorder.

Recently, the neuropsychological literature has been dominated by articles from two groups of workers, one in Britain and one in Boston, U.S.A. The British group of Warrington, Weiskrantz and Baddeley agree with Milner that STM is intact and LTM impaired in amnesics, but repudiate the consolidation theory. They claim that recent work on perceptual-motor learning in amnesics (see Milner, 1970) and their own work on the use of facilitatory retrieval techniques has shown that the long-term retention defects of amnesics are not as absolute as their behaviour in daily life or on some formal learning experiments would suggest (Warrington, 1971). They attribute the memory defect to a failure to inhibit or dissipate information in storage, resulting in difficulty at the time of retrieval. An interpretation based on disinhibition and interference rather than on faulty consolidation brings the human amnesic syndrome more in line with that produced by hippocampal ablation in animals, which has been interpreted as a failure of internal inhibition (eg. Kimble, 1969; Isaacson, 1972).

The Boston group of Cermak, Butters, Samuels, Goodglass and others have consistently produced findings that conflict with those of the British group. The most notable area of conflict is that of STM which they have found to be markedly impaired in alcoholic amnesics. They consider the basic memory defect to be one of encoding which then leads to inaccessibility of data at the time of retrieval.

The Boston and British groups agree that amnesics are abnormally sensitive to interference. They differ, however, as to whether this sensitivity affects STM or LTM processes. Experiments on amnesics have led to disputes about the following: whether STM or LTM is impaired; whether various retrieval techniques are differentially affected; whether there is an abnormal rate of forgetting; whether the defect is material specific; whether there is an encoding defect; whether there is an underlying cognitive disturbance in the rate of information-processing; and the importance of familiarity and temporal context in affecting recognition. These areas will be dealt with separately in an effort to clarify the nature of the impairment.

Both groups seem to build up a coherent body of experimental evidence to support their theories. A close reading of their actual experiments, however, shows that there are a host of different variables operating which could have affected the memorizing ability of amnesics and the authors have often not realized the importance of methodological details in producing their findings. Possible sources of distortion include differences on the variables listed in Table 1:

TABLE 1: Variables Producing Differences in Experimental Findings.

VARIABLE		NATURE OF DIFFERENCES
Patients	Patient population.	Aetiology; number, age.
Presentation	Nature of material presented. Modality of presentation. Rate of presentation.	Amount; meaningfulness; verbal - nonverbal. Auditory, visual, tactile. From 1" per item to patients' choice of rate.
	Number of learning trials.	From one to multi-trial presentation.
Interference with learning	Length of delay interval between presentation and recall.	No delay; seconds, minutes, hours, days, weeks, etc.
	Distractor techniques filling delay interval.	Unstandardized; visual; verbal. Same/different to preceding material. Performance paced, unpaced.
	Intervals between trials; blocks of trials, and conditions.	None; uncontrolled; timed. Interference: maximized, minimized.
	Ordering of conditions, experiments	Uncontrolled, counterbalanced. Proactive, retroactive interference.
Retrieval	Free recall Cued recall	Time: limited or unlimited. Fragmented words, initial letters; category cues; visual images.
	Recognition	Yes-no; two-choice; multiple-choice.
Scoring	Corrections for false positives; guessing.	Applied to some, all or none of retrieval technique.

Patient population: One consistent difference between the British and Boston groups has been the patient populations studied. The British group typically use amnesics of mixed aetiology, numbers are very small (from 4 to 6 only), and include from 3 to 5 alcoholic Korsakoffs and a selection from 3 patients with amnesia following right temporal lobectomy, cardiac arrest and encephalitis. Mean age is in the mid to late fifties and mean I.Q. in the average range, ± 100 (Baddeley and Warrington, 1970). The Boston group use alcoholic Korsakoffs only and have numbers varying from 6 to 11. Mean age is around 55 and mean I.Q. ± 100. Butters and Cermak (1974) provide test data on 13 of their patients which refute the suggestion that they are intellectually deteriorated and that discrepancies in experimental findings between them and the British group can be accounted for on this basis. They agree that many alcoholic Korsakoffs (half, in their experience) demonstrate a general organic brain syndrome, but maintain that, as their test data shows, they have been selective in their choice of patients of experiments.

Brooks and Baddeley (1976) separated the experimental results for 3 alcoholic Korsakoffs and 2 post-encephalitic amnesics and found aetiology not to produce differences on their particular experiments. However, reports of different findings on single post-encephalitic amnesics have come from Cermak, (1976) and Starr and Philips (1970). Neither of the patients did as poorly as the alcoholic Korsakoffs on the STM-forgetting and interference experiments. However, other factors may be operative as both have I.Q.s above 130. As

Cermak (1976) points out, it is not the aetiology which is important but the area of the brain involved: A second post-encephatic patient with primarily subcortical damage behaved in precisely the same way as the alcoholic Korsakoffs on the tests of memory and encoding. The patients with bilateral hippocampal involvement rather than the deep midline damage of the alcoholics tend to be aware of their defect and to show great concentration in attempting to compensate for it. The Korsakoff alcoholics are often unaware of that defect and passive in attempting to overcome it.

Both groups describe their patients as having severe memory defects as assessed by clinical methods, ie. they are unable to recall day to day events, are disoriented in time and space, and have retrograde amnesias of varying lengths. Confabulation is not a prominent feature. Although the terms amnesic syndrome and Korsakoff syndrome are regarded as synonymous, the terms used by the authors have been retained in the following discussion.

Interference Phenomena, STM and LTM

Observers from Brodmann in 1902 onwards have commented on the inability of amnesics to retain material in the face of distraction from an interpolated activity and have noted interference from previous learning and a tendency to perseverate errors (Brodmann, 1902 and Wechsler, 1917, quoted Talland, 1965; Milner, 1969; Baddeley and Warrington, 1970; Samuels, Butters, Goodglass and Brody, 1971). Intrusions from previous learning form an important part of the argument that there is long term retention and storage in amnesics and that the defect is therefore not one of consolidation and transfer into storage.

It is known that in normals there is rapid forgetting of material well within span over intervals as short as 20 to 30 seconds if rehearsal is prevented by a distracting activity (Peterson and Peterson, 1959). With increased duration or frequency of the original presentation, short-term memory (STM) for such new information shows marked improvement, with perfect recognition and complete recall after very long periods of time as the limit (LTM). In spite of this apparent continuity of STM and LTM,some theorists (eg. Baddeley and Warrington, 1970; Waugh and Norman, 1965; Tulving, 1970; Broadbent, 1970) assume that two mechanisms with different characteristics are involved. Others, (eg. Melton, 1963, 1970; Murdock, 1970; Gruneberg, 1976) assume that the processes involved in STM are qualitatively the same as those involved in LTM and that operational differences in forgetting over time are quantitative only, ie. both STM and LTM are similarly affected by the passage of time and by interference from preceding and interpolated activities.

It is beyond the scope of this study to deal with these theoretical disputes. However, interpretations within a STM-LTM dichotomy have been imposed on experimental data on amnesics and it seems to the writer that reinterpretation within a continuum and interference framework would remove much of the confusion. A few of the main points of contradiction will thus be dealt with briefly:

1. It has been claimed that STM is normal in amnesics and that LTM only is impaired and that this is evidence that the two systems are separate (Warrington and Baddeley,1970). However, an impairment of STM in amnesics has been shown by Corsi (Milner,1970) and by the Boston group (eg. Cermak, Butters and Goodglass, 1971) and studies by Warrington and Weiskrantz (1968, 1970, 1974) have shown that LTM is not as impaired as was once imagined.
2. Coding in STM was thought to be acoustic and coding in LTM semantic (Warrington 1971, Craik,1971). Both types of encoding are now conceded to occur within both systems, even by Baddeley, the original exponent of separate coding mechanisms for separate systems (Gruneberg, 1976).
3. Different mathematical functions postulated for short and long term traces may be accounted for by the use of experimental paradigms with different interference effects. (Gruneberg,1976). Wickelgren, who claimed support for his two-trace theories from his experiments on the amnesic H.M. (1968), has now become a single trace theorist (Gruneberg,1976).
4. Dichotomists accept that LTM traces are susceptible to interference effects from the similarity of the to-be-remembered-unit (TBRU) and prior or interpolated activity (ie. proactive or retroactive inhibition, P.I. and R.I.), but deny the importance of this similarity in STM and instead attribute STM forgetting either to the passage of time and autonomous decay processes or, to the number of perceptual acts intervening between presentation and recall of the TBRU (Melton,1970). Evidence for interference from semantic similarity in STM as well as LTM, and for interference from sensory qualities in LTM as well as STM is given by Gruneberg (1976). The following review will also provide evidence from experiments on amnesics that the similarity of the distractor technique to the TBRU is crucial for the production of an interference decrement, whether in a STM or a LTM paradigm. Failure to realize this led to the misinterpretation of findings as showing that amnesics had a material specific (ie. verbal) memory defect only (Butters, Lewis, Cermak and Goodglass, 1973).

3-letter words, word triads (WWWs), and geometric designs. The groups were equal in retention at zero delay, so there was no impairment of registration; they were insignificantly different at 3 seconds delay, but the Korsakoffs were significantly impaired at 9 and 18 seconds delay under all conditions. This held whether retention was assessed by free recall or recognition and they interpret their findings as showing a severe generalized impairment of STM.

They postulate (Butters and Cermak,1974) that the difference between their findings and those of Baddeley and Warrington (1970) can be attributed to the latters' methodology permitting greater rehearsal of material: they used a slower presentation rate, visual and auditory input, and their "distraction" was counting backwards by 1s, a task that may have been too automated to block rehearsal. The Boston group used counting backwards by 2s or 3s and required a pace of one number per second to be maintained (with the examiner pacing if necessary). Baddeley and Warrington do report that the pace maintained varied widely, and the fact that their curves show less than normal forgetting for both amnesics and controls (asymptote being at 60 seconds instead of the usual 20), suggests that their tasks were easier.

That these discrepant findings are not a function of different brain damage in the two groups is suggested by Corsi's finding of impaired short-term retention of CCCs in patients with left temporal excisions and of the position of a cross on a line in patients with right temporal excisions (Milner,1971). Cermak (1976) found normal STM retention in one post-encephalitic amnesic, but impaired retention in another. The I.Q. of the first patient was 133 so possibly the counting backwards by 3s was too easy a task for him to block rehearsal.

Proactive and Retroactive Interference

Little forgetting occurs in normals on the first trial of experiments using the Peterson and Peterson distractor technique, but marked forgetting occurs on the second and subsequent trials. Interference theorists such as Keppel and Underwood (1962) attribute this to proactive inhibition (P.I.) from the items that have gone before. (P.I. refers to the failure of unlearning of previously appropriate responses and their substitution in the new task). It has been shown that the P.I. effect dissipates if trials are separated by 2 to 3 minutes. Using blocks of 5 tests, each with 15 second inter-test delay

followed by a 5 minute rest, Baddeley and Warrington (1970) showed a clear drop in performance between the first and subsequent items by both amnesics and controls and no significant difference in the rate of development or amount of P.I. in the two groups.

In contrast, Cermak and Butters (1972) have shown that build up of proactive interference produces a greater decrement in the retention of Korsakoffs than of controls. In one experiment they contrasted performance on massed practice trials (high P.I. condition) with that on distributed practice trials (low P.I. condition), using 6 second or 1 minute inter-trial intervals on the Peterson and Peterson forgetting paradigm. They found that while both groups recalled significantly less after mass than after distributed practice, and while the Korsakoffs recalled less than their alcoholic controls under all conditions, the Korsakoffs showed a greater relative decrement under massed practice than did the controls. This finding was significant, whether CCCs or WWWs were learned. They speculate whether, if the inter-trial intervals were to be lengthened further still, the Korsakoffs performance would not approach normality.

Investigating interference from the similarity of the material learned, they found that both Korsakoffs and controls recalled less when the learning of word triads (WWWs) was preceded by learning of other WWWs (high P.I. condition) than when it was preceded by learning of CCCs (low P.I. condition), but at both the 9 and 18 second delay intervals the Korsakoffs showed a greater relative loss under the high P.I. condition than did the alcoholic controls. Again, the Korsakoffs performed worse than the controls under all conditions; for both groups the P.I. effect increased with the longer distraction interval, but this growth was proportionately greater for the alcoholic Korsakoffs.

Since all these experiments are based on the short-term forgetting with distraction paradigm, discrepancies in findings between the Boston and British groups can again perhaps be accounted for by differences in methodology, (eg. presentation time and distraction technique).

Butters, Tarlow, Cermak and Sax (1976) repeated these interference experiments on a group of patients with Huntington's chorea. These patients perform almost as poorly as the Korsakoffs under massed practice and high P.I. -

similarity conditions, but do not show the significant improvement shown by the Korsakoffs under distributed practice and low P.I. conditions. The Korsakoffs' amnesic disorder thus appears to involve an increased sensitivity to interference while the chorea patients' more diffuse disorder does not.

That interference from the similarity of the material does produce a greater decrement in amnesics than in normals has in fact been shown by the British group, but is interpreted as a LTM phenomenon (Winocur and Weiskrantz, 1976). They manipulated learning conditions in a series of experiments to determine the effects of increasing or constraining interference on amnesics. Learning lists of 12 paired associates, amnesics showed the usual inability to learn unrelated pairs even over several trials, but when interference was constrained (ie. competing associations reduced) by learning to either a semantic (eg. chair - bench) or phonetic (eg. hair - fair) rule, amnesics achieved the same level as the controls. The amnesics were unable however, some 20 or 30 minutes later, to learn a second paired associate list which increased the potential for interference by pairing stimulus words from the first list with new responses. This was largely because of intrusion errors from List I. Controls achieved learning of the second list and made significantly fewer intrusion errors than the amnesics. That this tendency of the amnesics was not simply one of perseverating responses, but resulted from the lack of constraints on proactive interference (ie. poor discriminability) was supported by a further experiment in which first list words paired with unrelated words on a second list produced no learning at all in amnesics, but also few direct intrusion errors. The errors were now ones of omission.

Winocur and Weiskrantz also demonstrated increased sensitivity to retroactive interference in amnesics (1976). In spite of the fact that the amnesics demonstrated very little learning of a second list of semantically related pairs, when recall of the first list was retested they showed a significantly higher number of intrusion errors from the second list than did the controls. Both groups demonstrated an ability to retain a list over a 30 minute interval in the absence of an R.I. condition.

These experiments show that amnesics can learn and retain material over quite long intervals when the response set is constrained, and that they can recall it, although erroneously. The patterning of learning and errors was the same in the 3 alcoholics as in the 2 encephalitic amnesics. That high

discriminability of material produces low P.I. and facilitates amnesic learning receives support from the finding of an unusually high recognition rate of pictorial material in amnesics by Huppert and Piercy (1976); they chose their pictures for their discriminability. These findings on interference phenomena in amnesics are consonant with the findings on experimental animals with hippocampal or fornical lesions. The animals are deficient in acquiring new responses following training on similar problems, largely because of interference from past learning. In rats with hippocampal damage, manipulations which enhance the discriminability of test conditions also reduce the amount of P.I. (Kimble, 1969).

It should be noted that poor discrimination of material might in turn arise from difficulty in "time-tagging", or impairment in the discrimination of familiarity or in the discrimination of "contextual" cues associated with different experiences.

Non-verbal Short-term Memory

Normal non-verbal STM in amnesics is postulated by Warrington and Baddeley (1974), whereas impaired non-verbal STM is postulated by the Boston group. The latter however first created considerable confusion by stating that the STM defect was specific for verbal material (Butters, Cermak, Lewis and Goodglass, 1973) and then changing their position (de Luca, Cermak and Butters 1975) as they realized it was the nature of the distractor technique that produced the verbal deficit.

In the 1973 experiment Butters, et al presented verbal and non-verbal materials in different modalities as follows:

1. Visual: CCCs and Vanderplas and Garvin (1959) computer-generated random shapes (unnamable).
2. Auditory: CCCs and sequences of 5 piano notes.
3. Tactile: outlines of letters and raised unfamiliar figures.

They used a combination of the Peterson and Peterson distractor technique and the Konorski delayed comparison procedure (the subject has to say whether a second stimulus is the "same" or "different" from that first shown, Stepien and Sierpinski,1960). They found the 9 Korsafoff's were significantly impaired in their retention of verbal material in all modalities at both 9 and 18

second delays compared with normal and alcoholic controls. They reported retention of the non-verbal material as normal.

In 1975, de Luca et al used verbal and non-verbal distractor conditions in the visual and auditory modalities to study the learning of verbal (CCCs) versus non-verbal (random shapes) material. There were no significant differences between the Korsakoffs and controls on the nondelay trials, but the Korsakoffs demonstrated a severe verbal memory deficit when the retention interval was filled with a verbal distractor activity, visual or auditory. When no distraction or a non-verbal distractor was used (eg. scanning snowflakes or plotting musical notes) their verbal retention was equivalent to that of the controls. In contrast, retention of non-verbal material was impaired under all distractor conditions and even when there was an unfilled delay interval.

Reassessing their 1973 data, the authors now comment that there had been a non-verbal deficit in this study for the Korsakoffs at the 18 second interval for materials presented in the visual and tactile modalities, but it was not nearly as severe as the verbal memory deficit. They postulate a defect in visualization imagery, a mechanism thought to be used to maintain non-verbal information. To support this they point to the fact that the Korsakoffs' retention of the shapes was more easily disrupted by visual than auditory distraction, whereas the opposite effect was found for the controls. This finding could be explained, however, on the basis of the Korsakoffs' increased sensitivity to interference from similar material.

Poor retention of the shapes could also be interpreted in terms of a defect in information processing (Oscar-Berman, 1973): perhaps the controls were quicker in finding associations for the shapes? This in turn could be related to a failure of verbal mediation and encoding.

That amnesics are impaired in the short-term retention of material which does not lend itself to verbal mediation and thus rehearsal had already been suggested by studies on H.M. Prisko (reported Milner,1970) used a series of non-verbal visual and auditory tasks (shades of red, lights flashing at different frequencies, nonsense patterns, clicks and tones) in the Konorski delayed-comparison paradigm and found that H.M.'s performance fell off sharply as the delay interval increased (even without distraction), so that

by 60 seconds his performance approached chance levels. His performance was normal when there was no delay. Normals in contrast, had low error rates on these tasks even at 60 seconds with distraction.

Sidman, Stoddard and Mohr (1968) found that H.M. could not correctly match ellipses to a sample with delays greater than 5 seconds, and that by 30 seconds his choice was not even close to the sample. Normals, including children, show accurate matching for delays of 40 seconds or longer. They postulate that his deficit could have been due to his failure to devise a verbal code to mediate retention. H.M.s' performance was in fact similar to that of a dysphasic and contrasted with his ability to retain CCCs for intervals of 40 seconds or longer if there was no distraction, a task on which the dysphasic was inferior (Isaacson, 1972).

Warrington and Baddeley (1974) take issue with these studies on H.M. saying that since normals show no forgetting on the delays tested, STM is either not being measured, or forgetting is being washed by a ceiling effect. In support of their hypothesis that STM is normal and LTM only impaired, they cite the study of Wickelgren (1968) which appeared to find a normal STM decay for tones in H.M. They fail to mention that H.M.s' original learning was below normal in this study, that decay rates were only assessed up to 8 seconds, and that there was no attempt made to assess LTM. (Wickelgren has since become a single-trace theorist, Gruneberg, 1976). In their own study Warrington and Baddeley found 7 amnesics to be significantly impaired in their recall of the location of 5 dots 2 minutes after 10 learning trials, but no different from the normal controls in their recall of the location of a single dot over intervals from 0 to 60 seconds, filled with a counting task. They conclude that for non-verbal as for verbal material, LTM is impaired and STM normal in amnesics. However, they overlook entirely the significance of the interference theory hypothesis that it is the <u>similarity</u> of the intervening material to the preceding material that produces the forgetting, whether in STM or LTM: counting backwards is not a visual task and so would not produce the decrement seen with <u>interference</u> in the amnesics.

This forcing of the STM-LTM dichotomy in interpreting experimental results on amnesics, and redefining 'STM tasks as LTM tasks if the amnesics do show a defect, also occurs in the 1973 paper by Warrington and Taylor. Here they

found amnesics impaired compared to normals in their immediate span for faces and in their retention of 3 faces over 30 seconds. They conclude that performance on this task depends on LTM and that this is why amnesics are defective. This sort of circular reasoning to support theories about both separate systems and amnesic impairment is not acceptable.

Drachman and Arbit (1966) found 5 amnesics with bilateral hippocampal damage to have normal immediate span for both paired lights and digits, but impaired accumulative storage of both visual and verbal supraspan material. The amnesics were unable to learn extended sequences although given as many as 25 trials without delay. They redefine the limits of LTM as including the immediate recall of supraspan memoranda and the recall of subspan memoranda where there is distraction or delay. STM they regard as lasting until attention is redirected. (Thus the Peterson and Peterson technique becomes a measure of LTM). It is beyond the scope of this study to evaluate these theoretical proposals. It seems more parsimonious to leave aside where STM ends and LTM begins and merely postulate that in supraspan learning there is interference from the later items in the list.

Defects of non-verbal retention have also been shown by Starr and Philips (1970) who found a post-encephalitic amnesic to recognise abstract designs at only chance levels, both immediately and 20 minutes after presentation, in contrast to his better visual recognition of words and familiar objects - although he was impaired on all tasks compared with normals. Kimura has also shown defective continuous recognition of nonsense designs following right temporal lobectomy (1963), and Brooks has shown a similar defect of continuous recognition in patients with memory defects following severe head injury (1972, 1974a, 1974b).

Talland (1965) tested progressive trends in repeated recognition of patterns in a group of 10 Korsakoff alcoholics. Although they could match adequately with the model present, the Korsakoff performance was defective at zero delay and declined with each successive attempt, while that of the controls remained constant. Talland also found the Korsakoffs to be deficient in determining the similarity or difference of two short musical patterns presented in quick succession (1965).

Perceptual-Motor Learning

There is evidence that continuous motor skills may be learned by amnesics. H.M. has shown acquisition of such motor skills as mirror-drawing and a variety of manual tracking and coordination tasks (Milner, Corkin and Teuber, 1968). Learning of a visual stylus maze however was grossly defective when the number of choice-points was in excess of immediate span, and he showed no reduction in errors on a 28 choice-point maze over 215 trials. Milner (1970) postulates that this is because later learning interferes with the retention of earlier choice points. When the maze was shortened he still took far longer than normals to learn it, but showed some "savings" at relearning (although again inferior to that of normals) a week and even two years later. It should be noted the acquisition of these various skills is "learning without knowledge" as H.M. always denied having ever seen the materials before.

Starr and Philips (1970) have shown learning and "savings" at relearning on the Porteus mazes in a post encephalitic amnesic, although his performance was defective compared with normal controls. He was also able to learn new pieces of music and demonstrate perfect retention over days once started on the first notes, although he had no recollection of the name of the piece or the practice session. This disjunction between his grossly impaired verbal retention and relatively intact motor learning was consistent with his daily behaviour: he could find his way around the hospital grounds, but was inaccurate in reporting conversations held minutes earlier.

Brooks and Baddeley (1976) similarly have demonstrated almost normal perceptual-motor learning in a mixed group of amnesics on the Porteus mazes, a jigsaw puzzle assembly and a pursuit rotor task.

Talland (1965) found that on problems where learning proceeds with immediate proprioceptive cues, eg. puzzles, mazes, pegboards, Korsakoffs may start at a disadvantage, but improve with practice at much the same rate as the controls. Where more extensive plans of action are required, amnesics do not improve with practice, perhaps because they cannot retain maps and plans of action for any length of time, whether in a visual, a kinesthetic, or a symbolic code.

It seems possible that different memory mechanisms are involved in perceptual-motor learning than in other learning.

Long-term Storage and Retrieval

a. Long-term Storage

Impairment of long term retention is well documented in amnesics. Evidence compiled shows defective retention of lists in excess of span; little or no improvement in learning over trials; abnormal forgetting with increasing delay intervals, and defective day to day retention (Talland, 1965 Samuels et al 1971; Cermak et al 1971; Warrington and Weiskrantz 1968a,1968b; Brooks and Baddeley, 1976). This was attributed by some observers to a failure to transfer information to long term storage (eg. Drachman and Arbit,1966; Milner,1970). However, evidence has gradually built up that some of this seemingly unlearned or forgotten material has in fact been stored.

Korsakoff himself had come to the conclusion that patients in fact retained some unconscious impression of passing events, and that it was recall that was faulty; while Brodmann in 1902 had shown "savings" in nonsense syllable relearning after 7 months; and Scheider in 1912 had demonstrated "savings" in the recognition of partly exposed pictures (Talland,1965). Williams (1950) also showed savings in picture recognition in patients in the post ECT amnesic state. Learning on perceptual-motor tasks had also shown that even severe amnesics could retain some material (Milner,1970, Starr and Philips,1970). The tendency of amnesics to make intrusion errors from previous learning has frequently been observed (eg. Talland,1965; Baddeley and Warrington,1970; Starr and Philips,1970; Samuels et al,1971) and constitutes evidence that storage has in fact taken place.

b. Retrieval by partial information techniques

The Warrington and Weiskrantz studies (1968b, 1970, 1974, 1975) showed that relatively efficient learning and retention could be demonstrated in amnesics when partial information techniques were used to facilitate retrieval. The partial information was given in the form of fragmented drawings of words and objects or the initial 3 letters of words. In these experiments,amnesics required more learning trials than normals to reach the criterion, showed the usual significantly impaired retention

when tested by free recall or recognition, but showed either significant savings or normal retention for intervals from 1 minute to 72 hours when retention was tested by partial information techniques. Using lists of 8 words, they showed the normal superiority of retrieval by recognition over retrieval by free recall for the controls, but not for the amnesics. In contrast, retrieval by partial information was superior to recall in the amnesics but not in the controls. This differential effect of the retrieval conditions for the two groups was statistically significant (1970).

The paradox that partial information in the form of initial letters or fragmented words should be more effective for retrieval in amnesics than yes-no recognition where the whole word is presented, Warrington and Weiskrantz attribute to the property of partial information in allowing for the elimination of false positives, thereby reducing the number of alternatives available. This would be important if information in LTM was not properly categorized or if there were too many items of information in storage. Since some of their studies (eg. Warrington and Weiskrantz, 1971) have suggested that amnesics can organize and classify information to some extent, they favour the explanation that information in storage is either not inhibited or not dissipated in amnesics as in normals. This would account for the high incidence of prior list intrusion errors in amnesics on free recall, and their tendency to false positives on recognition (which is known to be particularly subject to proactive inhibition). They suggest that what both retention by partial information and the learning of motor skills have in common that preserves them in amnesics is a freedom from the effects of interference (Warrington and Weiskrantz, 1970).

In 1974 Warrington and Weiskrantz attempted to test the hypothesis that the partial information technique works for amnesics because it limits the number of response alternatives available. In a series of experiments they manipulated the number of alternatives possible from their initial 3 letter prompts. Findings are contradictory and do not reach significance. These experiments are all rather flawed for interpretation: they are often based on only 4 amnesics (eg. 1970, 1974); guessing is difficult to control, there are ceiling effects, and they use different control subjects for the various experiments which would mean different P.I. loadings between amnesics and controls.

The notion that the amnesic syndrome is a defect of retrieval from storage but not of encoding or consolidation of information to be stored, was challenged by Woods and Piercy (1974). They were able to duplicate the finding of a significant interaction between the method of testing retention and subject group using normals with a weak memory trace (ie. 1 week later) versus normals with a strong memory trace (ie. 1 minute later). Each subject learned a list of 100 words and was tested on half of them at 1 minute and half at one week. Different subjects were used for the different retention conditions. The performance of normals on yes-no recognition at one week was significantly inferior to their performance at one minute; but their performance on partial information techniques at 1 week was not significantly different from that at 1 minute. They thus conclude that amnesic memory can be simulated by normal forgetting over time, making it misleading to interpret the amnesic defect as one of retrieval. Their observations on false response rates using yes-no recognition versus initial letters make it difficult to believe that the partial information technique does limit the occurrence of false positives.

Weiskrantz and Warrington (1975) reply to this article with a detailed criticism of the role of Woods and Piercy's methodology in producing this result. They reject the fragmented word technique as unreliable and adjust Woods and Piercy's initial letter scores for false positives such that the forgetting of the normals on this task parallels that on recognition and the differential retrieval effect disappears. They then repeat the experiment on normals, and show that forgetting on both initial letters and recognition is less at 10 minutes than at 24 hours, but the forgetting decrement is parallel for the two techniques. The interaction between retrieval technique and retention interval is not significant. However, in this experiment a few more methodological variables still were introduced by the use of different subjects for the different time intervals (ie. both retrieval techniques were assessed in half the subjects at 10 minutes and the other half at 24 hours).

It is difficult to determine which findings are acceptable. Methodology in these studies has differed with regard to use of various combinations of the same or different subjects over time intervals and retention conditions, (all of which would produce contaminating effects from

practice, rehearsal and interference); with regard to the procedures used in correcting the different retrieval conditions for guessing and false positives, and with regard to a host of other factors such as presentation rates, list lengths, the number of lists presented, inter-list intervals and the number of learning trials. It is not disputed that there is retention in amnesics, but it is not clear that the partial information technique reliably supports the hypothesis that the amnesic defect is one of interference in storage as opposed to, say, poor encoding or deficient search strategies, or a combination of factors.

c. Storage defects versus retrieval defects

Cermak et al (1971) showed savings in the paired-associate learning of Korsakoffs over 4 days using a recognition technique, although they were defective compared with controls. As it was those items that were learned to criterion on Day I that were successfully retrieved over the following days, they conclude the problem is less one of retrieval than of a transfer from STM to LTM.

An impairment in the long-term storage of amnesic patients has been demonstrated by Bushke and Fuld (1974) and Fuld (1976) using a restricted reminding technique which permits analysis of storage, retention and retrieval. In restricted reminding, each item on a list is presented only until it is recalled once, but attempted recall of the whole list is required on each trial. Recall of an item that was not presented on the previous trial shows that information about the occurrence of the item on the list has been encoded. The cumulative number of items recalled at least once without presentation on the preceding trial can then be used to estimate storage. Each instance of such recall without further presentation shows that encoded information is retained in long-term storage, and ability to retrieve this information can be assessed for amnesics relative to normals.

The technique permits verbal learning in amnesics as it restricts the interference that has been found to occur with presentations on every trial (Fuld and Buschke in press, Fuld 1976). An extended recall period has been found necessary to demonstrate storage and retrieval: many items were retrieved from patients after they had said "I can't", but

were encouraged to keep trying.

Fuld (1976) used this restrictive reminding technique with 3 Korsakoff alcoholics and 3 office workers matched for age. A single category list (20 names of animals) was presented and attempts to recall the whole list were repeated for 12 trials, with words only being presented again if they had not yet been recalled on any trial. As in previous studies (eg. Talland,1965; Warrington and Weiskrantz,1968a),there was virtually no increase in patients'overall recall over trials (ie. $\pm$ 8 items per trial). However, there was considerable encoding in long-term storage as demonstrated by their spontaneous recall of different items on each trial without presentation. The Korsakoffs were significantly impaired in their overall storage of items compared with the controls though, (ie. they recalled a total of 12 items at least once compared with the controls' 16). Patients made only half as many item retrievals as controls: their ability to retrieve items consistently over trials (list learning) was seriously impaired but their ability to make random retrievals was not.

This failure of consistent retrieval may be the consequence of a failure to encode-for-consistent-retrieval, but this in turn may be related to deficits in a number of cognitive strategies, as,for example, difficulties in item processing, in relating items to other items in a semantic context; and difficulties in changing hypotheses relating to retrieval strategies.

Recognition

Defective recognition has been shown in amnesics for words, faces, familiar objects, paintings and abstract designs (eg. Cermak, Butters and Goodglass, 1971; Warrington,1974; Starr and Philips,1970). Recognition is superior to free recall in amnesics as well as in normals, but that it does not show the same degree of advantage in amnesics has been suggested by Warrington and Weiskrantz (1968a, 1968b, 1970). Their 1968a study suffers from a confusion of effects as they were assessing not only free recall and recognition using different procedures, but also the learning over trials and the effects of increasing the retention intervals. Nonetheless it is evident that the continuous recognition technique, in which the same 10 "new" words were

presented along with the learned words for yes-no recognition after each learning trial, yielded very poor scores in the amnesics. False positives were higher on this retention condition than on any other, the incidence being the highest with the maximum number of learning trials. Controls did not have the same difficulty with this technique. One cannot conclude, as they do, that recognition does not show the normal marked superiority over recall in amnesics, but only that this particular recognition technique fostered the build up of P.I. and confusion as to the temporal context of the familiar "new" and "old" material.

In the 1970 Warrington and Weiskrantz experiment, amnesics achieved normal levels using partial information (fragmented words or initial letters), but did not show the superiority of recognition over recall shown by controls. Reading their experimental procedure, one can see that the recognition condition would build up more P.I. than the other retention conditions, simply because, after list learning, double the number of words were presented for yes-no recognition and there were no interlist intervals, whereas in the other retrieval conditions there was an interval for guessing in which P.I. could dissipate before the next list was presented. This build up of P.I. should produce a greater relative decrement in the amnesics than the normals (Cermak and Butters, 1972). In addition, Warrington and Weiskrantz corrected the recognition score for false positives, but did not subtract errors on the free recall or partial information conditions.

Huppert and Piercy's 1976 study suggests that it is the familiarity of the material that leads to confusion in recognition and that amnesics are severely impaired in discriminating the temporal context of learned material. In one experiment they presented 80 magazine pictures (chosen to be as discriminable as possible), 80 words, (half of high frequency, ie. familiar, and half of low frequency, ie. unfamiliar) and assessed recall at 1 minute and recognition at 10 minutes, 1 week and 7 weeks in 5 Korsakoff alcoholics and 5 non-Korsakoff alcoholics. The Korsakoffs were inferior to the controls on recognition, and grossly inferior on recall, but they showed the same rate of forgetting across the retention intervals as the controls. Like the controls, they were best at recognising pictures and worst at recognising high frequency words. However, on the high frequency words the Korsakoffs showed an abnormally high false positive rate and it is evident that they have a tendency to say "yes" to familiar words whether or not they were in the presentation list. On the unfam-

iliar material, ie. the rare words and the pictures, they can achieve good recognition by making a familiarity judgment alone, but for familiar material recognition by context is required.

They further conclude that the memory defect is not material specific as the magnitude of the Korsakoffs' performance decrement relative to that of the controls did not differ over the 3 types of material. It should be noted, however, that this experiment does not tell us about non-verbal retention as subjects were required to verbally describe each picture as it was presented.

They also did not find 2-choice recognition proportionately superior to yes-no recognition in the Korsakoffs as would be expected on the basis of Warrington and Weiskrantz's hypothesis (1970) that techniques which limit the number of alternatives have a greater facilitatory effect for amnesics. However, their procedure probably did not build up interference in the normal way as the presentation rate was slow (9 seconds per picture); material was highly discriminable; and there seems to have been no limit imposed upon the time taken for recognition. These factors undoubtedly also account for the high rates or recognition achieved by amnesics in this study (eg. 74% correct on yes-no recognition of pictures at 7 weeks).

On a second experiment, recognition by temporal context was required. Korsakoffs were impaired in their ability to differentiate material seen 10 minutes before from material seen the day before, but not in their ability to differentiate material seen before from that never seen before. They had a dramatically higher proportion of false positive responses to the familiar material in the temporal context experiment. The finding that the judgement of familiarity per se was at ceiling level is inconsistent with Gaffan's hypothesis (1972, 1974) that amnesia is a defect of distinguishing the familiar from the unfamiliar. They suggest that the primary defect in amnesia may concern contextual memory rather than memory for items as such.

Talland (1965) similarly found that Korsakoffs would misjudge a list of words presented minutes before as having been presented a week or so before.

Impaired contextual memory may implicate encoding processes but, before moving onto experiments related to this, it is interesting to note that some observers have attributed the entire amnesic defect to an underlying disturbance in apprehension of the flow of time. Thus van der Horst in the 1930s considered

there to be a breakdown in the process by which temporal markers are attached to experiences (Talland 1965). This would help to account for the disorientation in amnesics, the lack of correct sequencing of their memories of the past, and some aspects of confabulation. His conclusion that patients would therefore be more likely to forget events impregnated with temporal signs, ie. personal experience, rather than impersonal information imparted to them, has not been supported by empirical evidence. Furthermore it has been shown that Korsakoffs' are not incapable of registering the sequence of events (Talland 1965). Williams and Zangwill (1950) similarly noticed disturbed temporal judgments in their patients with severe memory disorders and coined the phrase "agnosia of succession", but regarded this temporal disordering as an effect rather than a cause of the memory impairment.

Encoding

One possible explanation for the poor retrieval of amnesics is that failure to encode or categorize material efficiently in the input stage may result in no access routes or cues being available at the time of retrieval. Several studies have been done on organizational processes in amnesics, with the usual conflicting results. Starr and Philips (1970) found that their post-encephalitic amnesic had his best recall of verbal items when he ordered them into categories and generated a story from them. Weingartner (1968) demonstrated better learning for related than random words in patients with left temporal lobectomies. However they were not as good at clustering as their controls who had had right temporal lobectomies. Talland (1965) found perceptual classification to be broader in Korsakoffs than in controls, ie. they were overinclusive, but Warrington and Weiskrantz (1971) failed to reproduce this difference between amnesics and normals. Warrington and Weiskrantz's other experiments on perceptual classification, isolation, and subjective clustering were marred for interpretation by too low a level of learning in the amnesics, ceiling effects in the controls, or a failure of any effect in either group.

In teaching lists of words to normals, it is known that providing cues such as the class name of intra-list categories (eg. animal, vegetable) increases the probability of the item being recalled. The Boston and British groups published contradictory interpretations of the relative benefits of cued recall versus free recall in amnesics. They agreed that amnesics are inferior to normals in their retention of words under both conditions, but Warrington and

Weiskrantz (1971) reported a superiority of cued recall over free recall for both amnesics and normals, while Cermak and Butters (1972) reported that the recall of Korsakoffs, in contrast to that of their controls, decreased significantly under cued conditions. These discrepancies were produced by methodological differences, the Boston group having assessed immediate recall, while the British group assessed recall after a 1 minute distraction interval.

A repetition of these experiments by Cermak, Butters and Gerrein (1973) confirmed the findings of both groups: cued recall was inferior to rote free recall at no delay, but was superior to free recall following distraction. This latter effect, however, was not due to an increase in cued recall, but to a decline on the free recall task. (The distraction task probably blocked the recency effect). This suggests that the Korsakoffs tend to rely on rote recall, but can use category cues to retrieve the words lost on free recall after a delay.

The false recognition experiment (Cermak, Butters and Gerrein, 1973) involves yes-no recognition of 60 words presented on card, only 6 of which are actually repetitions. It assumes that if a subject encodes primarily on an acoustic dimension he will falsely recognise homonyms (eg. bear - bare); if on an associative dimension, his errors will be associates (eg. table - chair); while synonym errors (eg. robber - thief) indicate that a still higher level on encoding has been reached. There were no significant differences among the types of errors made by the controls, but the Korsakoffs made significantly more homonym and associate errors. They conclude that although Korsakoffs are able to encode upon all dimensions when instructed to do so, left to themselves they tend to use more elementary, less efficient coding devices, particularly that of acoustic (rote) encoding which is known to be subject to very rapid decay even in normals.

Repetition of the false recognition experiment on a post-encephalitic amnesic yielded findings parallel to those of the Korsakoff alcoholics (Cermak 1976), while a group of Huntington's chorea patients had a different pattern of errors with no more false recognitions under any condition than the controls, but also fewer correct recognitions (Butters, Tarlow, Cermak and Sax, 1976).

That amnesics may be particularly prone to encode acoustically rather than semantically is supported by Brooks and Baddeley's finding of significantly

more acoustic intrusion errors in the free recall of word lists by amnesics, but no differences between them and the controls in the number of semantic and unrelated intrusion errors (1976).

An impairment of spontaneous taxonomic encoding in Korsakoff alcoholics is also suggested by their failure to show the normal release from P.I. that occurs when material from a category differing from that of preceding material is introduced on the STM forgetting paradigm (eg. if there is a change over to "vegetables" after several trials of "animals"). (Cermak, 1976): Impaired processing of words with respect to their category membership, although the distinction between numbers and letters was adequately processed, has evidently also been shown in Korsakoffs by Cermak, Butters and Moreines (reported Fuld 1976).

Support for a defect of sophisticated encoding strategies is also suggested by Baddeley and Warrington's (1973) finding of a failure in the amnesics to take advantage from visual imagery coding, although they claimed to be able to generate visual images (eg. to pictue "The Irishman gave a penny to the monkey playing the violin", the underlined words being the ones given for recall). The amnesics performed at a lower level than controls on all conditions, but were able to gain advantage from phonemic (acoustic) and semantic (category) clustering compared with their free recall of unrelated words. They did not gain proportionately as much from the semantic clustering as did the controls, but the authors decline to interpret this on the grounds of the smallness of the sample size and differences in guessing probabilities and overall performance levels on the tasks. It has been suggested that semantic memory comprises two separate but related systems, one based on linguistic relationships, the other based on imagery (Paivio, cited Baddeley and Warrington 1973). They conclude that amnesics are impaired in their usage of at least one type of semantic coding.

Jones (1974) found that the use of visual imagery significantly improved the paired-associate learning and delayed recall of patients with left temporal lobectomies, although they were still impaired when compared with normals and with right temporal lobectomies. It had been expected that the right temporal lobectomies would be impaired in their use of visual imagery to aid recall, although their free recall of paired associates would be normal. Their performance was comparable to that of normals under both retention conditions, however, which may suggest that the visual imaging of words is a left hemis-

phere function. The two bilateral amnesics in this study (who would be comparable to Warrington and Baddeley's patients) were totally unable to recall any paired-associates with or without visual imagery. (It should be noted that Baddeley and Warrington, 1973, used lists of 4 single words presented four times, while Jones used lists of 10 paired-associates presented three times).

Cermak (1975) was able to demonstrate facilitation of recall in Korsakoffs with visual imagery coding techniques when only 2-unit associations, instead of 4-unit associations, were required. He concluded from a series of experiments that imagery can aid both storage and retrieval of verbal information, but that semantic cueing aids only the retrieval process.

Talland (1965) also noted the possibility that amnesics do not have available the devices by which information in excess of storage capacity can be recoded into shorter lists of items that are within capacity. He postulated, that the source of their ineffective coding operations was a low rate of search for appropriate categories of classification. The Korsakoffs' trouble began when the familiar templates for information did not quite fit. They were then unable to sort according to other criteria, and had particular difficulty when the material was meaningless or unfamiliar.

It can be concluded from these experiments that, while amnesics can encode along semantic dimensions when instructed to do so, they are impaired in their ability to do so spontaneously and in their ability to devise encoding strategies generally.

Talland (1965) also postulated that it might not be the unavailability of codes that distinguishes amnesic performance, but their lack of flexibility and inability to see the same information in more than one pattern. His experiments had shown an inability in the Korsakoffs to use more than one perceptual set at a time. This, however, suggests a defect in information processing.

Information Processing

One explanation for the impoverished encoding in amnesics has been offered by studies suggesting that they may have a deficit in the amount of information they can process at any one time. Talland (1965) found Korsakoffs performed poorly on tests of divided attention because these tasks demand rapid shifts in orientation and the maintenance of multiple sets. Their performance was

inferior to that of the controls on disjunctive reaction time (RT) experiments demanding a divided perceptual set. This decrement increased as the amount of information per signal increased and when more than one sensory channel was used. An anticipatory signal, instead of having the normal effect of speeding up RT, paradoxically slowed it down. Talland postulated that the proper response to a preparatory cue is continued inhibition until the response signal arrives, and concluded that Korsakoffs may either be slow in releasing the inhibitory reaction, or they may have greater difficulty in coding information received in multiple signals.

Studies by Oscar-Berman and the Boston group (Glosser, Butters and Samuels, 1976) have demonstrated that alcoholic Korsakoffs have abnormally long processing times for materials presented tachistoscopically and that the more information they have to process, the more impaired their performance. On auditory tasks, involving dichotic inputs, they do not seem able to analyse all incoming information when the decision processes are complicated. Given extra time, they can extract more information, but still make more errors than controls.

Oscar-Berman (1973) used the learning of 2-choice visual discrimination tasks to evaluate hypothesis testing and focusing behaviour in Korsakoff alcoholics, non-Korsakoff alcoholics and normal controls and left hemisphere damaged patients. The Korsakoffs could formulate and use hypotheses, but their strategies were inefficient and they arrived at the correct solution less frequently. They used fewer hypotheses, but tended to perseverate these strategies even when they were inappropriate. This pattern of results continued in the presence of memory aids, thus suggesting impaired functioning independent of a retention deficit. These findings are interpreted as provinding support for the role attributed to limbic system structures in maintaining normal inhibitory control of behaviour.

The difficulty with evaluating the significance of these studies is that they seem to confound information processing and retention variables. A change in strategy requires that knowledge of the outcome of the previous strategy should be retained. The instructions for the different conditions are often so complicated (eg. Glosser et al, 1976) that it would be remarkable if the Korsakoffs could retain them, especially if the possibility of interference from instructions in the previous conditions is considered. Nonetheless this suggestion of an information processing deficit may account for some of the discrepant findings between the Boston and the British groups as the former tended to use a faster presentation rate. This would then lead to poorer encoding and fewer cues at retrieval.

SUMMARY OF IMPAIRED MEMORY PROCESSES IN AMNESICS:

It is concluded from the preceding review that there is experimental evidence to support the following postulates about the nature of memory impairment in amnesics:

1. There is abnormal sensitivity to interference from preceding and interpolated experiences. This is accentuated by massed practice or continuous presentation techniques and by the similarity of the intervening material to that which is to be learned.
2. Learning and retention may be facilitated to normal or near normal levels when the rules governing learning restrain interference. When interference is not constrained, however, there is less cumulative learning over trials than in normals and a greater proportionate loss over time of what has been learned. (The passage of time allows for a progressive build up of interference from endogenous and exogenous distractions: Drachman and Arbit, 1966).
3. Encoding is impaired. There is a tendency to use the rapidly decaying acoustic coding rather than the more durable semantic encoding. There is a deficit in the application of category cues and clustering techniques and in the use visual image strategies. This may lead to the poor organization of material in storage and/or result in few cues and access routes being available at the time of retrieval.
4. The information-processing rate is slower than in normals and multisensory inputs (interference?) increase the performance decrement. (Encoding may be impaired because at presentation rates adequate for normals, amnesics do not have time to process and integrate the information, eg. detect category cues or form associated visual images).
5. Nonverbal material is poorly retained over even short intervals. This may be related to impaired encoding strategies (eg. a deficit in verbal mediation or poor visualization abilities) or may be related to an underlying defect in information processing.
6. Perceptual-motor skills may be acquired and retained, but there is no conscious recollection of the acquisition process, and learning and retention are often not at normal levels.
7. Consolidation in storage may be impaired. That is, less of the information that has been shown to have been registered may be consolidated and retained for long term retrieval by amnesics than by normals. Material in storage may be poorly categorised or not adequately inhibited or dissipated.

8. Retrieval is impaired:

   a. Free recall techniques, particularly where learning was not governed by cues given again at the time of retrieval, result in little of whatever was stored being retrieved. Extending the recall period available may facilitate recall, but not to normal levels.

   b. Cued recall by partial information techniques (initial letters, fragmented words) facilitates retrieval, but the 'normal' levels reported may be an artefact of methodology.

   c. Recognition techniques facilitate retrieval, particularly if material is highly discriminable, but the facilitation is less marked than in normals. One explanation for this that recognition techniques mean that more material of a similar nature is presented and thus interference is increased, particularly where continuous recognition is used. Where recognition by temporal context is required, amnesics are impaired.

Implications for Memory Test Techniques

The following principles should be followed to maximize manifestation of defective memory processes:

I Presentation principles

1. Information given should be in excess of immediate memory span so as to allow concentration on the later material to interfere with retention of the earlier.
2. Rate of presentation of material should be rapid, particularly where encoding (ie. categorizing, forming associations, or visualizing) would facilitate retrieval.
3. Verbal materials in which clustering by category would facilitate retrieval should be presented without directing attention to these cues.
4. Visual materials presented should not lend themselves to verbal encoding.
5. In multi-trial learning, all the material should be presented on each trial, not just that which was not recalled on the previous trial.
6. Inter-trial intervals should not be given, ie. multi-trial presentations should be closely packed.
7. Materials presented for yes-no recognition should not be easily discriminable.
8. Judgment by temporal context should be required (ie. potential for confusion as to what was presented when should be enhanced).

II Interference in Learning

1. In multi-trial learning, distraction tasks which block rehearsal and facilitate interference should be used:
   a. Distraction tasks should follow immediately upon presentation of material to be learned.
   b. Distraction-task material should be in the same modality as the material to be retained.
   c. Performance on the distractor task should be paced.
2. Tests, particularly those in the same modality, should follow upon one another without inter-test intervals.

III Retrieval Principles

1. Recall procedures should be "free", ie. no cues should be provided.
2. A limit should be placed upon the time available for recall.
3. Recognition procedures should be multichoice or involve continuous recognition as "old" or "new".
4. Delayed retention should be assessed.

IV Scoring

1. Intrusions from earlier learning or personal experiences should be penalized in recall techniques.
2. False positives in recognition should be penalized.

CHAPTER 5

REVIEW OF CURRENT MEMORY TESTS

Current memory tests will now be assessed in terms of their validity and clinical usefulness. In assessing the memory of an individual a wide range of tests is needed. Memory debility is not an all-or-none affair, even in the most severe amnesics: Talland (1965) found there was no stable hierarchy of performance amongst his Korsakoff patients and that correlations between test scores rarely reached statistical significance.

'Memory' is regarded as a group-factor within the wider field of cognitive ability. Early studies include those of Ebbinghaus in the 1880s on forgetting, and Bartlett in the 1930s on remembering. Bartlett warned against studying memory in isolation, and demonstrated that what is remembered is dependent on other cognitive and affective factors (Talland, 1965). Memory is an active process and depends on the involvement and response of the organism, factors difficult to control in the test situation.

Several memory tests seem to have been compiled without any theoretical basis, and without knowledge of the nature of organic memory impairment and of test techniques which would elicit memory defects. Comments on the tests reviewed are made in terms of their validity in detecting memory defects, the range of memory functions covered, their suitability for use with the local population, and their usefulness in identifying the hemisphere in which the lesion occurs. (The validity of this last concept is admittedly questionable but was imposed in selecting tests for the current battery. See p.64 for justification).

Early memory tests, little used nowadays, but whose items occur in adapted forms in many current tests and memory experiments, include the Wells and Martin Memory Examination (1923) and some subtests of the Babcock and Levy Test of Mental Efficiency (developed in 1930 and revised in 1940 and 1965). 'Old' memories, eg. personal information and school knowledge (reciting the alphabet, days of the week, doing arithmetic, naming objects, giving town-state associates, etc.) are assessed and the time taken to reproduce these memories is reflected in the scoring. The only tests of current memorizing ability on the Wells and Martin are picture postcard recognition and the repetition of digits and sentences. Items tapping the "fixation" phase of memory on the Babcock and Levy include repetition of sentences, repetition and retention of

a paragraph, picture and word recognition, reproduction of block-tapping sequences and of designs, and a 3-trial learning of town-state associates.

Both tests are complex and time-consuming. They were standardized on restricted populations (psychotics and paretics) and the contents and norms are outdated (Yates, 1972).

Zangwill (1943, 1946) dispelled some of the myths about tests such as the above which were regarded as tapping memory. He found that tests requiring verbatim reproduction of a short series of discrete stimuli from immediate memory, eg. digit or sentence repetition, may be well done by patients with gross organic retention defects, and tests requiring recall of unrelated items after a few minutes, (eg. the "Name, Address and Flower" test), did not differentiate organics from functionals. He presented (1943) three tests of rote learning:

1. Supra-span repetition of digits: This involved the repetition of digit sequences one or two digits in excess of span. Zangwill cited patients with post-traumatic memory difficulties who had normal memory span (6, 7, or 8 digits) but who could not repeat strings one digit in excess of span even over 10 or more trials.

2. Sentence Repetition: This involved rote learning of the Babcock sentence "One thing a nation must have to become rich and great is a large secure supply of wood". Rate of learning depends upon immediate memory span and it is necessary to use a longer paragraph with highly intelligent patients. Zangwill provisionally assumed a retention defect if more than 8 repetitions were needed. Amnesics tended to have difficulty with serial organisation of responses, while dysphasics had difficulty with syntax, not substance.

3. The Rey-Davis pegboards. This is a performance test in which the subject has to learn the position of 1 fixed peg amongst 8 other removable pegs on each of 4 boards. The Boards can then be rotated and relearned at each new orientation. Zangwill gave no indication of what would be considered normal learning, but the qualitative errors he observed in organics included stereotyped patterns of response, perseveration of responses from one board to the next or from one orientation to the next, and unstable

learning. The test was not reliable in patients of high intelligence.

Zangwill found that the performance of neurotics on these tests was variable and inconsistant, while the learning of organics was slow and incomplete. He pointed out that post-traumatic cases whose main difficulty is forgetfulness, may be able to cope with these learning tests. The language and content of the Babcock sentence make it unsuitable for use in South Africa; the problems of the Rey-Davis Board are discussed under the William's battery; but supra-span digit learning has been incorporated into the present study.

The Wechsler Memory Scale

(Wechsler, 1945) is in wide clinical use despite little and controversial data on its efficacy (Howard, 1950; Bachrach and Minz, 1974). Although it is marketed, it is not listed in the exhaustive Seventh Mental Measurements Year Book (1972). It consists of seven subtests: Personal and Current Information; Orientation; Mental Control (counting backwards from 20, reciting the alphabet and counting by threes); logical memory (two storied for immediate recall); Memory Span (digits forward and backward); Visual Reproduction (of geometric designs exposed for 10 seconds each); and Associate Learning (3-trial learning of 10 paired associates). The test takes only about 15 minutes.

Provisional norms were based on 200 subjects and the mean scores at each age level weighted so that they would be equivalent to Wechsler-Bellevue intelligence quotients. A memory quotient (M.Q.) is derived. Two forms are available, but comparability is difficult to assess as the test ceilings are too low for normal adults with a high school or better education. Wechsler concludes that the scale "should be useful in detecting special memory defects in individuals with specific organic brain injuries" (1945, P.6). Wechsler, however, did not validate the test on such a group and other studies have yielded disappointing results.

Cohen (1950) using 15 scores derived from WMS subtests, found no significant differences at all between groups of 45 patients with intracranial pathology, 81 psychoneurotics and 18 schizophrenics matched for age and Wechsler-Bellevue I.Q.s. In fact, the M.Q.-I.Q. discrepancy is least for the organic group (95.5

to 99.1). Parker (1957), using two groups of 30 male medical hospital patients matched for age and intelligence, found their M.Q.s to be almost identical, (93.9 to 93.7) although the one group had extensive brain injuries of fairly recent origin. He concludes that M.Q.s derived from the WMS are not valid indices of memory. He points to the Eysenck and Halstead (1945) study (discussed more fully later) which suggest that the common factor in such tests as those found on the WMS is one of intelligence and not memory.

Howard (1950) compared the WMS scores of a group of organic psychotics with non-organic psychotics matched for age, length of hospitalization, education and occupation and was able to differentiate only some of a subgroup of paretics from their controls. The groups were not matched for intelligence,and inspection of his data shows that the organic groups, and particularly the significant paretics, had lower intelligence than their controls. Thus it could be argued that the WMS score is reflecting a general decline in intelligence rather than any specific impairment of memory ability. In a later study using 126 psychotics, half of whom were organic , Howard (1954) was able to confirm only 1 of 12 a-priori hypotheses based on WMS scores.

Kljajic (1975) compared 19 organic neuropsychiatric admissions (diagnosed by AEG and EEG) with 18 nonorganic admissions, matched for age, sex and intelligence and found no significant difference on M.Q.s or any of the WMS subtests except the Associate Learning.

Walton (1958),using the WMS in a 2 year follow-up of 50 psychotic patients over the age of 65, found that single testing yielded a high percentage of misclassification of functional disorders as organic. By the 4th assessment, however, the WMS was a more accurate predictor of diagnosis. Scores of "learning" were derived which showed that functionals improved with repetition of the test to a more significant degree than did organics. It takes time to use the WMS in this way, however, and Walton points out that there is a need for a shorter test involving the principle of successive opportunities to learn. He suggests that depression or apathy induced by long hospitalization produced an apparent memory disorder and a false diagnosis of dementia. This results from the limited type of memory measurement offered by the WMS though: it measures only registration which has been shown to be impaired in depressives, but does not assess retention which would differentiate the depressives

from organics (Cronholm and Ottosson, 1963b; Sternberg and Jarvik, 1976).

Some studies have shown individual WMS subtests to be useful in detecting organic brain damage. Brooks (1972) found patients with severe head injuries to have significantly lower scores on the stories and paired associate learning than their controls, but it should be noted that he matched for education level (a premorbid factor) and not for intelligence. Bachrach and Mintz (1974) found that Information, Stories, Designs and Associate Learning significantly discriminated between 2 groups of 42 psychiatric patients with and without mild cerebral dysfunction, though the amount of differentation achieved by Designs alone (89%) was nearly the same as that of all subtests combined. A criticism of this study is that patients were matched on vocabulary scores, a 'hold' test more likely to indicate premorbid than present intelligence (Wechsler, 1958).

Predictive indices developed using information from the WMS include Holland's (1974) cut-off points for improvement across trials of the Associate Learning which significantly differentiated brain damaged from non-brain-damaged psychiatric patients; and Kljajic's (1975) regression equations: (1) Digit span - 1 $>$ Associate Learning. (2) Information and Orientation $\geq$ Associate Learning), which discriminated organic from non-organic neuropsychiatric cases with 70% accuracy. The usefulness and reliability of these formulae need to be established by cross-validation studies.

WMS and Intelligence:

One assumption arising from the lack of memory defects found in the organics in the studies where intelligence was controlled, is that the WMS is tapping general intelligence rather than any specific memory factor. Ivinskis, Allan and Shaw (1971), extending WMS norms down to the 10 year old level, did a factor analysis of subtest score intercorrelations on the WMS, WISC and WAIS, and found there was clearly no single "memory" factor for their sample. They concluded that it is questionable whether these subtests do constitute a scale of memory, particularly when the relatively low split-half reliability of the WMS and the low intercorrelations between its subtests (only 4 out of 21 were significant) are considered.

Eysenck and Halstead (1945) did a factor analysis on the scores of 60 neurotic

patients on the Ravens Progressive Matrices and on 15 tests of the type commonly used to assess memory, eg. digit repetition, stories, paired associates, design reproduction (as on the WMS); letter, word, and photograph recognition, Knox Cube imitation and sentence repetition, etc. All the memory tests correlated with the intelligence test, but with the influence of intelligence excluded (which accounted for 74% of the variance) they had little in common. They conclude that there is no need to regard these tests as estimates of a separate "memory" factor. They point out that these tests measure only registration and do not proceed to the retention phase of memory.

WMS and Amnesics

It could be argued that there is no reason to assume any specific memory impairment in the groups of organics discussed above, and that the validity of the test should be considered in terms of its efficacy in discriminating groups, where there is such specific impairment. The WMS has a better record here. The classic studies on the alcoholic Wernicke - Korsakoff syndrome by Victor, Talland and Adams (1959) show that the WMS M.Q. was significantly lower than the Wechsler-Bellevue I.Q. at all phases of the disease, even though intelligence was initially affected as well. The subtests, however, varied considerably in their sensitivity to impairment. Orientation and Visual Reproduction scores improved as the early confusion and perseveration cleared; stories were initially grossly impaired, but improved in the later phases; while Associate Learning revealed the most severe deficit with many of the patients unable to learn the difficult associations even in their stable chronic phase.

Drachman and Arbit (1966) found that their 5 patients with severe memory defects from proven or presumed bilateral hippocampal lesions had WMS quotients significantly lower than those of controls (84 to 133), although there was no significant difference in the intelligence of the two groups (119 to 121). There were significant differences on the Orientation, Stories, Digits Backwards, Visual Reproduction and Associate Learning subtests, but no significant differences on Digits Forward, Information and Mental Control.

Since the WMS taps primarily verbal rather than visual memory, one would expect scores to be depressed in patients with left temporal lobe lesions. Milner's 1958 studies show that in fact the M.Q. was lower that the I.Q. both pre- and post-operatively. Glowinski (1973) found that temporal lobe epileptics have difficulty with the WMS stories, but that none of the other subtests discriminate

effectively between them and a comparable group of centrencephalic epileptics, or contribute any significant information about the nature of memory impairment.

Summary on the WMS

The conclusion from this survey is that the WMS is of little use in differentiating organic disorders from non-organic disorders unless there is a severe and specific impairment of memory functions, and then it reveals little about the differential nature of the memory impairment. Several factors contribute to this:

1. The lack of scaled scores for the different subtests. This is statistically and theoretically unsatisfactory. Raw scores are simply totalled so that a point on a subtest where 6 out of 6 is the mean (Information) carries the same weight as a point on a subtest where 8 out of 21 is the mean (Associate Learning), and a point on a subtest which has little to do with memory, the same weight as a point on a subtest which has been shown to tap memory.

2. Factor analytic studies, consideration of the way the test was designed, and validation attempts on organics all suggest that it is tapping a general intelligence factor rather than a specific memory factor.

3. It taps only very limited aspects of memory. Associate Learning which assesses acquisition over several trials seems to be the most useful subtest, followed by the Stories which tap immediate recall for material in excess of span. Its greatest deficiency is the absence of any measure of delayed retention. Several of the authors reviewed above (eg. Milner, 1958 and Glowinski, 1973, on temporal lobe epileptics, and Brooks, 1972 on head injuries) report that they found delayed recall of WMS Stories the most valuable measure in discriminating their groups, yet no such measure is included in WMS scores.

4. Cultural bias in the selection of stories, language factors in the paired-associate learning, and the need of education before complex shapes can be drawn, make the WMS unsuitable for use in a culturally mixed society.

Guild Memory Test

(Gilbert, Levee and Catalano, 1968): This test was developed in response to a need for tests of "meaningful" memory; ie. of the ability to form new associations, to integrate new data or retain recently learned material. It is an adaptation of the WMS and is available in two forms, consisting of:

(i) immediate recall of two paragraphs;
(ii) immediate recall of 10 paired associates;
(iii) digit span forward and reversed,
(iv) recall of the number associated with each of 10 numbered designs presented earlier and in a different order for 5 seconds each;
(v) retention of the two paragraphs; and
(vi) retention of the paired associates.

The test is meant to be used as a supplement to the Wechsler Adult Intelligence Scale (WAIS), (Wechsler, 1958) and the authors intend to provide separate scores for each test at each age level comparable to the WAIS. In the preliminary standardization, 300 subjects between the ages of 20 and 34 had been tested. Correlations between the tests throughout the intelligence span are quite high, (scores increasing with vocabulary level), but when intelligence is restricted to the normal, the correlations are not high. They conclude that there is no single test which can adequately measure "memory", but that different aspects of the memory function must be measured to secure a picture of learning ability. It seems unlikely however, that this test is tapping different aspects as, although it has introduced a measure of retention as well as registration, it is primarily tapping only verbal free recall. There is no measure of multi-trial learning or retrieval through recognition. The memory for designs test, altered to eliminate the perceptual-motor factor which often complicates assessment of memory for non-verbal material, appears to tap visual-verbal association rather than non-verbal memory per se. While the test as a whole will probably be an improvement on the WMS, its heavy verbal loading makes it of little use with a culturally mixed patient population.

Williams Scale for the Measurement of Memory (1968):

Williams stressed the diagnostic necessity of assessing different aspects of a person's memory independently and considering the pattern of performance rather than any single score. The Williams scale has been prepared in 3

parallel forms to measure the following functions:

1. Immediate recall: Digits forwards and backwards.
2. Non-verbal learning: The Rey-Davis boards (see Zangwill's test above) scored for the number of errors made over a maximum of 5 learning trials.
3. Verbal learning: A list of 8 rare words and their meanings are presented and scored for errors made on up to 5 learning trials.
4. Retention of recent events: Delayed recall of pictures of 9 common objects after 7 to 10 minutes in which Test 5 intervenes. A second trial is given with cues for objects not previously recalled, and then a third trial in which objects must be recognised from amongst a group of 15. The score for omissions increases on each trial and is cumulative.
5. Memory for past personal events: Questions to assess recollections in different periods of life, ranging from school days to recent events such as last Christmas. Individual variations made the test difficult to quantify so it was left out of further calculations.

Williams provided weighted scores based on the performance of 50 nursing staff and university graduates, mostly under 30 years, and on a group of 102 patients with mixed neuropsychiatric symptomatology. No significant differences were found between the 3 forms of the test, and test-retest showed no significant practice effects for the normals. There was a tendency for intelligence to be correlated with increased scores amongst the normals. The effects of age could not be assessed in the under 30 year old control group, and were confounded by the effects of different symptomatology in the patient group (ie. younger patients had neurotic or personality disorders, while the older patients were diagnosed as organic or depressed). Considering groups of alcoholics, neurotics, depressives and organics separately, Williams concluded that the Rey-Davis is sensitive to the effects of age, while the Delayed Recall is sensitive to age, but predominantly to organic impairment. There was poor differentation of organics and non-organics on the other subtests.

White, Merrick and Harbison (1969) in a study of the Williams scale with psychiatric patients, found the Delayed Recall test to be the most valid in terms of its ability to predict EEG abnormalities and in terms of its high correlation with the Walton Black Modified Word Learning Test (MWLT), which enjoys some standing as a valid measure of cerebral pathology. Digit span also showed a significant correlation with EEG abnormalities, (predictable

as the EEG abnormalities suggested Alzheimer's dementia and this test correlates with intelligence). The Verbal Learning subtest correlated significantly with the MWLT, but just failed to discriminate patients with abnormal EEGs. The Rey-Davis test proved neither valid nor very reliable, and suggestions for changes in administration are made by the authors.

Although the three forms of the scale yielded significant correlations, these were not sufficiently high for the forms to be regarded as interchangeable. Test-retest reliability correlations were significant but low. The unstable nature of the psychiatric population used could have influenced both these findings, however. The subtests did not appear to be independent (in terms of tapping different aspects of memory) as positive correlations emerged between the Rey-Davis and Verbal learning subtests and between Verbal Learning and Delayed Recall. These correlations were low, however, and became even more tenuous when intelligence was partialled out. The Rey-Davis was affected by both age and intelligence, while Delayed Recall was affected by verbal intelligence.

Limited local experimentation with the William's Battery, not formally analysed, tends to support the findings of White et al with regard to the usefulness of the different subtests. The Rey-Davis has proved difficult to administer and score,and no confidence has been felt in interpreting results from it. Verbal learning is useful (with educated groups only),but not as sensitive as the MWLT. Delayed Recall (Set A) has proved extremely useful with all population groups as a quick bedside test of memory. Minor difficulties have included the translation of cues for prompting and the scoring of false recognitions. Since 1968, the Delayed Recall has been used by many Clinical Psychologists in a number of different hospitals in the U.K. and Williams has put out a manual with the scores of 949 subjects, tabulated by age groupings. There is considerable over-lap in diagnostic categories and, as would be expected, not all 'organics' are impaired.

Delayed Recall was not selected for inclusion in the present battery, as picture learning does not clearly tap only visual or verbal learning. It correlates with the verbal learning subtest, and is affected by ECT to the left hemisphere, but can be learned by aphasics on a non-verbal basis, ie. without the interference from covert verbal mediation usually found in normals (Conrad, 1964; Williams, 1973; Goodglass, Denes and Calderon, 1974).

Williams has said that a list of words would probably be as effective (White et al 1969) and this assumption is tested by the inclusion of delayed recall of the shopping list in the present battery.

Barbizet and Cany (1968; 1969) have a battery of memory tests, some personal, some borrowed, which they have used extensively at their Center for the Rehabilitation of Memory and Learning near Paris:

1. Auditory Stimuli, Verbal Responses

   a. Digit Span A: repetition of digit strings of increasing length.
   b. Digit Span B: a supra-span test with one more item added each time to those in the previous list.
   c. Lion Story: a 22 unit story presented for immediate recall and for recall after delays of 1 hour, 24 hours and 1 week.
   d. Rey's Word List: 15 familiar words presented 5 times with intervals of 10 seconds allowed for free recall after each presentation. Performance is scored for number of words correctly recalled, words regularly recalled, intrusions, and time taken. A story containing all the words in the list is then given and scored for recognition.

2. Visual Stimuli, Verbal Responses

   KIM: 20 items are presented on a tray for naming and immediate recall. The tray is presented again with objects correctly recalled on one side and the others grouped apart. Delayed recall is tested after 1 hour, 24 hours, and 1 week. Performance is scored for time taken and number of items recalled.

3. Visual Stimuli, Motor Responses

   7/24 Test: The position of 7 pieces on a 24-square checker-board has to be reproduced. Up to 15 trials, each with a 10 second exposure, are allowed. Delayed reproduction, with relearning if necessary, is tested after 5 minutes, 30 minutes and 24 hours. Each performance is scored for the number of pieces correctly placed and trials required to reach perfect learning. If a subject continued unsuccessful, the pattern was

simplified to 5 pieces.

The following aspects of memory are thus tapped: (Barbizet and Cany's terminology)
Immediate memory: Digit Span A; 7/24 test
Immediate recall (for a supraspan amount of information): KIM Tray; story.
Learning: Digit Span B; Rey's Word List; 7/24 test.
Retention: Story; KIM Tray; 7/24 test.

Findings

The test was administered to 120 patients with cerebral lesions (1968): 30 with left hemisphere lesions; 30 with right hemisphere lesions; 42 with neurological disease of alcoholic origin, and 18 with senile or presenile dementias. Mean scores obtained by different groups of normals, often medical students or a group over 64 years, are given but they point out that these should be regarded merely as points of reference and that they have no indices of variability. This obviously imposes limitations on the use of the test, but the study is extremely valuable for the light it throws upon the sensitivity of different materials in detecting various lesions, and the differences in memory functioning between alcoholics and dementias.

The story clearly differentiated between the right and left hemisphere groups, with the rights achieving normal scores, the lefts being as impaired as the dements, and the alcoholics scoring in between. Only the alcoholics and the dements showed a decline in material retained over the delay intervals. This test was considered suitable for inclusion in the present battery.

It is difficult in the absence of statistical analysis to see how well span and supraspan techniques differentiated the groups. The dements were slightly poorer on span A and span B, but otherwise only the lefts were impaired on Span B, and this varied relative to the amount of aphasia present. Drachman and Leavitt's (1974) adaptation of this task was preferred for inclusion in the present battery.

The Rey word list showed the most impairment in the left-hemisphere group; the alcoholic encephalopathies and the dementias have depressed scores; while the

right hemisphere group have completely normal scores. The word list given is not culturally suitable, but it was considered that the usefulness of this type of task had been sufficiently well demonstrated to warrant adaptation as a shopping list in the present battery.

The KIM Tray and the 7/24 test, both of which were given as "visual" tasks, showed greater impairment in the left than the right hemisphere group, suggesting that verbal mediation was involved. The greatest impairment was shown by the dements, while the alcoholics' performance was roughly equivalent to that of the lefts. Since these tasks seem to involve mixed visual-verbal memory, they were not included in the present battery.

More adequate norms are needed before these tests can be used. It is not clear from the articles how long the test takes, nor how the tests were presented. It is obviously important to know how the delay intervals were filled and how the presentation of new materials overlapped with the delayed recall of old materials. A letter to Barbizet in 1974 failed to elicit this information.

NOTE: This study tells us little about memory in the right and left hemisphere groups (they showed almost no forgetting of material learned), but something about the cerebral functions that must be intact in order for structured information to be apprehended. Lesions were in the retro-Rolandic area and not specific temporal lobe lesions.

Cronholm, Molander and Ottosson Battery

Three tests have been developed into a battery which has been validated in studies of patients following ECT (Ottosson, 1960; Cronholm and Ottosson, 1963a, 1963b). Material is presented once (learning) and remembering is assessed immediately and after 3 hours. Scores are obtained for immediate reproduction, delayed reproduction, and "forgetting" (the difference between immediate and delayed reproduction). The first session takes 30 to 45 minutes and the second session 15 minutes. Two forms of the test are available. The tests are:

1. The 30 figure test: The 30 common objects depicted are named by the examiner. Recognition is from a picture with 60 drawings and incorrect answers are subtracted to correct for guessing.

2. The 30 Word-pair test: The word pairs, which have a conceptual relationship although the degree of association is under 1%, are shown and read to the subject. Order of presentation is changed when the stimulus words are presented to elicit recall.

3. The 30 personal data test: Six drawings of fictitious persons are shown in succession and 5 facts related about each (eg. age, profession, hobby). The score is the number of facts correctly recalled when the drawings are presented in a different order.

Reliability and validity data culled from several studies are presented by Cronholm and Ottosson (1963b). Pre- and post-shock test data for 112 patients undergoing various modifications of ECT are compared. The coefficient of internal consistency (Kuder-Richardson formula) is higher for the test as a whole that for any of the subtests. It is satisfactory (ie. in the 80's or 90's, Anastasi , 1968) for the immediate-reproduction scores, but sometimes lower for the forgetting scores. This is to be expected, however, as the latter are derived from the Immediate and Delayed scores, both of which are subject to experimental error. Data on the 'parallelism' of the two forms of the test are not that clear and higher scores by the control group on Form I in one study are attributed to an unequal composition of the groups receiving the two forms.

Evidence for concurrent validity was estimated through point-biserial correlation of test scores with ECT treatment or control condition. In order to get independent data, groups of patients under experimental conditions were compared with all other control conditions. 'Forgetting' proved a highly valid measure of both retrograde and anterograde amnesia, achieving perfect or nearly perfect discrimination for all three tests, so combining them could not increase validity. In the study of retrograde amnesia, measures of immediate reproduction were taken prior to ECT and, as would be expected, were much the same under experimental and control conditions. In the study of anterograde amnesia, where learning occurred after ECT, the validity coefficients for immediate reproduction are consistently fairly high, though not as high for "forgetting", and none of these coefficients reach the magnitude of those obtained for "forgetting" in the retrograde amnesia study.

Construct validity is suggested by results supporting their hypothesis that all measures denoted "immediate reproduction" indicate a common, hypothetical construct "learning", and all measures denoted "forgetting",a common hypothetical construct "retention". They used the Campbell and Fiske' multitrait-multimethod correlation matrices to demonstrate the convergent and divergent validity of such measures. The pattern of correlations for "forgetting" is sometimes divergent for the two test forms, but is more consistent when they are combined. Spurious correlations between "immediate reproduction" and "forgetting" (from the latter score being partly derived from the first) rather distort findings on divergent validity.

Further support for the validity of the test is provided by the Cronholm and Ottosson (1963b) study on the relationship of ECT to objective and subjective memory change as a function of the alleviation of depression,and the Sternberg and Jarvik (1976) study on memory defects in depression and response to antidepressants. This latter study used the battery in an abbreviated form, 15 words pairs, 15 figures and 9 personal data and found that the greater the improvement in the clinical state, the greater the improvement in immediate reproductions scores. (Depression affects registration, but not retention and forgetting scores were not impaired).

This test appears to have acceptable validity and reliability. It taps different stages of the memory process (immediate registration and retention) and for fairly diverse materials and retrieval processes (eg. associate verbal recall and multiple-choice visual recognition) although the latter variables are not subjected to statistical analysis. Materials were not suitable for the present study as they are not culture free (the paired-associate learning involves language; the common objects are not "common" locally; and data such as hobbies and professions related to the photographs are too sophisticated and Westernized). Further, both the figures test and the personal data test tap a mixture of verbal and visual memory.

Conclusion

Of all the tests described above, only the Cronholm, Molander and Ottosson battery has provided data which show it to be a reasonably reliable and valid test of memory. The Williams test attempts to provide adequate standardization data, but only one of the 5 subtests has been shown to detect organic

memory impairment. The earlier tests such as the Wells and Martin and the Babock and Levy are cumbersome measures of a host of cognitive abilities besides memory and have outdated or inadequate norms. The work of Zangwill (1943; 1946) and of Barbizet and Cany (1968, 1969) provides a guide to the type of test items useful in detecting memory impairment in patients with various cerebral disorders, but does not constitute a standardized test battery amenable to cross-validation. Wechsler (1945) seems to have selected tests on their face validity and his scale is neither statistically acceptable nor has it stood up to cross-validation. If a test is to measure memory impairment, it requires validation on subjects with defective memory. Standardizing tests on normal groups and weighting scores for age and intelligence levels is premature when it has not been established that the test measures memory. This was Wechsler's mistake,and it seems to be being perpetuated by the authors of the Guild test.

Since the one adequate test of memory is not suited for use with a multiracial and often poorly educated patient population, it is necessary to design a test that is.

CHAPTER 6

SELECTION OF TESTS FOR THE EXPERIMENTAL MEMORY BATTERY (EMB)

CRITERIA FOR THE SELECTION OF TESTS FOR THE EMB

In an attempt to ensure the clinical usefulness of the tests in the present battery, the following criteria for selection were imposed:

A. Empirical Validation

The test, or the principle on which it is based, should have been shown to detect memory impairment.

B. Construct Validity

Comments under this heading will refer back to the Summary of Impaired Memory Processes in Amnesics, (p. 44) based on the review of experimental evidence. Rather than state each time that poor performance on a particular test could be due to an information processing defect, an encoding deficit, failure of consolidation, disinhibition in storage, or retrieval problems, but that these processes cannot be operationally differentiated, attention will be drawn to the principles that were utilized to enhance manifestation of memory impairment. (See Implications for Memory Test Techniques, p.46). Where an operational definition of a process is possible, a hypothesis regarding its impairment will be given. Where it is possible to determine whether a scoring principle did contribute to increasing the discrimination of scores, a hypothesis stating this will be proposed.

C. Verbal-Visual

The test material should be clearly verbal or nonverbal. There is a body of evidence that associates verbal functions with the left cerebral hemisphere, and visual-spatial and constructional skills with the right cerebral hemisphere (Milner, 1962, 1971; Mountcastle, 1962; Piercy, 1964; McFie, 1969; Dee and Fontenot, 1973; Kimura, 1973).

(For the limitations, problems and paradoxes of such an approach to hemispheric specialization see Geschwind, 1969; Sperry, Gazzaniga and Bogen, 1969; Vincken and Bruyn, 1969; Milner, 1971; Marshall, 1973).

There have been numerous reports in the literature attesting to the success of various psychological tests in predicting the lateralization of brain lesions. These tests use the concept that verbal deficits are the result of left-hemisphere lesions, and visual-spatial deficits the result of right-hemisphere lesions (McFie and Piercy, 1952; Reitan, 1955; Dennerll, 1964; Fields and Whitmyre, 1969; Goldstein and Shelly, 1973; Benton, Levin and Van Allen, 1974; Lansdell, 1975). It therefore seems useful to build such possibilities of prediction into the test, bearing in mind the limitations of such an approach.

D. Cultural

The test material should be so "culture-free" that it is equally meaningful or meaningless to all population groups involved in the study. The verbal items should lend themselves to easy translation into the patient's home language (or daily working language, in the case of Africans) and should not be obscure nor require education for comprehension.

For the visual items, tests involving recognition rather than any drawing or constructional abilities were preferred. Studies in Africa, India and the West Indies have shown that perceptual and executive skills may be less well developed in nontechnological cultures than in Western society (McFie, 1969). Local studies on Coloureds from the lower socioeconomic groups and Africans have shown that their scores on tests involving the copying of designs and assembling of block-patterns are well below the norms of the standardization groups (usually American or British), and may even be in the brain damaged ranges. (Egnal, 1975a, 1975b; Friend, 1974).

Where possible, materials that would be equally familiar (eg. stories, shopping lists, faces) or unfamiliar (eg. nonsense designs, block-tapping) to all groups were chosen.

E. Motivation

It was assumed that material that had some meaning in daily life (eg. shopping lists, faces, stories) would be intrinsically interesting. To provide motivation where material was less relevant to daily experience, an opportunity was given to improve performance over trials. It has been shown that the need for achievement can be a strong motivating force (eg. Byrne, 1966).

RATIONALE FOR TEST SELECTION

Each of the tests included in the EMB will be described in terms of how they meet the selection criteria.

I VERBAL TESTS

1. Lion Story

A. Empirical Validation:

(i) Immediate Recall: Impairment in the number of items amnesics can recall from a story immediately after presentation has been shown by Zangwill (1946), Talland (1965), Drachman and Arbit (1966) and Starr and Philips (1970). Such impairment has also been shown in patients with severe head injuries (Brooks, 1972), and in temporal lobe epileptics as contrasted with centrencephalic epileptics (Glowinski, 1973).

(ii) Delayed Recall: A deficit in delayed recall has been found to be a valid discriminator of patients with organic memory impairment by Zangwill (1946), Milner (1958), Drachman and Arbit (1966), Barbizet and Cany (1969), Starr and Philips (1970), Brooks (1972), and Glowinski (1973).

B. Construct Validity:

(i) Immediate Recall: The story material is in excess of span and requires some sequential integration. Rehearsal of the first part of the story may interfere with processing of the second part. Alternatively, concentration on the second part may interfere with consolidation of the first part. Attempting to retell the story starting from the beginning would block the acoustic traces of the second part. Since patients may choose to concentrate on either half, or may just attempt to extract a sketchy gist of the story (Talland, 1965), it is not possible to predict which half of the story will be less well recalled. Correlation between the two halves will be computed for patients and controls, however, and qualitative comments made, if possible, on strategies used.

(ii) Forgetting: Patients could achieve lower Delayed Recall scores than the controls on the basis of inferior Immediate Recall scores. Whether there is greater relative forgetting in the patients than in the controls will be assessed by the formula "Immediate Recall-Delayed Recall". Greater forgetting could be anticipated on the basis of decay or interference in consolidation from the intervening tests; or from a failure of cues available to facilitate retrieval. To exercise some control over this last possibility, anyone "forgetting" completely what the story was about will be given a reminder in the question. "Was it about a dog, a lion or a policeman?"

(iii) Confabulation: Details, characters and incidents introduced that were not in the original story, termed "confabulations", will be subtracted from both the Immediate and Delayed Recall scores. A tendency for amnesics to introduce such confabulations has been reported by Zangwill (1946); Victor, Herman and White (1959); and Talland (1965). Such confabulation could result from a lack of limits set upon the alternatives available in recall (Warrington and Weiskrantz, 1970), or from a lack of cues as to temporal context (Huppert and Piercy, 1976).

Whether subtracting such confabulations from the story scores helps to increase the discriminant power of the test will be assessed by comparing the incidence of confabulation in patients and controls.

C. Verbal-visual: Story recall has been shown to be impaired in patients with left-hemisphere lesions but not in those with right hemisphere lesions (Barbizet and Cany, 1968; Milner, 1958).

D. Cultural: Story telling is a communication form that probably occurs in all cultures. The theme, the longing of a mother to obtain her baby back from a lion, would seem to have universal human significance. The sequence of events is clear and elements are those likely to be within the experience of all race groups. The story lends itself to easy translation.

E. Motivation: A story is meaningful material, corresponding to the sort of anecdote or incident one is expected to remember in daily life.

2. Shopping List

A. Empirical Validation:

(i) Multi-trial learning of lists of words has consistently been shown to be impaired in amnesics, whether assessed by free recall or recognition (Talland, 1965; Warrington and Weiskrantz, 1968a; Cermak et al, 1971; and Fuld, 1976). Distraction through counting for intervals of 20 to 30 seconds following presentation is known to block the probability of rote recall of the last few items on the list and result in defective retention of the entire list (Baddeley and Warrington, 1970; and Brooks and Baddeley, 1976).

(ii) Delayed recall of lists of words has been found to be defective in amnesics by Talland (1965); Warrington and Weiskrantz (1968a, 1968b, 1970); and Starr and Philips (1970).

B. Construct Validity:

(i) Multitrial Learning: Irrespective of the particular process to which one attributes the amnesic memory defect, one would predict poor performance on this type of multiple-presentation with interference task:

a. The list is in excess of immediate memory span so patients should be defective in their cumulative acquisition (Drachman and Arbit, 1966).

b. The rate of presentation of words, 1 per 2 seconds, should be too fast if the defect is one of information-processing (Talland, 1965; Oscar-Berman, 1973).

c. Clustering by category (eg. cleaning materials, vegetables) would facilitate retrieval, but no attention is drawn to these categories. Patients should perform poorly if their defect is one of spontaneous encoding of material (Cermak et al 1973).

d. Presentation of the entire list in different order on each trial should interfere with continued learning (Talland, 1965; Fuld, 1976).

e. The lack of inter-trial intervals should foster the build up of P.I. (Cermak and Butters, 1972).

f. Items on the list are common and should be confused with the patients' own shopping lists (Huppert and Piercy, 1976).

g. The distraction task is in the same modality as the shopping list, is presented immediately after the list, and is semi-paced, all of which should block rehearsal and increase interference (Cermak and Butters, 1972; de Luca et al 1975).

h. No cues are provided at retrieval, which should limit free recall (Warrington and Weiskrantz, 1971; Cermak et al, 1973).

i. Intrusion of items not on the list will be penalized, so patients should be impaired if they are confused by temporal context, ie. if they cannot discriminate this list from any other shopping list (Huppert and Piercy, 1976; Starr and Philips, 1970).

(ii) Delayed Recall: Delayed recall should be impaired if there is abnormal forgetting over time (Talland, 1965); if there is sensitivity to interference from the rest of the battery (Cermak and Butters, 1972); if too few access cues available (Cermak et al 1973), or if there is disinhibition in storage of other shopping lists (Warrington and Weiskrantz, 1968b, 1970) and a lack of temporal context for the present list (Huppert and Piercy, 1976).

Four of these possibilities will be assessed operationally:

a. The rate of learning over trials will be compared to see if there is a greater relative increase for normals than patients, ie. whether the patient learning gradient is less steep than that of the controls.

b. The use of clustering by category will be assessed in patients compared with controls.

c. Differences in the frequency of confabulation (assumed to be interference from a lack of discriminable temporal context for "shopping lists") will be assessed between amnesics and controls.

d. Patients could achieve lower Delayed Recall scores than controls on the basis of a lower level of original learning. Whether there is greater relative "forgetting" in amnesics will be assessed by the formula "Trial 5 Recall-Delayed Recall".

C. Verbal-visual: Impairment of word learning tasks with left-hemisphere lesions has been demonstrated by Zangwill (1946) and Barbizet and Cany (1969). The learning and retention of verbal material is selectively impaired by left temporal lobectomy, but not by right temporal lobectomy (Meyer and Yates, 1955; Milner, 1958, 1971; Blakemore and Falconer, 1967).

The goods on the list may perhaps be visualized, or visual images of their position in the supermarket may be formed. However, when actual objects or their pictures are presented instead of a list of their names, learning still tends to be primarily in the verbal medium (Barbizet and Cany, 1969; Williams, 1973; Goodglass et al 1974).

D. Cultural: Remembering a group of necessary purchases without the aid of a written list is a task common to most people living near shops. Supermarket items were chosen with the help of patients and staff from different racial groups to ensure that the items were common or familiar purchases for all. Several very basic items such as bread, sugar and coffee, were left off the list to ensure that people had to learn the actual list rather than simply itemize basic necessities.

E. Motivation: Remembering a shopping list is a task common in every day life. The material is meaningful and can be grouped.

3. Digit Span and Supraspan

(i) Digit Span:

This test was included as a warm-up for the supraspan test. In terms of construct validity, it is anticipated that it is not a test of memory but one of intelligence and that therefore immediate span for amnesic patients will not differ significantly from that of the controls (Zangwill, 1943; Eysenck and Halstead,1945; Wechsler, 1958; Milner, 1959; Talland, 1965; Drachman and Arbit, 1966; Baddeley and Warrington, 1970).

(ii) Supraspan:

A. Empirical Validation: Recall of verbal material in excess of span has been shown to be impaired in amnesics and they have been found not to show normal acquisition with multi-trial learning (Zangwill, 1943; Drachman and Arbit, 1966; Milner, 1970). A similar impairment of supra-span learning has been found when memory defects are produced in subjects by administration of substances such as scopolamine, a blocker of the effectiveness of acetycholine in the nervous system (Drachman and Leavitt, 1974).

B. Construct Validity: Normals require multiple repetition of supraspan memoranda before achieving perfect recall. Drachman and Arbit (1966) postulate that the accumulation of information with each successive exposure represents a relatively pure measure of "storage" as no additional variable of a delay interval is introduced. Storage refers to the acquisition and retention of information beyond the limits of immediate memory span. This failure may result from interference, however. Rehearsal of the first items may interfere with the processing and acquisition of the later items, or concentration on the later items may block out the acoustic traces of the earlier ones. (If counting backwards blocks the rote recall of the last words on a list, then the acoustic trace of digits should be blocked out by the presentation of yet more digits). As in the story, it is customary to begin at the beginning, which could in turn block the traces of the later items. Operational separation of possibilities is difficult, but qualitative observations as to strategies employed will be recorded.

Proactive Inhibition: If there is abnormal sensitivity to interference from previous learning (Cermak and Butters, 1972; Winocur and Weiskrantz, 1976), patients should show greater perseveration of sequences from supra-span a when learning supraspan b than do the controls. The incidence of perseveration in both groups will be assessed.

C. Verbal-visual: Left hemisphere damage has been found to impair basic digit span (Zangwill, 1946), whereas right hemisphere damage does not (Barbizet and Cany, 1969). Corsi (reported Milner, 1971) showed that cumulative learning of recurring strings of digits presented amongst non-recurring strings was impaired following left temporal lobectomy, but not following right, and that the deficit was proportional to the amount of hippocampus removed.

D. Cultural: Digits constitute sounds familiar to all population groups, whether the individuals are educated or not. An additional advantage attending the use of such materials with Africans is that they learn sequential counting in English or Afrikaans rather than in their tribal language, and so are not disadvantaged by second-language translations, (more difficult to tolerate on meaningless than meaningful material).

E. Motivation: This task lacks the intrinsic interest of meaningful material, but the successive opportunities for improved performance are a challenge to achievement. Drachman and Arbit's (1966) technique of presenting lists of increasing length for up to 25 trials each, was considered too exhausting to form part of a larger test battery, and Drachman and Leavitt's presentation of 15-digit strings was considered too intimidating for unsophisticated people. Inspection of the tables in the 1966 study showed that their amnesics (all of above average intelligence) had needed 20 trials to get 10 digits correct, while the controls had needed only 4 trials. A 10-digit string presented for a maximum of 10 trials was therefore considered likely to be sufficient to discriminate amnesics, but not to be too arduous a task.

II VISUAL TESTS

1. Continuous Recognition

A. Empirical Validation:

(i) Impaired recognition of shapes in amnesics has been found by Talland (1965); Sidman et al (1968); Prisko (reported Milner, 1970); Starr and Philips (1970); Samuels et al (1971); Butters et al (1973); Warrington (1974) and de Luca et al (1975). Brooks (1972, 1974a, 1974b) has reported impairment on this continuous recognition task in patients with memory defects following severe head injury.

(ii) An abnormally high incidence of false positives on recognition techniques, visual or verbal, has been reported by Warrington and Weiskrantz (1968a, 1970); Samuels et al (1971); Huppert and Piercy (1976).

B. Construct Validity: The rate of presentation of designs is rapid (3 seconds each) and does not allow much time for associations to be formed and encoding to occur. Half the designs are geometric and half are nonsense designs not easily described verbally. Presentation of designs for "old" - "new" (yes-no) recognition is continuous with no inter-trial intervals. Such continuous presentation is known to foster the build up of proactive inhibition (P.I.) in normals (Shepard and Techtsoonian, 1962) and to interfere with learning in amnesics (Talland, 1965; Fuld, 1976). Continuous recognition of similar designs as old or new should build up confusion as to what was seen when. False positives will be penalized.

The following possibilities will be assessed operationally:

(i) Learning curves over the 7 trials will be compared for patients and controls as it has been postulated that recognition is defective in amnesics even when false positives are not subtracted (Starr and Philips, 1970; Huppert and Piercy, 1976).

(ii) The incidence of false positives over trials in patients and controls will be compared. Interference from the similarity of the material presented (Cermak and Butters, 1972), from the competition of responses in storage (yes-no recognition does not limit the alternatives; Warrington and Weiskrantz, 1968b, 1970), or from a loss of temporal

context (Huppert and Piercy, 1976) should result in a higher false positive rate in patients than in controls.

(iii) Incidence of learning and false positives for the geometric versus the nonsense designs will be investigated in the patients and their controls.

a. The patients may have fewer correct recognitions and more false positives than the controls on the geometric designs if their defect is one of a failure of verbal mediation (Sidman et al, 1968; Butters et al, 1973).

b. The patients may have fewer correct recognitions and more false positives than the controls on the nonsense designs if their defect is one of a failure of visualization (de Luca et al, 1975), or an inability to form associations in the brief time allowed, ie. a failure of coding, (Cermak et al, 1973).

C. Verbal-visual: The performance of patients with right temporal excisions on this task is significantly inferior to that of patients with left temporal excisions, particularly on the nonsense designs (Kimura, 1963).

D. Cultural: This test was not considered "culture-free", but a search of the literature revealed little that was that did not also require elaborate construction (eg. the supraspan light strings of Drachman and Arbit, 1966). Tests such as the Benton Visual Retention Test; the Memory for Designs and the Designs of the Wechsler Memory Scale, (apart from not having been found to detect visual memory defects in patients with right temporal excisions, Milner, 1958) involve reproduction. Perceptual distortions in copying designs have been found in lower class Coloureds (Friend, 1974) and in people from non-technological cultures (McFie, 1969). This perceptual-motor distortion produces poor scores without the introduction of a memory factor. A test such as the Continuous Recognition which involves recognition instead of reproduction was therefore considered more suitable.

The nonsense designs could possibly be equally meaningless to everyone (ie. require the subject to form his own associations). The educated might have some advantage in the use of more rapid verbal mediation on

the geometric designs, but verbal mediation is not necessarily a helpful strategy as the description soon requires lengthy elaboration if designs are to be differentiated.

E. Motivation: Recognition tests are easier than tests involving recall (Warrington and Weiskrantz, 1968a). After the hard work of the multi-trial learning and free recall on the two preceding tests, it was postulated that the recognition test would be experienced as easier. Recognition also has the advantage over recall in that failure is not as obvious.

2. Faces

A. Empirical Validation: Amnesics have been found to be deficient in their recognition of faces with no delay (Warrington, 1974) and with delays of 20 seconds (Warrington and Taylor, 1973).

B. Construct Validity: The number of faces presented is in excess of immediate memory span (Warrington and Taylor, 1973, found amnesics deficient relative to normals in their immediate recognition of 2,3, and 4 faces). Recognition is delayed, with a distraction task in the same modality, (the block-tapping test) filling the interval. No inter-test intervals are given. The recognition procedure is multi-choice. A forced-choice of 12 out of 25 is required, which, while not maximizing the possible false positive contribution, also limits the number of correct recognitions that can be obtained by 'recognising' all the faces. A choice between correct recognitions and competing false positives is forced: the higher the false positive rate, the lower the correct recognition rate.

The presentation of the extra and poorly discriminable material in the multiple-choice recognition should foster interference (Warrington and Weiskrantz, 1968a). Strategies will be recorded and a qualitative assessment made of differences between amnesics and controls.

C. Verbal-visual: Facial recognition is impaired by right hemisphere lesions (De Renzi and Spinnler, 1966; Warrington and James, 1967; Milner, 1968; Yin, 1970), and by ECT to the right, nondominant hemisphere (Williams, 1973).

D. Cultural: Perception and recognition of faces is common to all people. On the maxim that "all Chinese look alike, except to other Chinese", it was originally planned to have separate sets of faces for the different racial groups. However, as members of other racial groups did not seem to have any difficulty in recognising the Coloured faces used in the pilot study, it was decided to retain them. (Collecting sets of photographs of people with no 'dress' cues and establishing their equivalence is time-consuming. Coloured people are derived from a mixture of the other two racial groups and their faces are familiar to all locals).

E. Motivation: This task was considered an interesting measure of a form of memory required in daily life. People may not be aware of their failures, so little damage is done to morale.

3. Spatial Span and Supraspan Block Tapping

(i) Spatial Span:

This test was included as a warm up for the supraspan test. In terms of construct validity, it was expected that, like digit span, it would constitute a measure of intelligence (Sterne, 1966) rather than of memory and therefore would not differ significantly in patients and normals (Drachman and Arbit, 1966; Corsi, reported Milner, 1971). Experiments on the retention of nonverbal subspan memoranda over even very short delays or no delay have yielded confusing findings, however, (Sidman et al, 1968; Prisko, reported Milner, 1970; Warrington and Taylor, 1973; de Luca et al, 1975) so the prediction of no difference is not made with any certainty.

(ii) Supraspan Block Tapping:

A. Empirical Validation: Recall of nonverbal material in excess of span has been shown to be impaired in amnesics and they have been found not to show the normal improvement with multi-trial learning (Drachman and Arbit, 1966; Corsi, reported Milner, 1971).

B. Construct Validity: Patients may be inferior to controls on this task if there is a failure of cumulative 'storage' (Drachman and Arbit, 1966). This may be the result of interference, however. The material is in excess of span and concentration on the first items in the sequence may interfere with the acquisition of the later part of the sequence, or concentration on the last items may interfere with retention of how the sequence began. Attempting to reproduce the pattern from the beginning could interfere with whatever was retained of the end of the sequence. Qualitative observations on strategies employed will be recorded.

Proactive Inhibition: If there is abnormal sensitivity to interference from previous learning (Cermak and Butters, 1972; Winocur and Weiskrantz, 1976), patients should show greater perseveration of sequences from supraspan a when learning supraspan b than do the controls. The incidence of perseveration in the two groups will be assessed.

C. Verbal-visual: Right hemisphere damage has been found to impair basic spatial span, while left hemisphere damage does not (De Renzi and Nichelli,

1975). Corsi (reported Milner, 1971) showed that cumulative learning of recurring block-sequences presented amongst non-recurring sequences was impaired following right temporal lobectomy, but not following left, and that the deficit was proportional to the amount of hippocampus removed.

D. Cultural: Learning block-sequences is a task equally unfamiliar to all population groups.

E. Motivation: This task lacks the intrinsic interest of meaningful material, but the successive opportunities for improved performance are a challenge to achievement. Corsi's technique of repeating a sequence every third trial, failed to produce learning of this sequence (the Hebb effect) in normals, so was abandoned in favour of continued presentation of the same sequence.

AIMS AND HYPOTHESES OF THE PRESENT RESEARCH

AIM

The aim of the present study is to develop a battery of verbal and visual tests which will detect memory impairment in people from different cultural backgrounds.

HYPOTHESES

The major hypotheses relate to the validity of the tests in terms of their ability to differentiate patients with organic impairment from controls without such impairment, ie. criterion validity. The hypotheses related to construct validity are concerned with investigating which aspects of memory the tests measure, and to what extent certain theories of memory impairment account for performance on the tests. The rationale of these hypotheses was detailed in the preceding section. A subgroup of hypotheses has to do with the reliability of the tests.

I CRITERION VALIDITY

The Verbal Memory Tests

1a. The scores obtained on the verbal tests by patients with bilateral temporal lobe damage ("bilaterals") will be significantly lower than those obtained by their matched controls.

1b. The scores obtained on the verbal tests by patients with left temporal lobe damage ("left-temporals") will be lower than those obtained by their matched controls.

1c. The scores obtained on the verbal tests by patients with right temporal lobe damage ("right-temporals") will not differ markedly from those obtained by their matched controls.

The Visual Memory Tests

2a. The scores obtained on the visual tests by patients with bilateral temporal lobe damage will be significantly lower than those obtained by their matched controls.

2b. The scores obtained on the visual tests by patients with right temporal lobe damage will be lower than those obtained by their matched controls.

2c. The scores obtained on the visual tests by patients with left temporal lobe damage will not differ markedly from those obtained by their matched controls.

Discriminant Analysis

Discriminant Analysis of the memory test scores will produce a linear combination of variables which will maximize the correct classification of patients as falling in the "brain damaged" category and of controls as falling in the "normal" category.

3a. Using the verbal memory test scores, the bilaterals and left-temporals will be classified as "brain damaged", while the right-temporals and all controls should be calssified as "normal".

3b. Using the visual memory test scores, the bilaterals and the right-temporals will be classified as "brain damaged", while the left-temporals and all controls should be classified as "normal".

4. The verbal and visual memory test scores will not be significantly affected by age, intelligence, sex or race.

4a. Age: Will not significantly correlate with the Discriminant (D) scores obtained by patients and controls on either the verbal or the visual tests.

4b. I.Q.: will not be significantly correlated with the D scores obtained by patients and controls on either the verbal or the visual tests.

4c. Sex: There will be no significant difference between the mean D scores obtained by males and females on either the verbal or the visual tests.

4d. Race: There will be no significant differences between the mean D scores obtained by Whites, Coloureds and Africans on either the verbal or the visual tests.

II CONSTRUCT VALIDITY

The Verbal Tests

5. The Lion Story

5a. Immediate Recall: Patients will tend to concentrate on only half the story, while controls will be more able to integrate the entire story;

(i) More patients than controls will have scores on one half of the story which are double or more than double those obtained on the other half.

(ii) The correlation between the two halves of the story will be lower for the patients than for the controls.

5b. Forgetting: There will be significantly more "forgetting", as assessed by the formula "Immediate Recall-Delayed Recall", by the patients than by the controls.

5c. Confabulation: There will be more "confabulations", ie. introduced details, characters, incidents, amongst the patients than controls on both Immediate and Delayed Recall of the story.

6. The Shopping List

6a. Rate of Learning: The patients will have a significantly slower increase in their rate of list learning over the five trials than will the controls.

6b. Clustering by Category: Significantly fewer of the patients than of the controls will use clustering by categories, ie. grouping of items according to categories such as "cleaning materials", "vegetables", etc. (For a list of possible categories see Appendix D).

6c. Confabulation: Significantly more of the patients than of the controls will introduce items not on the list, "confabulations", over the five list-learning trials and in their Delayed Recall of the list.

10. Spatial Span and Supraspan Block Tapping

10a. Spatial span: There will be no significant difference in the spatial span of the patients and the controls.

10b. Supraspan, Proactive Inhibition: Significantly more of the patients than of the controls will show perseveration of series a in their learning of series b. Perseveration = using the first item of sequence a to start sequence b, the last item of sequence a to end sequence b, or any series of 3 items from sequence a in any position on sequence b.

III RELIABILITY

Preliminary evidence of reliability will hopefully be provided by the consistency of the results obtained by the patient and control groups (Yates, 1954). Test-retest reliability is not suitable as the test involves learning and the practice effects would be marked, for the control groups at least. (Patients could be expected to improve variously according to the individual degree of their memory impairment).

Going to the trouble of developing an alternate form for a test, the validity of which has not been established, does not seem practical; also, changes in the condition of patients could affect test results if the alternate form was used to test variability in performance over time,as well as the variability of content sampling. In a busy hospital situation, it is furthermore not practical to obtain subjects to undertake testing on two different occasions.

In an effort to obtain some measure of internal consistency, it was decided to assess split-half reliability where possible. With the exception of the two supraspan tests where performance on a series a could be compared with learning on series b, few of the tests lent themselves to split-half analysis. Items on the two halves of the story are not independent. On the shopping list, an increment over trials rather than any consistency of performance is expected, and this is the case for Continuous Recognition as well. On the Faces, recognition of the individual photographs would probably be influenced by a combination of factors,such as where they occurred in the presentation sequence and their position in the recognition sequence. Nonetheless, the following split-half reliability coefficients will be calculated.

The Verbal Tests

(i) Lion Story: The split-half reliability coefficient for scores on the first half of the story (15 items) and scores on the second half (15 items) will be determined.

(ii) On the Supraspan digits, the split-half reliability coefficient of list a and list b will be determined.

The Visual Tests

(iii) On the Faces, split-half reliability will be assessed by an odd-even split of the faces in their order of occurrence on the recognition sequence.

(iv) On the Supraspan Blocks the split-half reliability coefficient of sequence a and sequence b will be determined.

Interscorer reliability: The scoring of most of the tests included is objective and a matter of clerical accuracy. The only test where the scoring rules permit a degree of subjectivity is the Lion Story, where it may be difficult to decide whether the subject's response is close enough to the original to be credited or not. Furthermore, determining what constitutes a confabulation may be difficult.

(v) Interscorer reliability on the story will be determined for a random sample fo patients and controls.

CHAPTER 7

METHODOLOGY

DESIGN

It was decided to validate the test by the method of contrasted groups. The performance of groups of patients with organic memory impairment was therefore compared with that of non-brain-damaged controls, individually matched with the patients for variables other than memory that could affect performance. Control over the following variables was thought to be necessary: (See Tables 3 to 7).

1. Intelligence: The test was designed to test 'memory' and not general intelligence. Performance on cognitive tests is influenced by a general intelligence factor (g), of which 'memory' constitutes a specific or sub-group factor (Anastasi, 1968). It was considered necessary to control the operation of the broad general factor.

2. Race: In this country, differences in race are associated with differences in cultural, socioeconomic, nutritional and educational factors, all of which could influence test performance.

3. Age: Performance on some cognitive tests declines with age (Anastasi, 1968), so it was thought necessary to control this variable.

4. Sex: This variable was not considered likely to influence memory test performance generally, but was controlled as it has been suggested that females have superior verbal skills and males superior visuo-spatial skills (Flor-Henry, 1974) and this could affect performance differentially on the verbal and visual parts of the test.

Criterion-related Validity, (in this study, classification within a "normal" group), is considered most appropriate for local validation studies in which the effectiveness of a test is to be assessed (Anastasi, 1968).

SUBJECTS

The research sample consisted of 70 subjects: 34 Whites, 28 Coloureds, and 8 Africans. It comprised 35 patients with diagnoses implying disorders of the limbic system who were individually matched for age, race, sex and intelligence with 35 control subjects who had no evidence of cerebral disease.

I THE BRAIN DAMAGED PATIENTS

Criteria for Inclusion in the Brain Damaged Sample

1. There was surgical or radiological evidence of a lesion which on anatomical grounds would be likely to give rise to a memory defect (ie. the limbic system was involved).

OR

2. Organic cerebral disease (traumatic, infective, vascular, etc.) had been diagnosed and there was a complaint from the patient, relatives, or close associates of a memory disorder. (This requirement of a "complaint" was imposed as not all patients who have had these disorders have persistent or even transient memory disorders.)

OR

3. There was a clinical diagnosis implying organic cerebral pathology (as in the alcoholic Korsakoff Syndrome or in dementia) which had been based on an apparant memory disorder existing in conjunction with a suggestive history and other clinical signs.

Procedures for Selection of Brain Damaged Patients

1. Examination of the summaries of the departments of Neurology and Neurosurgery, supplemented by clinicians' knowledge of the patients.
2. Examination of neuroradiological records for patients with lesions interfering with the limbic system and its connections.
3. Screening of referrals from all hospital departments of patients with complaints of memory defects and a suspected or proven pathology likely to cause such defects.
4. Examination of records of patients in the local mental hospital (Valkenberg) diagnosed as "Organic Brain Syndrome: Korsakoffs Psychosis."
5. Screening of a computer print-out of all hospital patients who had been given a diagnosis of Korsakoff's Syndrome in the last 5 years.

Patients were excluded if it was evident that there was a global dementia, if visual or other handicaps prevented them from being able to do the tests, or if it was likely that there would be a communication problem (eg. dysphasics and rural Africans, or Africans with no education). Except in some of the cases diagnosed Korsakoff's Syndrome (alcoholism), patients' summaries or the patients themselves were screened by an experienced neurologist to ensure that they met the criteria for inclusion. All suitable patients from Neurology and Neurosurgery were included as these patients tended to have been more fully investigated. Inclusion of patients from other sources was adjusted to make the final group representative in terms of race, sex, etc. of the patient population usually referred for psychological assessment.

Distribution of Diagnosis in the Brain Damaged Group

See Chapter 2 Aetiology, and Appendix B for details of each patient.

A. Nutritional Deficiencies: 11
   11 Korsakoff's Syndrome, alcoholic origin.

B. Neoplasm/Surgery: 9
   3 With deep midline tumours (craniopharyngiomas, colloid cysts of the 3rd ventricle).
   4 Right medial-temporal lesions.
   2 Left medial-temporal lesions.

C. Trauma: 7
   6 Severe generalized head injuries.
   1 Right temporal contusion.

D. Infective: 2
   1 Presumed Herpes Simplex encephalitis.
   1 Syphilitic meningo-encephalitis.

E. Vascular: 2
   1 Arterio-venous malformation, incompletely removed.
   1 Left posterior cerebral artery occlusion.

F. Metabolic: 2
   2 Lipoid proteinosis with radiological evidence of bilateral hippocampal calcification.

G. Epilepsy: 1
   1 Temporal lobe epilepsy.

H. Uncertain:
   1 Presenile dementia of unknown cause.

The following subgroups of brain damaged patients resulted: (See Table 2)

TABLE 2: Number of Patients in each Brain Damaged Group

Diagnosis	Number of Patients
Bilateral Limbic Damage	27
Left Temporal Damage	3
Right Temporal Damage	5
	TOTAL 35

Clinical Description of Patients: It should be noted that most of these brain damaged patients did not have the clinically obvious and severe memory disorders described in the amnesic patients who were the subjects of the experiments in the earlier Review section (Chapter 4). Those patients were described as having a severe memory defect for day to day events and as being disoriented in time and space (Baddeley and Warrington, 1970; Cermak et al 1971). The following descriptions are included to show that the majority of the present sample of patients were far less severely affected.

(a) Orientation: At the time of testing, only 4 of the 35 patients were disoriented in time, but were oriented in place; a further 2 had the year and day of the week correct, but were not sure of the month, and 1 was correct on everything except the time of the day.

(b) Employment: 11 Patients were in full employment; 2 were in-between jobs, but employable, and another 3 or 4 could expect to return to work following discharge. A few (about 8), were housewives and schoolboys, and only 7 were on, or likely to be given, disability grants; often for their physical disabilities as much as for any mental impairment. None of the 4 mental hospital patients had been hospitalized for more than 6 months: 2 could expect discharge in the near future, with return to employment, and for the other 2 discharge depended upon family resources.

(c) Other Tests: The Modified Word Learning Test (Walton and Black, 1959) had been administered to 2 patients, both of whom obtained normal scores, reaching the criterion within their first two attempts. The Memory for Designs (Graham and Kendall, 1960) had been administered to 6 of the patients, 5 of whom obtained normal scores (with 0 to 3 errors only).

(d) Impression: The impression created by the conversation of these patients was one of "normality." (This lasted until they attempted the memory tests).

II THE CONTROLS

35 Controls were selected from hospital patients and staff. This population was considered likely to be similar in socioeconomic status to the brain damaged group. Of the controls, 25 were patients, drawn mainly from the Urology, Dermatology, Ophthalmology, Cardiac and E.N.T. wards. Those patients included were those who were not too sick, in pain, or on high doses of drugs, provided that they had not been admitted for conditions likely to cause cerebral pathology. The 10 staff included were domestic workers, and clerical and administrative staff.

Each control was matched to a patient for race, sex, age (within 3 years) and intelligence as measured by the Ravens Standard Progressive Matrices. This test was administered to 132 people before controls with I.Q.s similar to those of the patients could be found: most were within 2 to 3 points of each other, and the biggest gap was 5 points. Means and standard deviations for each group on intelligence and age are given in Tables 3 and 4.

It was considered more important to control for intelligence than education level as the latter is very often determined by socioeconomic pressures. However, as Table 7 shows, a fortuitous matching was achieved on this variable as well.

III SAMPLE STATISTICS ON CONTROLLED VARIABLES

TABLE 3: Raven's I.Q.s: Range, Means and Standard Deviations for the Patient and Matched Control Groups

GROUPS	N	RANGE	$\bar{X}$	SD
BILATERALS	27	65 to 121	89,30	14,44
CONTROLS	27	66 to 120	89,78	14,73
LEFT TEMPORALS	3	103 to 126	113,00	11,79
CONTROLS	3	101 to 126	113,00	12,53
RIGHT TEMPORALS	5	71 to 105	93,80	13,16
CONTROLS	5	71 to 103	91,60	12,12

TABLE 4: Age Levels: Range, Means and Standard Deviation for the Patient and Matched Control Groups

GROUPS	N	RANGE	$\bar{X}$	SD
BILATERALS	27	17 to 63	39,56	14,62
CONTROLS	27	16 to 63	39,41	14,94
LEFT TEMPORALS	3	17 to 28	21,67	5,69
CONTROLS	3	19 to 28	22,67	4,73
RIGHT TEMPORALS	5	18 to 67	40,20	20,47
CONTROLS	5	16 to 67	39,60	20,50

TABLE 5: Distribution by Race in Patient and Control Groups

GROUPS	N	WHITES	COLOUREDS	AFRICANS
BILATERALS	27	12	11	4
CONTROLS	27	12	11	4
LEFT TEMPORALS	3	3	-	-
CONTROLS	3	3	-	-
RIGHT TEMPORALS	5	2	3	-
CONTROLS	5	2	3	-
TOTAL	70	34	28	8

TABLE 6: Distribution by Sex in Patient and Control Groups

GROUPS	N	MALES	FEMALES
BILATERALS	27	20	7
CONTROLS	27	20	7
LEFT TEMPORALS	3	2	1
CONTROLS	3	2	1
RIGHT TEMPORALS	5	3	2
CONTROLS	5	3	2
TOTAL	70	50	20

TABLE 7: Years of Education: Range, Means and Standard Deviations for the Patient and Control Groups. t - test for dependent samples.

GROUPS	N	RANGE	$\bar{X}$	SD	t
BILATERALS	27	3 to 17	9,19	3,55	-0,82
CONTROLS	27	4 to 12	8,67	1,69	NS
LEFT TEMPORALS	3	10 to 11	10,33	0,58	
CONTROLS	3	10 to 11	11,33	1,15	
RIGHT TEMPORALS	5	6 to 15	9,00	3,67	
CONTROLS	5	6 to 15	10,00	3,32	

NS = nonsignificant; $p > 0,05$; df = 26

IV CRITERION-RELATED SAMPLE VALIDITY (Buros, 1970)

In validating a test it is necessary to show that the validation sample is representative of the population for whom the test is intended (Buros, 1970). The test is designed for the hospital population typically referred for psychometric assessment. As the following descriptions will show, considerations of race, socioeconomic level and education (usually interrelated), determine which patients are referred. Thus the Coloured and African patients referred tend to be those who have had more education or have achieved a higher socioeconomic level. (For a description of these factors as related to the different race groups, see Appendix A).

Groote Schuur Hospital (GSH) serves a multiracial population. Most patients come from the lower socioeconomic groups as hospital services are specified as available only to those whose family income is under R240 per month. Most of the local African and a large proportion of the Coloured population meet this criterion. The Whites who attend the hospital are comprised of those who are of a lower socioeconomic level, and a subgroup of better educated, retired people who were of a higher socioeconomic level, but whose income now meets hospital specifications. The hospital income limit is waived where there is an emergency or where facilities for investigation and treatment do not exist privately, so some patients of all race groups come from the upper socioeconomic levels.

Data on the sample's representativeness along the dimensions of race, socioeconomic level, education, age and sex will be given. Where possible, comparisons will be made in terms of the population typically referred for psychological assessment. Where descriptive statistics for this population are not available, comparisons will be made in terms of the total S.A. population. Footnotes will explain differences between the total population and the hospital population typically referred. Patients were selected according to diagnosis, so perfect balancing was not possible. The African sample was too small for representativeness to be achieved.

A) Race Representation in the Research Sample

TABLE 8: Race Representation in the Research Sample compared with the Total Hospital Population and Patients referred to Psychologists (GSH) statistics, (1975).

POPULATION	N	WHITES	COLOURED	AFRICAN
Total Hospital In- and Out-patient Consultations	1 036 567	33%	57%	10%
Adults referred to Psychiatry Psychologists	172	63%	34%	3%
Adults referred to Neurology Psychologist	177	52%	45%	3%
Research Sample	70	49%	40%	11%

B) Socioeconomic Representation in the Patient Sample

Data on Socioeconomic level, as graded by occupation, were not collected for the controls, so will be given for the patient group only. Patients not working are rated according to their previous occupation or that of their father. Occupation levels tend to vary according to racial group membership and are therefore given separately. Percentages are rounded.

TABLE 9: Socioeconomic Level by Occupation in the Patient Sample Compared with the Total S.A. Population. (Statistics from the 1970 Population census).

RACE	GROUP	UNSKILLED SEMI-SKILLED	SKILLED CLERICAL	MANAGERIAL PROFESSIONAL TECHNICAL
Coloured	Population	75%	20%	5%
	Sample (N=14)	65%	30%	7%
White	Population	35%	45%	20%
	Sample (N=17)	6%[a]	35%	60%[a]
African	Population	80%	20%	2%
	Sample (N=4)	25%[b]	25%	50%[b]

Note: [a] The white patient sample is representative of the hospital population, which is skewed by the retired people of higher previous socioeconomic standing. [b] Africans referred to psychologists are typically those at the higher socioeconomic levels as they tend to be better educated and more Western in their orientation.

C) Education Levels in the Patient Sample

These levels tend to vary according to racial group membership and will therefore be given separately. Percentages are rounded.

TABLE 10: Education Levels in the Patient Sample as Compared with the Total S.A. Population. (Statistics from the 1970 Population census).

RACE	GROUP	LITERACY Sub A–Std 2	PRIMARY Std 3–5	JNR HIGH Std 6–8	HIGH Std 9&10	DEGREE DIPLOMA
Coloured	Population	20%	25%	15%	1%	1%
	Sample (N=14)	14%	64%	14%	–	7%
White	Population	10%	10%	40%	20%	10%
	Sample (N=17)	–	6%	60%	6%	30%
African	Population	20%	15%	7%	1%	0.3%
	Sample (N=4)	–	–	50%	25%	25%

Note: In the S.A. population, 60% of the Africans, 40% of the Coloureds and 15% of the Whites have no education. Patients with no education were not included in the sample, however, as few are referred for psychometric assessment.

The groups are representative of the hospital population typically referred; ie. there is a subgroup of better educated retired Whites; Africans referred tend to be the better educated ones, and the bulk of Coloured patients have primary school education.

D) Representation by Age in the Research Sample

TABLE 11: Representation by Age in the Research Sample Compared with 1975 Adult Referrals to the Neurology Psychologist. (Percentages are rounded).

GROUP	N	Under 30	30 to 49 years	50+ years
1975 Referrals	177	34%	33%	33%
Research Sample	70	40%	30%	30%

Note: Representation at the different age levels varies considerably for the different racial groups. Thus 50% of Whites referred tend to be 50 and over (dementias amongst retired people), while 50% of the Coloured population referred tend to be under 30 (there is a greater incidence of head-injury, epilepsy, alcoholism, and poverty-linked diseases occurring at a younger age in lower socioeconomic groups).

E) Representation by Sex in the Research Sample

TABLE 12: Males and Females in the Research Sample Compared with 1975 Adult Referrals to the Neurology Psychologist.

GROUP	N	MALES	FEMALES
1975 Referrals	177	56%	43%
Research Sample	70	70%	30%

Note: The sample ratio of males to females was skewed by the diagnostic requirements for inclusion in the study: more males than females become Korsakoff alcoholics (2:1, Victor, Adams and Collins, 1971) and more males than females suffer severe head injuries (Walker, 1966).

PROCEDURE

a) Method of Obtaining Subjects

In the brain damaged sample, in- and out-patients were given the memory test as part of a routine neuropsychological assessment. Ex-patients were sent letters requesting that they come for further assessment. It was explained to all patients that we would like them to do a memory test to see how they had recovered and to use as a baseline in assessing future recovery.

The control group were volunteers. They were told that we were standardizing a memory test and were interested in seeing how normal people of their age could perform. A few of them were offered R2.00 as a nominal compensation for giving up their spare time.

b) Testing Procedure

The Ravens Progressive Matrices and the Experimental Memory Battery, EMB, were usually administered on separate testing occasions, varying from the same day to within 2 weeks of each other. Controls, as they were being selected for the correlation of their I.Q. to that of a patient, always did the Ravens first. Amongst the patients, the EMB occasionally formed part of a broader psychological assessment, but was always done in a separate session, with the Ravens being given afterwards if this score was not already available.

c) Test Conditions

The EMB was administered to all subjects by the writer, who has had 8 years of experience in testing brain damaged, psychiatric and normal patients.

The test was administered in the subject's home language or, in the case of Africans whose basic language was Xhosa, in the language in which they had been educated and which they spoke in their working lives. The examiner is fluently bilingual, speaking English at home, but Afrikaans most of the working day.

The subject did the test sitting across the table from the examiner in a non-sound-proof office. (Most subjects were seen in the same office in Groote Schuur Hospital; 4 patients were seen in offices in Valkenberg Hospital;

2 patients in offices in Conradie Hospital; 1 control was tested in a ward, and 1 control at home. None of the settings were sound proof). Distracting noises were thought to occur randomly for both groups. Interruptions were discouraged, but occurred with a few subjects in each group.

The mean time for administration of the EMB was about an hour and fifteen minutes, varying from an hour to an hour and a half.

Subjects who felt they were doing badly were encouraged to keep trying. (Eg. "It doesn't matter. Just do the best you can. We just want to see what you can do, and what is difficult for you").

APPARATUS

I) STANDARD PROGRESSIVE MATRICES

This test was developed by Raven (1938) as a nonverbal measure of Spearman's g factor. It consists of 60 matrices, or designs, from each of which a part has been removed. The subject chooses from several options the part which best completes the design. The items are grouped into 5 sets, each with 12 problems of increasing difficulty but similar in principle. The earlier sets require discrimination, the later analogies, permutations and eduction of logical relationships. It is claimed to be a test of a person's capacity to "apprehend meaningless figures presented for his observation, see the relations between them, conceive the nature of the figure completing each system of relations presented, and, by so doing, develop a systematic method of reasoning." (Raven, 1960, p. 1).

The test is administered with no time limit and requires only simple verbal instructions. Percentile norms are presented for each age group from 8 to 14 years, and for each 5 year interval between 20 and 65 years. In the present study, the conversion table of Peck (1970) was used to convert raw scores into deviation I.Q.'s. The norms are based on British samples, but have been found applicable in several European countries (Anastasi, 1968) and in America (Vincent and Cox, 1974). The test has been found helpful in comparing various socioeconomic and ethnic groups and in estimating the general intellectual level of individuals who have communication disorders (Buros, 1965).

The Ravens was considered more suitable for use with the present multiracial sample than verbally loaded intelligence tests. Research with Africans has suggested that the test is not "culture-free", but test scores approach Western patterns as the groups adopt Western value systems (Irvine, 1969).

II) EXPERIMENTAL MEMORY BATTERY: EMB

The battery is divided into 3 verbal and 3 visual tests. Rationale for test selection was detailed earlier (Chapter: 6). Details of the tests, administration and scoring will be given here. (Afrikaans translations of the verbal tests and of all test instructions are given in Appendix C).

General Instruction: "This is a test of memory. It is made up of 6 short tests. If you can't do one, don't worry you will make it up elsewhere."

A) VERBAL TESTS

1.) Lion Story

This story from Barbizet and Cany (1969) was adapted slightly to facilitate translation and scoring, but mostly to ensure language comprehension at all levels.

(a) Immediate Recall:

Instruction: "I am going to read you a story. Listen carefully and, when I am finished, I want you to tell me as much of the story as you can remember. Ready?"

> A lion named Simba escaped from his cage which was left open by a careless keeper. A large crowd of people, visiting that Sunday, escaped to the nearby buildings. A woman, dressed in blue, dropped her son, one year old. The lion seized him. The woman went back and with tears in her eyes, begged the lion to return her baby. The lion stared at her for a long while. Finally, he let the child free, without having done him the least harm.

Figure 2: Lion Story. Adapted from Barbizet and Cany (1969).

Instruction: "Tell me whatever you can remember."

Procedure: The subject's words were written down verbatim. Since it had been found in pilot studies that people will often say "I don't know"

or "that's all" when in fact they do remember more, a series of questions were asked:

i. "Is there anything else; any more details you would like to add?"
ii. "Who else was in the story?" (To people who would only say it was about a lion).
iii. "What happened then?" or "How did it end?" (To people who have only part of the story).

Average Time Taken: Under 5 minutes.

(b) Delayed Recall:

At the end of the test battery, approximately an hour after they had first heard the story, subjects were asked to repeat the Lion story again. No forewarning of this request had been given.

Instruction: "You remember that story I read to you at the beginning? Can you try and tell me as much of it as you can remember?"

Procedure: The subject's words were again recorded. The questions listed above were repeated. If the subject was blank as to what the story had been about, he was asked "Was it about a Dog, a Lion, or a Policeman?" If he then replied "a Lion" and continued with the story, the rest of the story was scored, but not the Lion.

Scoring: The story was divided into 30 units and 1 point was given for each unit mentioned. (Initially the story had been divided into 20 units, but this gave rise to too many half points and queries). Details, characters and incidents introduced by the subject were regarded as confabulations and 1 point was subtracted for each. Separate scores for Immediate and Delayed Recall were computed. (See Appendix D for scoring details).

(c) A "Forgetting" score, ie. "Immediate Recall-Delayed Recall", was computed.

2.) Shopping List

This list of 20 supermarket items was devised with the help of patients and staff to include purchases common to all racial groups.

(a) Multitrial Learning:

Procedure: The list was read to the subject at a presentation rate of 1 item per 2 seconds. The subject was then required to count backwards from 100, or whatever number was given, for 30 seconds. Practice in this task was given before the list was presented to determine whether taking away 3 each time was possible for the subject. Where this was too difficult, the subject practised taking away 2 or 1 or, in one or two cases, just counting forwards. Every effort was made to have subjects count at their maximum speed on a task that was sufficiently difficult to require concentration and block rehearsal of the list.

Instruction: "Now I am going to read you a shopping list of the sort of things you might buy at a supermarket. Try to remember as much of it as you can. Before I ask you what was on the list, I am going to ask you to count backwards from 100, or whatever number I give you taking away (eg. 3) each time. So, 100, (97) (94). Alright? Now you try: take off (3) each time and keep going backwards. Okay, now listen to the list and try to remember it." List 1 was then read. (See Figure 3).

SHOPPING LIST

NAME: ..... DATE: ..... TIME: .....

1	2	3	4	5
rice	potatoes	polony	cigarettes	toothpaste
tea	oranges	margarine	margarine	Vim
polony	margarine	toothpaste	tea	Ideal milk
cigarettes	cooking oil	Sunlight soap	sausages	rice
Vim	toothpaste	potatoes	cooking oil	mealie meal
Ideal milk	jelly	spaghetti	jelly	shoe polish
jelly	polony	baked beans	Vim	Sunlight soap
sausages	shoe polish	oranges	spaghetti	baked beans
mealie meal	baked beans	tea	Sunlight soap	pumpkins
cooking oil	Ideal milk	Ideal milk	potatoes	margarine
spaghetti	eggs	jelly	oranges	eggs
eggs	mealie meal	shoe polish	eggs	polony
toothpaste	spaghetti	eggs	polony	cigarettes
potatoes	cigarettes	rice	shoe polish	cooking oil
baked beans	pumpkin	pumpkin	pumpkin	potatoes
Sunlight soap	tea	mealie meal	mealie meal	sausages
margarine	Sunlight soap	Vim	rice	tea
shoe polish	rice	sausages	toothpaste	spaghetti
pumpkin	sausages	oil	Ideal milk	oranges
oranges	Vim	cigarettes	baked beans	jelly

Counting Practice: 100

1. 100
2. 86
3. 72
4. 96
5. 64

TOTAL: CONFABULATIONS: CORRECTED SCORE:

Figure 3: Shopping List.

At the end of the 30 second counting task, the subject was asked to repeat the list and the responses were either written down, or list items numbered in the order in which the subject repeated them. Two minutes were allowed for the recall of each list. (This limit was not mentioned to the subject). If the subject gave up before two minutes, he was told "You've got quite a bit of time left, see if you can think of anything else." The list was presented 5 times, with the items in a different random order each time, and a counting task following each presentation. The numbers from which each counting task began are shown in Figure 3. Before each presentation, the subject was told "I'll read it to you again. Ready?"

Average Time Taken: Approximately 15 minutes for all 5 trials.

Scoring: Each correct item scored 1 point and items clearly not on the list were subtracted as confabulations from the total for that trial. If subjects were hesistant about their responses they were asked "Well, was it on the list or not?" Half-correct items were neither credited nor subtracted (eg. 'beans' for 'baked beans', 'fish oil' for 'cooking oil' or 'soap' for 'Sunlight soap'). The corrected total for each of the 5 trials was computed and a grand total obtained.

(b) Delayed Recall

At the end of the battery, after recall of the Lion Story had been attempted, subjects were asked to repeat the Shopping List again. No forewarning of this request had been given.

Instruction: "Now, last thing, do you remember that shopping list of things you might buy at a supermarket that I gave to you at the beginning? Can you tell me again what was on it, please?"

Responses were written down; two minutes were allowed for recall, and scoring was 1 point per item with confabulations being subtracted.

(c) Forgetting: A "Forgetting" score, ie. 'Trial 5 Recall-Delayed Recall', was computed.

3.) Digit Span and Supraspan

i. Digit Span:

Random, nonordered series of digits from the Wechsler Memory Scale Forms I and II (Wechsler, 1945) were presented at the rate of 1 digit per second. Three different sequences of each length were available beginning with a 3-digit list. As soon as a subject passed one list at that length, the next length was presented. If a subject asked for a list to be repeated, he was told "No, but I'll read you another list. Listen." If a subject failed all 3 lists at one length, the test was discontinued. The longest sequence perfectly recalled was taken as the subject's Digit Span.

Instructions and digit sequences are given in Figure 4:

I am going to say some numbers. I want you to listen carefully and repeat them when I have finished. Just say what I say.

i) SPAN:

3)	582	3)	694	3)	317
4)	6439	4)	7286	4)	3582
5)	42731	5)	75836	5)	47186
6)	619473	6)	392487	6)	639158
7)	591742	7)	4179386	7)	5492736
8)	58192647	8)	38295174	8)	27153964
9)	429386175	9)	594827316	9)	916483752

ii) SUPRA SPAN:

a) Now I am going to give you a long number. Try and repeat it. I am goirg to read it to you over and over again until you get it right, or until you have tried 10 times. Ready, listen (a), listen again - , again.

b) Now I am going to give you a new long number, and again I will read it to you over and over again until you get it right or until you have tried 10 times. Ready (b), again - .

	a) 5271849362	b) 4973615847
1.		
2.		
3.		
4.		
5.	_____	_____
6.		
7.		
8.		
9.		
10.		

c) 3851469728

Figure 4: Digit Span and Supraspan Digits.

ii. Supraspan Digits

Three lists (a, b, and c) of 10 random digits were devised using numbers 1 through 9 such that no digit occurred more than twice in a sequence, adjacent digits were not identical, and no part of a sequence was a generally familiar grouping (eg. 1652 or 1815). Digits were read at the rate of 1 digit per second, with the examiner using a stopwatch for pacing. Presentation of each sequence (training trials) alternated with attempts by the subject to reproduce the sequence (testing trials) for up to 10 trials or until a criterion of two perfect recalls in succession had been reached.

Instructions and sequences are as given in Figure 4. Each response by the subject was recorded verbatim in the space available. Strings a and b were presented without an interval. (String c was only used if an interruption spoilt a or b). Subjects were encouraged to guess at the digits even if uncertain of the order in which they had been presented.

Time Taken: Digit span, plus all 10 trials of Supraspan a and Supraspan b, took about 15 minutes.

Scoring: A scoring system that permits the crediting of small groups of items in their correct sequence, even if out of place within the list, was used. The following rules, (adapted from Drachman and Zaks, 1967) were followed:

1. The first and last items in a list were each credited a point if correctly recalled in their positions.
2. Any correct items adjacent to correct first or last items were credited a point per item.
3. All items in a sequence of 3 or more whose order corresponded to a similar sequence in any location in the list were credited a point per item.
4. Where these rules resulted in a full score being given when an incorrect extra item was inserted, a point was subtracted.

Example: (a): 5271849362 repeated as 5✓6 1✓8✓4✓3 9 5 6✓2✓ = 6 points.

Thus a score of 10 points per trial and a total of 100 points over the 10 trials was possible for each of list a and b. A subject was credited 10 points for each trial remaining after he had reached the criterion of two perfect repetitions. The average total of the two lists was entered as the final score.

B) VISUAL TESTS

Continuous Recognition

In this visual learning task, developed by Kimura (1963), certain designs are repeatedly presented to the subject, along with other nonrecurring designs. The designs were obtained from Dr. N. Brooks, Glasgow, and drawn out on 3 inch square cards. The subject was initially shown a pack of 20 cards at a rate of 1 per 3 seconds and asked to try and remember them. On half of the cards there is a line drawing of a regular, geometric figure, and on half an irregular, nonsense figure that is difficult to encode verbally. (See Series A, Figure 5). Eight of these designs, 4 nonsense and 4 geometric, reappear randomly on each of the next 7 trials, along with 12 new cards per trial which do not recur. For these 140 cards, (Pack B, Figure 5) the subject must identify each card as "new" (first appearance) or "old" (a recurrence).

The subject was not told that the designs would recur regularly and the 140 cards were presented continuously. The only indication of a new trial (after every 20 cards) was a quick straightening of the pack. Designs were exposed for 3 seconds each and were then put aside. An answer was required for each card, even if it was a guess.

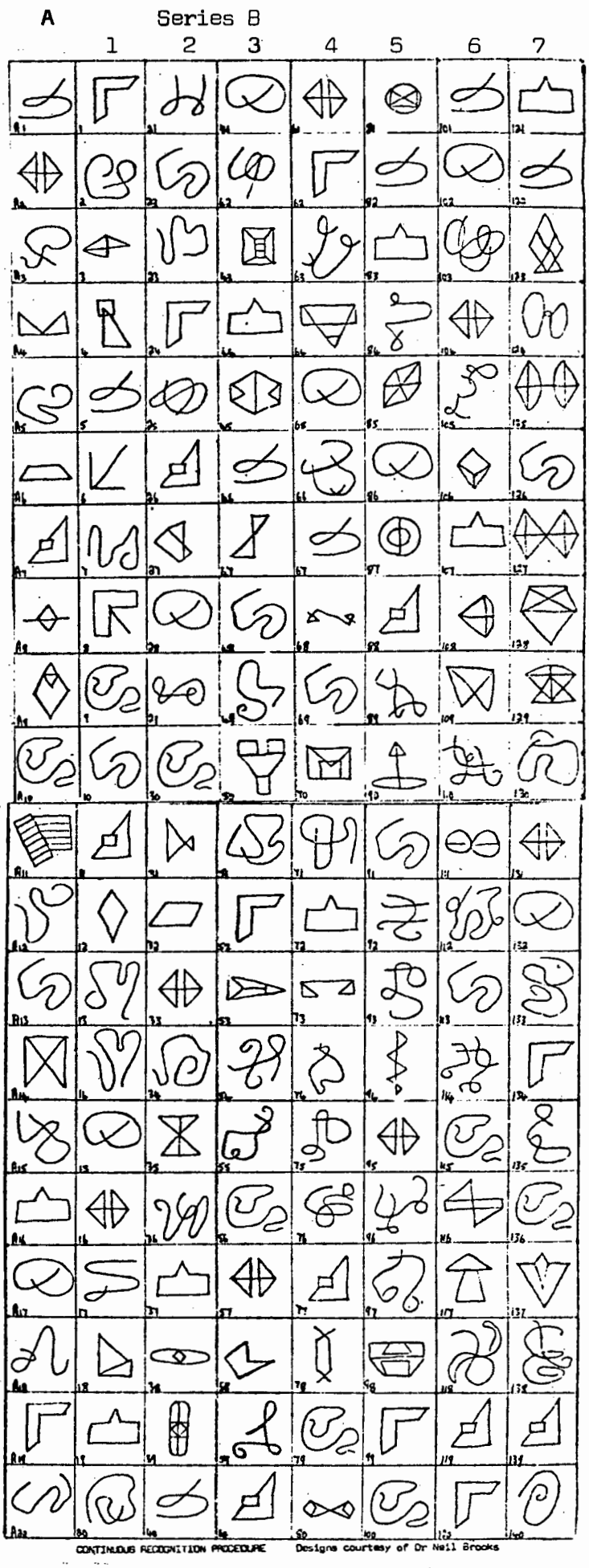


Figure 5: Continuous Recognition: Recurring Figures.
Designs courtesy of Dr. Neil Brooks, Glasgow.

Instruction: "These cards (pointing to Pack A) have drawings on them. Look carefully and try and remember them. Then I am going to show you all these cards (pointing to Pack B) and I want you to say "new" if you have never seen the drawing before, or "old" if you have seen it already."

A. "Alright, look carefully at these ....."

B. "Alright, now I am going to show you these. Say "new" or "old" for each one."

A few subjects became muddled as to 'old' and 'new' and were simply instructed "say 'Yes' if you have seen it before, 'No' if you haven't."

Average Time Taken: 15 minutes.

Scoring: Answers were ringed on the score sheet (see Appendix D, p 194). Each of the 7 trials was scored for the number of designs correctly recognised (maximum of 8 per trial) and the number of false positive recognitions (maximum of 12 per trial). The false positives were subtracted from the correct recognitions on each trial, and the corrected score for each of the 7 trials was totalled.

2.) Faces

The test material consisted of two sets of photographs of the faces of Coloured people. Set I (Figure 6) was a 4 by 3 array of photographs (6 male, 6 female), each photograph measuring 5 cms by 3 cms. Set II (Figure 7) was a 5 by 5 array of photographs of the same size, (12 male, 13 female). The 12 faces of Set I were interspersed among the 13 new faces of Set II according to the random pattern used by Milner (1968) on a similar task. All Set II faces were numbered.

Pilot Study: Initially an adaptation of the procedure detailed by Milner (1968) was used. The 12 Set I faces were presented for study for 45 seconds, then removed, and there was a counting task for $1\frac{1}{2}$ minutes before the subject was presented with Set II. However, this resulted in 'normals' achieving ceiling scores of from 10 to 12. Increasing the delay by only presenting Set II for recognition after the 10 to 15 minute Block Tapping Task made little difference, so exposure time was also reduced to $\pm$ 15 seconds. This seemed to allow enough time for all the faces to be viewed, but not sufficient time for little details to be verbally encoded.

Instruction: "I am going to show you some photographs of faces. I want you to try and remember them as later I am going to ask you to pick them out from a whole lot of photographs. You won't have long to study them, so look at all of them quickly."

Figure 6: Set I Photographs of Faces. (Reduced).

Procedure: Set I was then handed to the subject and removed after 15 seconds. After completion of the Block Tapping Task (10 to 15 minutes later), the subject was handed Set II with the following instruction:

Figure 7: Set II Photographs of Faces. (Reduced).

Instruction: "Now look at these faces and give me the numbers, or point to the ones you saw before."

Scoring: This procedure followed Milner (1968). If the subject selected fewer than 12 faces, he was encouraged to continue choosing, guessing if necessary, until he had made a total of 12 choices. If he recognised more than 12, he was asked to eliminate the choices of which he was least confident until only 12 remained. The numbers of the faces chosen were recorded. The score was the number of correct responses.

Average Time Taken: Approximately 5 minutes.

3.) Spatial Span and Supraspan Block Tapping
(Adapted from Corsi, reported Milner, 1971)

The test material consisted of 9 green blocks irregularly glued over a board (see Figure 8). Blocks were numbered on the examiner's side and numbers were not visible to the subject. The examiner and the subject each had an extra block for tapping.

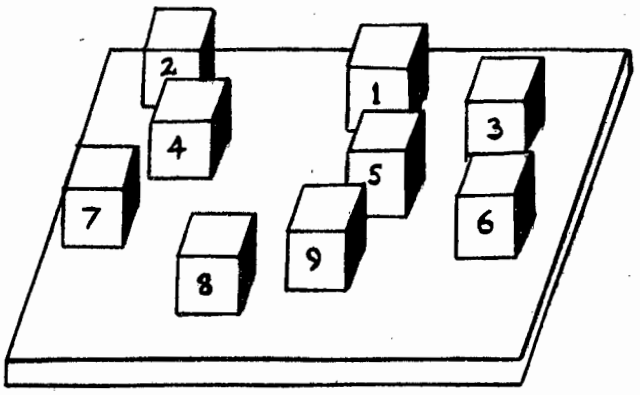


Figure 8: Sketch of Block-Tapping Board. (From P. Corsi, Milner, 1971).
Actual size of board = 20 x 25 cms.
Blocks = 3 cm. cubes.

i. Spatial Span:

Blocks were tapped in random sequences taken from the Wechsler digit series, at the rate of one block-tap per second. Three different sequences of each length were available, beginning with a 3-block sequence. As soon as the subject passed one sequence at that length, the next length was presented. If a subject asked for a sequence to be repeated, he was told "No, but I'll show you another one. Look...." If a subject failed all 3 sequences at one length, the test was discontinued. The longest sequence perfectly reproduced was taken as the subject's spatial span.

Instructions and Block-tapping sequences are given in Figure 9.

BLOCKS

NAME: ..... DATE: ..... TIME: .....

I am going to tap these blocks and, when I am finished, I want you to tap them in exactly the same order as I did. Watch.

(i) BLOCKS:

3) 582	3) 694	3) 317
4) 6439	4) 7286	4) 2548
5) 42731	5) 75836	5) 17352
6) 619473	6) 392587	6) 863174
7) 5917623	7) 4179386	7) 6893412

(ii) SUPRA SPAN:

a) Now I am going to tap out a long pattern. Try to repeat it. I will do it again and again until you get it right, or until you have tried 10 times. Watch (a), watch again –, again –.

b) Now I am going to tap out a new pattern, and again do it over and over until you get it right or until you have tried 10 times. Watch (b).

a) 58192647	b) 97531864
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
6.	6.
7.	7.
8.	8.
9.	9.
10.	10.

c) 49631852

Figure 9: Spatial Span and Supraspan Block Tapping Sequences.

ii. Supraspan Block Tapping:

Three sequences (a,b and c) of 8 random items (block-taps) were devised such that no block was tapped more than twice in a series, no block was tapped twice in succession, and no particular pattern (eg. one side of the board only) was tapped out. Blocks were tapped at the rate of approximately 1 block per second. Presentation of each sequence (training trials) alternated with attempts by the subject to reproduce the sequence (testing trials) for up to 10 trials or until a criterion of two perfect reproductions in succession had been reached.

Instructions and sequences are as given above. Each response by the subject was recorded in the space available. Sequences a and b were presented without an interval. (String c was only used if an interruption

spoilt a or b). Subjects were encouraged to guess at sequences even if uncertain of the order in which the blocks had been tapped.

Time Taken: Spatial Span, plus all 10 trials of Supra span a and b took about 15 minutes.

Scoring: The scoring system adapted from Drachman and Zaks (1967) for the Supraspan Digits was also used here. Thus small sequences occurring in their correct order were credited even if out of place within the series. See p.106 for the scoring rules.

A score of 8 points per trial and a total of 80 points over the 10 trials was possible for each of list a and b. A subject was credited 8 points for each trial remaining after he had reached the criterion of two perfect reproductions. The average total for the two sequences was entered as the final score.

CHAPTER 8

RESULTS

STATISTICAL ANALYSIS

a) Hotelling's T^2: Test results were examined by the Hotelling's T^2 statistic which compares the vector of means of samples from the two populations (patients with Bilateral Damage and Normal Controls). Since matched pairs of observations were used, the vector of the mean differences is compared with the vector of zero. The T^2 is converted into an F value which may be checked against tables for significance. Student t-tests are performed on the components of the vector in order to establish in which particular factors the differences lie. With matched pairs of observations, the t-test is used to test the hypothesis that the mean difference is zero. As predictions were made in a particular direction, a 1-tailed test of significance was used (unless otherwise stated). Test scores were normally distributed.

b) Bar diagrams: Yates (1954) has stated that it is not sufficient for validity to show that there are significant differences between groups. The clinician using the test must be able to estimate the degree of possible error when assigning a patient to the "normal" or "brain damaged group". Data will therefore be given in bar diagrams for each test showing the percentage of patients falling below and controls falling above various score levels. Bar diagrams will make it easy to see the point beyond which no normals of the sample fall and the point beyond which no brain damaged patient falls. The optimum cut-off point is represented by the mean and standard deviation.

c) Discriminant Analysis: As a combination of test scores is more likely to increase the percentage of correct classifications (Goldstein and Shelly, 1973), a discriminant analysis was carried out to find that linear combination of components which has the best discriminating power in terms of classifying an individual as belonging to the "Brain damaged patient" (ie. impaired memory) or "Normal Control" (ie. normal memory) population. From the test scores, a single score can then be calculated using the weights from the discriminant analysis. If the cost of misclassification is the same for both populations, the cut-off score would be taken to be half-way between the mean scores of the two groups. However, it was considered that the cost of misclassifying someone who is brain damaged as "normal" is greater than that of classifying a

normal as "brain damaged" as this may mean that no further investigations are undertaken. If a normal is classified as "brain damaged", further investigations will reveal the error. For this reason, cut-off scores on the verbal and visual tests will be adjusted to minimize misclassifications of brain damaged patients as "normal".

Note: The selection criteria were such that the term "brain damaged" in this study implies limbic system damage, rather than a more diffuse brain damage. Patients with right temporal lobe lesions should not appear "brain damaged" in terms of their performance on verbal memory tests, and patients with left temporal lesions should not appear "brain damaged" in terms of their performance on visual memory tests (Milner, 1971).

RESULTS

I CRITERION VALIDITY

The Verbal Memory Tests

1a. Bilaterals vs Controls: As predicted, the scores obtained on the verbal memory tests by patients with bilateral damage were significantly lower than the scores obtained by their matched controls (Hotellings $T^2 = 313,23$; $F = 42,17$; $df = 6, 21$; $p < 0,001$). The contribution of the separate test scores in producing this difference between bilaterals and controls is shown in Table 13. On all the verbal tests, the bilaterals achieved significantly lower mean scores than did their controls.

TABLE 13: Differences in the Verbal Test Scores for the Bilaterals and Matched Controls.

Test	Score	Statistic	Bilaterals N = 27	Controls N = 27	t	p
STORY	Immediate Recall	$\bar{X}$ SD	8.70 4.39	20.19 4.46	-9.64	<.001
	Delayed Recall	$\bar{X}$ SD	5.67 4.68	18.82 4.03	-11.00	<.001
SHOPPING LIST	Five-Trial Total	$\bar{X}$ SD	22.96 13.28	63.15 11.22	-14.14	<.001
	Delayed Recall	$\bar{X}$ SD	3.52 3.87	15.22 2.90	-12.09	<.001
SUPRASPAN DIGITS	Five-Trial $\bar{X}$ of a & b	$\bar{X}$ SD	13.41 6.21	19.52 6.99	-4.67	<.001
	Ten-Trial $\bar{X}$ of a & b	$\bar{X}$ SD	29.96 14.04	56.33 14.68	-7.96	<.001

df = 26 throughout

1b. Left Temporals vs Controls: As was predicted, the scores obtained on the verbal memory tests by patients with left temporal damage were markedly lower than those of their matched controls (Table 14). The significance of these differences has not been statistically determined as the sample is so small (N = 3). It can be seen from a comparison of Tables 13 and 14 that the mean scores obtained by the left-temporals on the verbal tests were similar to those obtained by patients with bilateral damage.

TABLE 14: Left-Temporals and Matched Controls: Means and Standard Deviations for the Verbal Tests.

Test	Score	Statistic	Left-Temporal N = 3	Controls N = 3
STORY	Immediate Recall	$\bar{X}$ SD	7,33 1,16	20,33 1,53
	Delayed Recall	$\bar{X}$ SD	3,67 1,53	19,33 5,03
SHOPPING LIST	Five-Trial Total	$\bar{X}$ SD	30,00 6,56	75,00 10,54
	Delayed Recall	$\bar{X}$ SD	6,67 4,93	16,67 3,51
SUPRASPAN DIGITS	Five-Trial $\bar{X}$ of a & b	$\bar{X}$ SD	18,67 5,53	33,00 10,15
	Ten-Trial $\bar{X}$ of a & b	$\bar{X}$ SD	42,17 13,04	77,33 18,46

1c. Right Temporals vs Controls: The scores obtained on the Story and The Shopping List by patients with right temporal damage were similar to those of their matched controls (see Table 15) and did not show the marked inferiority of those obtained by patients with bilateral or left temporal damage (compare Tables, 13, 14, and 15). However, the mean score obtained by the right temporals on the Supraspan Digits (10-Trial $\bar{X}$ = 43.30) was lower than that of the controls ($\bar{X}$ = 55.20), and similar to that of the left-temporals ($\bar{X}$ 42,17). Nonetheless, it was higher than that obtained by the patients with bilateral damage ($\bar{X}$29.96). The significance of these differences has not been determined statistically as the sample was so small (N = 5).

TABLE 15: Right Temporals and Matched Controls: Means and Standard Deviations for the Separate Verbal Tests.

Test	Score	Statistic	Right-Temporal N = 5	Controls N = 5
STORY	Immediate Recall	$\bar{X}$ SD	17.20 2,28	19,20 3,11
	Delayed Recall	$\bar{X}$ SD	14,60 3,78	18,80 3,56
SHOPPING LIST	Five-Trial Total	$\bar{X}$ SD	64,60 11,31	71,20 3,56
	Delayed Recall	$\bar{X}$ SD	14,40 2,07	16,00 1,00
SUPRASPAN DIGITS	Five-Trial $\bar{X}$ of a & b	$\bar{X}$ SD	18,60 5,41	21,30 6,14
	Ten-Trial $\bar{X}$ of a & b	$\bar{X}$ SD	43,30 9,17	55,20 17,95

The Visual Memory Tests

2a. Bilaterals vs Controls: As predicted, the scores obtained on the visual memory tests by patients with bilateral damage were significantly lower than those obtained by their matched controls (Hotelling's T^2 = 192,15; F = 32,52; df = 5,21; $p < 0.001$). The contribution of the separate test scores in producing this difference between bilaterals and controls is shown in Table 16. On all the visual tests, the bilaterals achieved significantly lower mean scores than did their controls.

TABLE 16: Differences in the Visual Test Scores for the Bilaterals and Matched Controls.

Test	Score	Statistic	Bilaterals N = 27	Controls N = 27	t	p
CONTINUOUS RECOGNITION	Recognition	$\bar{X}$ SD	40.56 9.26	52.19 4.15	-6.63	< .001
	False Positives	$\bar{X}$ SD	19.59 12.57	10.48 6.43	3.31	< .001
	Corrected Total	$\bar{X}$ SD	20.96 11.14	41.70 1.48	-7.84	< .001
FACES	Number Correct	$\bar{X}$ SD	6.48 1.22	8.93 1.00	-8.46	< .001
SUPRASPAN BLOCKS	Five-Trial $\bar{X}$ of a & b	$\bar{X}$ SD	9.98 7.44	17.48 7.04	-4.19	< .001
	Ten-Trial $\bar{X}$ of a & b	$\bar{X}$ SD	22.22 17.22	45.52 14.83	-6.19	< .001

df = 26 throughout

2b. Right Temporals vs Controls: As predicted, the scores obtained on the visual memory tests by patients with right temporal damage were markedly lower than those obtained by their matched controls (Table 17). The significance of these differences has not been statistically determined as the sample was small (N = 5). It can be seen from a comparison of Tables 16 and 17, that the mean scores obtained by the right-temporals on the visual tests were similar to those obtained by patients with bilateral damage.

TABLE 17: Right Temporals and Matched Controls: Means and Standard Deviations for the Visual Tests.

Test	Score	Statistic	Right-Temporal N = 5	Controls N = 5
CONTINUOUS RECOGNITION	Recognition	$\bar{X}$ SD	46,20 8,23	54,40 1,14
	False Positives	$\bar{X}$ SD	21,60 9,42	7,40 4,62
	Corrected Total	$\bar{X}$ SD	24,60 13,99	47,00 4,00
FACES	Number Correct	$\bar{X}$ SD	7,40 1,14	9,20 1,10
SUPRASPAN BLOCKS	Five-Trial $\bar{X}$ of a & b	$\bar{X}$ SD	7,50 3,39	20,10 6,20
	Ten-Trial $\bar{X}$ of a & b	$\bar{X}$ SD	24,60 6,96	56,60 9,28

2c. Left Temporals vs Controls: The scores obtained on the Continuous Recognition and on the recognition of Faces by patients with left temporal damage were similar to those obtained by their matched controls (Table 18) and did not show the marked inferiority of those obtained by patients with bilateral or right temporal damage (compare Tables 16, 17, and 18). However, the mean score obtained by the left-temporals on the Supraspan Block-tapping (10-Trial $\bar{X}$ = 38.33) was lower than that obtained by the controls ($\bar{X}$ = 62,17). Nonetheless, it was not far below that obtained by the bilateral controls (45,52) and it was considerably higher than that obtained by the patients with bilateral damage ($\bar{X}$ = 22.22) and with right temporal damage ($\bar{X}$ = 24,60). These data were not statistically analysed as the sample was so small (N = 3).

TABLE 18: Left Temporals and Controls; Means and Standard Deviations for the Separate Visual Tests.

Test	Score	Statistic	Left-Temporal	Control
CONTINUOUS RECOGNITION	Recognition	$\bar{X}$ SD	54,00 2,00	54,00 3,46
	False Positive	$\bar{X}$ SD	10,33 6,81	8,33 8,08
	Corrected Total	$\bar{X}$ SD	43,67 8,74	45,67 8,33
FACES	Number Correct	$\bar{X}$ SD	9,00 1,00	10,00 00
SUPRASPAN BLOCKS	Five-Trial $\bar{X}$ of a & b	$\bar{X}$ SD	15,00 5,50	23,67 9,29
	Ten-Trial $\bar{X}$ of a & b	$\bar{X}$ SD	38,33 24,01	62,17 3,33

Bar Diagrams

These diagrams show the cumulative percentage of patients falling below certain scores (Cum. % +) and the cumulative percentage of controls falling above certain scores (Cum. % −) for each test.

A. Verbal Tests:

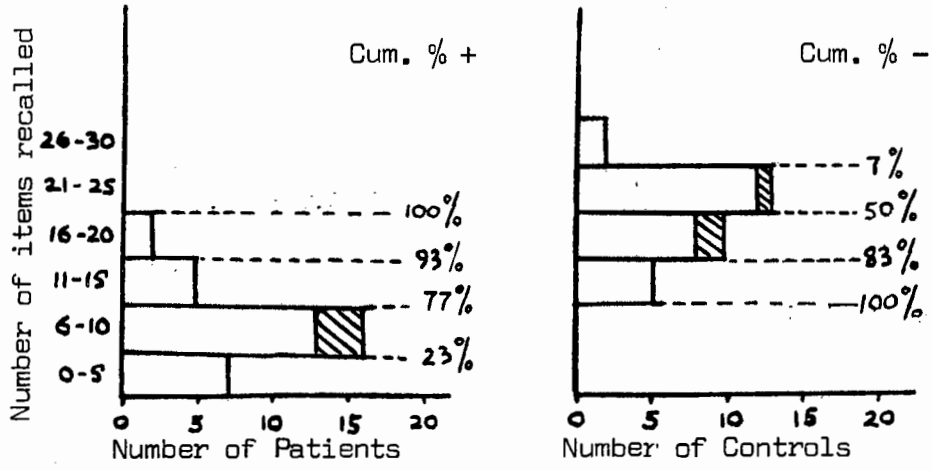
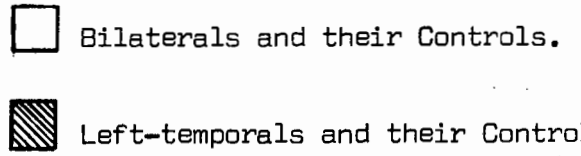


Figure 10: Lion Story. Immediate Recall Scores for Patients and Controls.



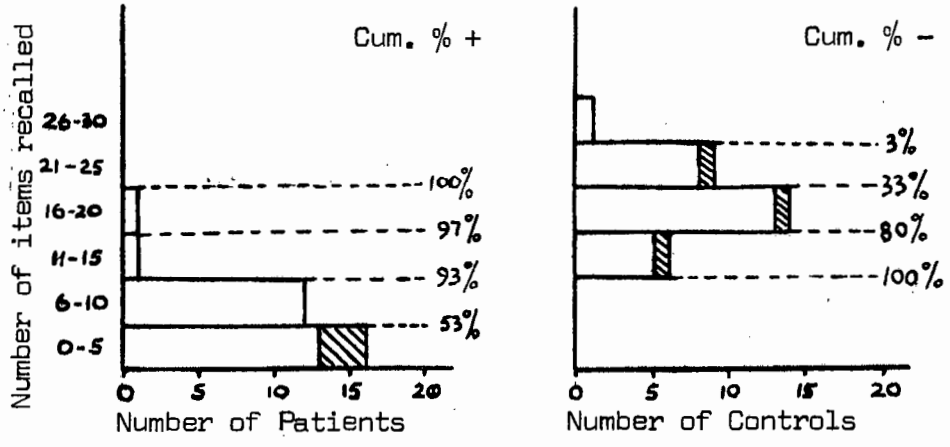


Figure 11: Lion Story. Delayed Recall Scores for Patients and Controls.

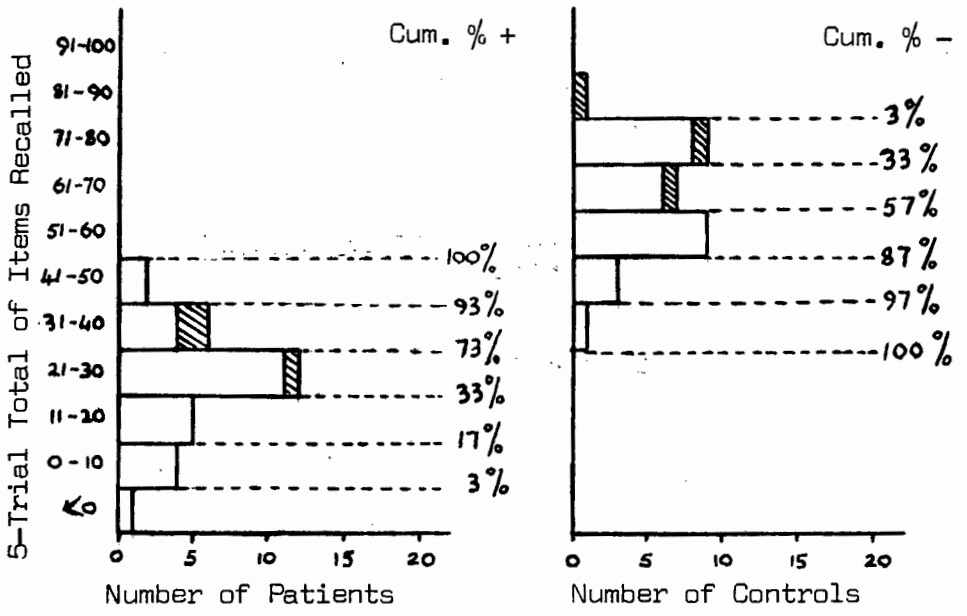
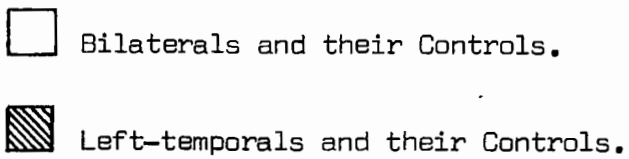


Figure 12: Shopping List. Five Trial Totals for Patients and Controls.



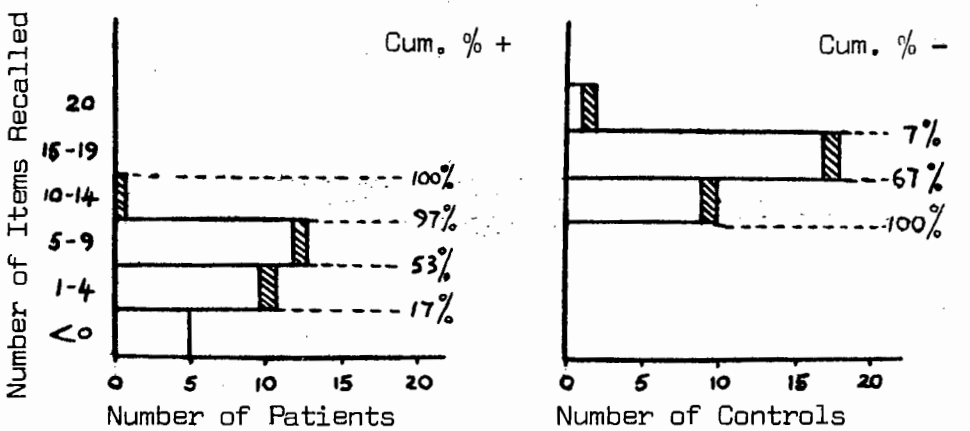


Figure 13: Shopping List. Delayed Recall Scores for Patients and Controls.

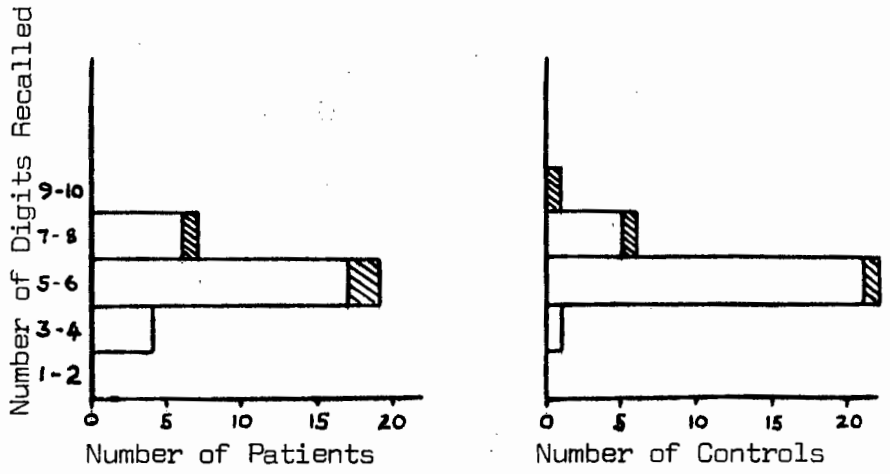
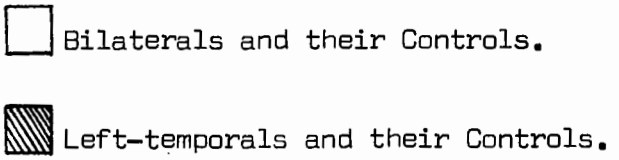


Figure 14: Digit Span for Patients and Controls.



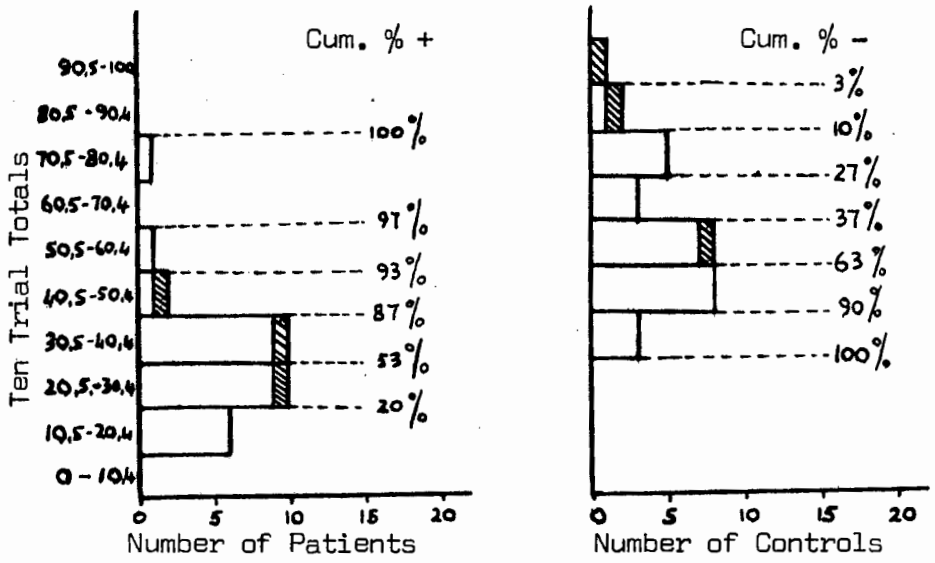


Figure 15: Supraspan Digits. Ten Trial $\bar{X}$ of a and b for Patients and Controls.

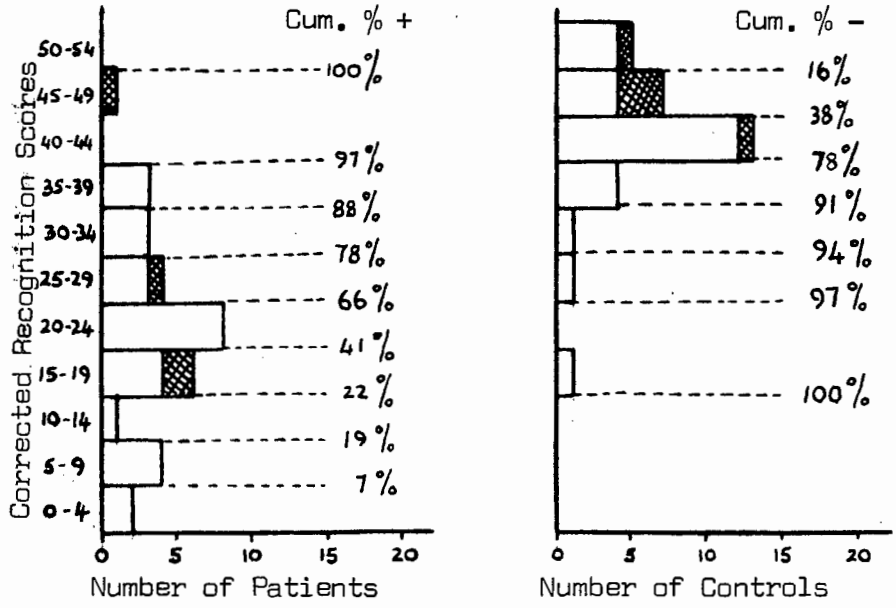


Figure 16: Continuous Recognition. Corrected Scores for Patients and Controls.

Bilaterals and their Controls.

Right-temporals and their Controls.

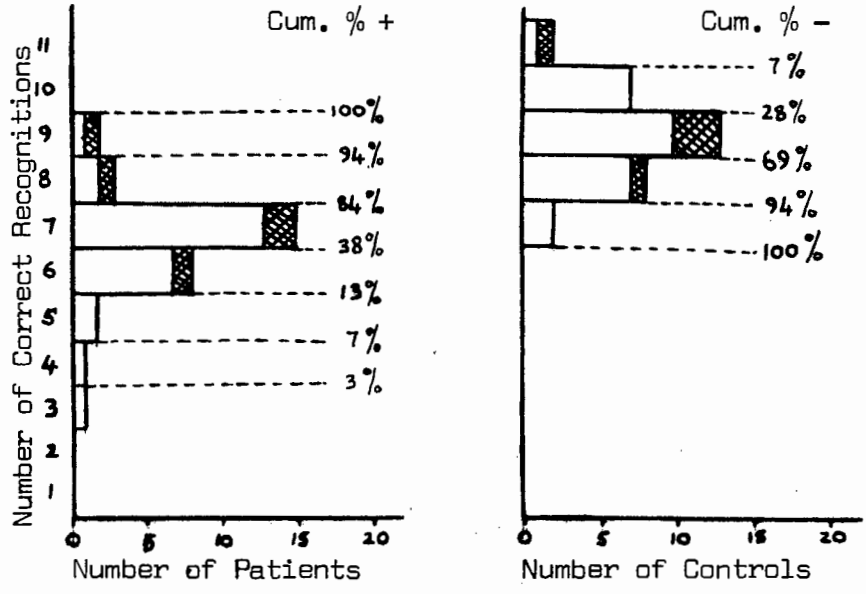


Figure 17: Faces. Correct Recognitions for Patients and Controls.

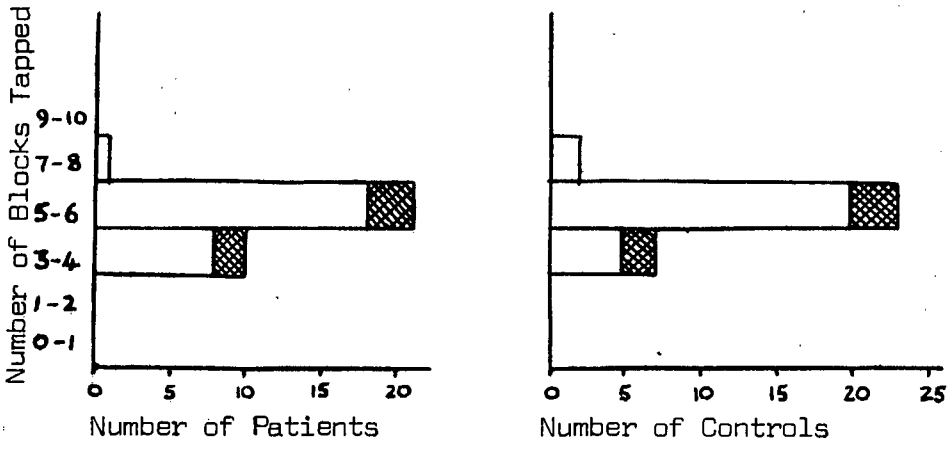


Figure 18: Spatial Span for Patients and Controls.

Bilaterals and their Controls.

Right-temporals and their Controls.

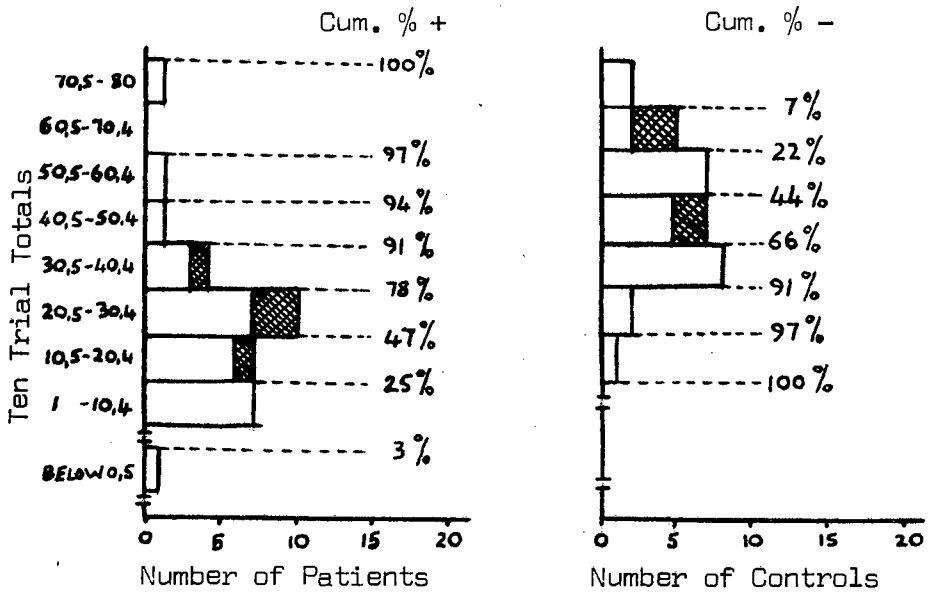


Figure 19: Supraspan. Ten Trial $\bar{X}$ of a and b for Patients and Controls.

Discriminant Analysis

3a. The Verbal Memory Tests: A discriminant analysis based upon the verbal test scores of the bilaterals and their controls indicated that the maximum discriminant power would be obtained by using the linear combination of variables listed in Table 19. Using these variables, weighted as shown, and a cut-off score of 290, none of the bilaterals or their controls were misclassified. (See Appendix E for ranking of patients and controls according to their Discriminant Scores).

When these same weights and cut-off score were applied to the test scores of the left- and right-temporals and their controls, all patients with left temporal damage were correctly classified as "brain damaged", ie. as having a verbal memory impairment, while the rest were all correctly classified as "normal", ie. not having a verbal memory impairment.

TABLE 19: Discriminant Analysis of Verbal Tests: Variables, Weights, and Cut-off Score.

Variables	Weights	Cut-off D Score
Delayed Story	7,71	
Delayed List	13,31	290 and Below
Supraspan Digits	1,55	
10-Trial $\bar{X}$		

Note: The midpoint between the means of the bilateral patient and control group was 286, but this results in one patient with bilateral damage being classified as "normal". The cut-off score was thus adjusted to ensure correct classification of all patients. (No controls are misclassified as a result of this adjustment).

3b. The Visual Memory Tests: A discriminant analysis based upon the visual test scores of the bilaterals and their controls indicated that the maximum discriminant power would be obtained by using the linear combination of variables listed in Table 20. Using these variables, weighted as shown, and a cut-off score of 410, none of the bilaterals were misclassified, but one of their controls (ie. 3% of the normal sample) was misclassified as "brain damaged", ie. as having a verbal memory impairment. (See Appendix E for ranking of patients and controls according to their Discriminant Scores).

When these same weights and cut-off score were applied to the test scores of the right- and left-temporals and their controls, all patients with right temporal damage were correctly classified as "brain damaged", ie. as having a visual memory impairment; and all controls were correctly classified as "normal". Of the 3 patients with left temporal damage, one patient (with a D score of 391) was "misclassified" as "brain damaged", ie. as having a visual memory impairment. (It is possible that in this case brain damage was not limited to the left temporal lobe, but it should be noted that this patient developed a tension headache as testing progressed, which could have affected her performance on the visual tests).

TABLE 20: Discriminant Analysis of Visual Tests: Variables, Weights and Cut-off Score.

Variables	Weights	Cut-off D Score
Recognition: Corrected Total	3,58	410 and Below
Faces	32,43	
Supraspan Blocks 10-Trial $\bar{X}$	0,8	

Note: The midpoint between the means of the bilateral and control groups was 389, but this misclassified 3 of the bilaterals and 1 of the right-temporals as 'normal', although all others (ie. left temporals and all controls) were correctly classified as "normal". The cut-off D score was adjusted on the grounds that the cost of misclassifying brain damaged patients is greater than that of misclassifying normals.

The Influence of Age, Intelligence, Sex and Race on the Verbal and Visual Discriminant Scores.

The influence of these variables on the Discriminant (D) Scores obtained on the verbal and the visual memory tests was analysed for the patients with bilateral damage and their controls (N = 54). As predicted, there was no significant effect for any of these variables on either the verbal or the visual test scores.

4a. Age: was not significantly correlated with the D scores on the verbal tests ($r = 0,05$, $df = 52$, $p > 0,05$), or with the D scores on the visual tests ($r = -0,09$, $df = 52$, $p > 0,05$).

4b. I.Q.: was not significantly correlated with the D scores on the verbal tests ($r = -0,15$, $df = 52$, $p > 0,05$) nor with the D scores on the visual tests ($r = -0,22$, $df = 52$, $p > 0,05$).

4c. Sex: There was no statistically significant difference between the means of the D scores obtained by the 40 males and the 14 females on the verbal tests (Male D score $\bar{X} = 277,98$; Female D score $\bar{X} = 307,71$; $t = 0,83$, $df = 52$, $p > 0,05$).

Similarly, there was no statistically significant difference between the means of the D scores obtained by the males and the females on the visual tests (Male D score $\bar{X} = 383,63$; Female D score $\bar{X} = 401,86$; $t = -0,99$, $df = 52$, $p > 0,05$).

4d. Race: had no significant effect on the memory test scores either. The mean D scores for the Whites, Coloureds and Africans were not significantly different on the verbal tests ($F = 0,18$; $df = 2,51$; $p > 0,05$), or on the visual tests ($F = 0,36$; $df = 2,51$; $p > 0,05$). (See Appendix F for Anova tables).

II CONSTRUCT VALIDITY (Based on an analysis of the data of the bilateral patients and their controls, N = 54).

The Verbal Tests

5. The Lion Story

5a. Immediate Recall: As predicted, there was a tendency for patients to concentrate on one half of the story (either the first or the second half), while controls appeared more able to integrate the entire story:

(i) More patients than controls (ie. 9 patients and only 1 control) had scores on one half which were double or more than double those they obtained on the other half.

(ii) The correlation between the two halves of the story was lower for the patients ($r = 0,49$, $df = 25$, $p < 0,01$) than for the controls ($r = 0,65$, $df = 25$, $p < 0,01$).

5b. Forgetting: As predicted, not only did the patients register less of the story in the first place (see Immediate Recall, Table 13), but they also showed a greater degree of forgetting (assessed by the formula "Immediate Recall-Delayed Recall") of what they had registered. The difference between the mean forgetting scores of the patients and the controls was statistically significant (pt $\bar{X} = 3,04$, control $\bar{X} = 1,44$; $t = 2,31$, $df = 26$, $p < 0,05$).

5c. Confabulation: On Immediate Recall, 4 patients introduced confabulations whereas none of the controls did. Using the Wilcoxen Match-Pairs Signed Ranks Test, this difference did not reach statistical significance ($T = 0$, $N = 4$). (Note: The incidence of confabulation is not normally distributed, so nonparametic statistics must be used). On Delayed Recall, 7 patients but no controls introduce confabulations, and this difference was significant ($T = 0$, $N = 7$, $p < 0,01$).

6. Shopping List:

6a. Rate of Learning: As predicted, there was a significantly slower increase in the rate of list learning over trials in the patients than in the controls ($t = -7,38$, $df = 26$, $p < 0,01$). See Figure 20.

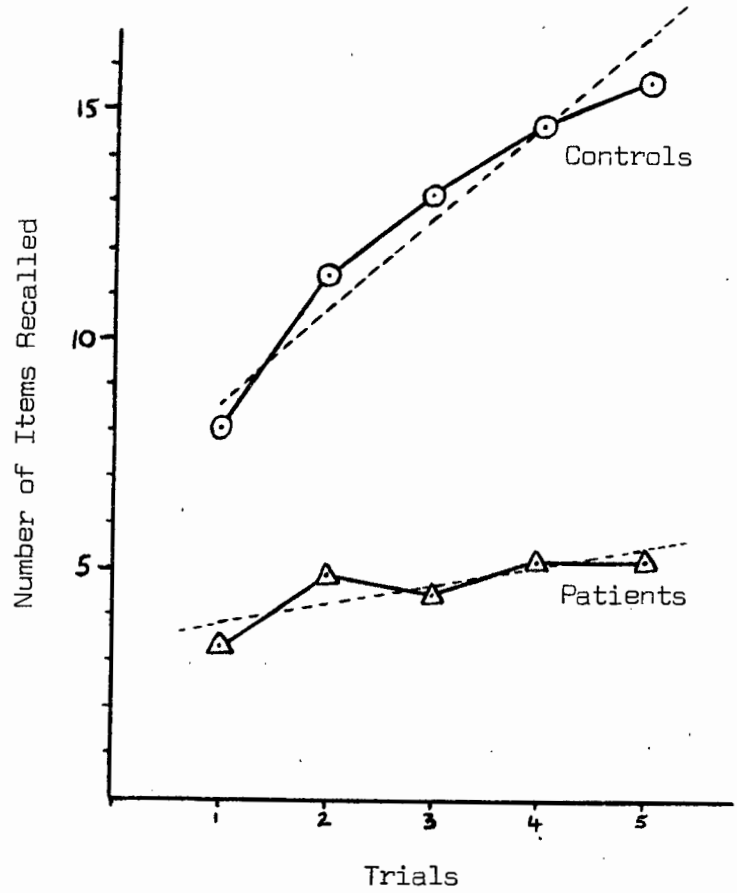


Figure 20: Shopping List: Learning over 5 Trials by Patients and Controls

6b. Clustering by Category: Significantly fewer of the patients (only 12) than of the controls (all 27) clustered items on the list according to categories ($\chi^2 = 20,77$, $df = 1$, $p < 0,01$). However, the patients did attempt to use clustering, or, at least, were stimulated by associations. This is shown by the fact that six of them grouped invented items by categories (eg. "bread and butter" "curry, cinamon and caramel"), whereas none of the controls did. This difference is significant ($\chi^2 = 6,75$, $df = 1$, $p < 0,01$). Similarly, a significantly greater number of the patients than of the controls had categories with one item on the list associated with another item not on the list, (eg. "margarine and butter"; "tea and sugar"), ($\chi^2 = 7,48$, $df = 1$, p 0,01).

6c. Confabulation: As was predicted, significantly more of the patients than of the controls introduced confabulations over the five list-learning trials ($T = 13$, $N = 23$, $p < 0,01$); and significantly more of the patients introduced confabulations in their Delayed Recall of the List ($T = 16$, $N = 23$, $p < 0,01$), (Wilcoxon Match-Pairs Signed Ranks Test).

6d. Forgetting: As predicted, not only did the patients learn fewer of the items on the list in the first place, (see Five-Trial Total, Table 13), but they also showed a significantly greater degree of forgetting of what they had learned. The difference in the mean forgetting scores, (assessed by the formula Trial 5 Recall-Delayed Recall) obtained by the patients and the controls is significant ($t = 1,96$, $df = 26$, $p < 0,05$).

Digit Span and Supraspan Digits

7a. Digit Span: As predicted, there was no statistically significant difference in the immediate digit span of the patients and the controls (patient $\bar{X} = 5,56$, control $\bar{X} = 5,78$; $t = 0,88$, $df = 26$, $p > 0,05$).

7b. Supraspan Digits, Proactive Inhibition: Perseveration of items of list a in the learning of list b occurred in 10 of the patients and 12 of the controls, but this difference was not statistically significant ($\chi^2 = 0,33$, $df = 1$, $p > 0,05$). However, 7 of the patients as opposed to none of the controls showed perseveration of their own version of list a in their learning of list b, and this difference was statistically significant ($\chi^2 = 8,14$, $df = 1$, $p < 0,01$).

The Visual Memory Test

8. Continuous Recognition

8a. Rate of Learning: In contrast to what was predicted, there was no significant difference in the rate of increase of correct recognitions over trials for the patients and controls ($t = 0,71$, $df = 26$, p 0,05). As can be seen from Figure 21, the learning slope was parallel for the two groups.

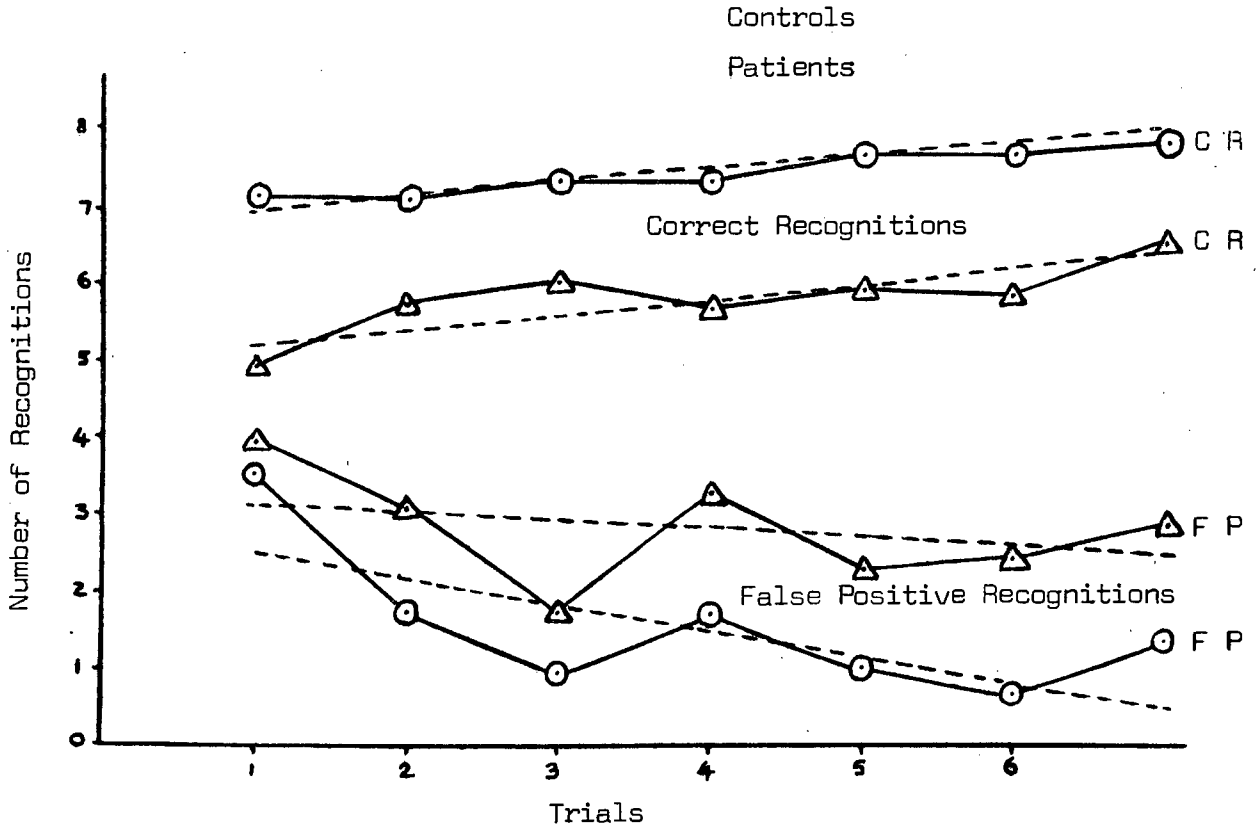


Figure 21: Continuous Recognition: Correct Recognitions and False Positives by Patients and Controls over 7 Trials.

8b. False Positives: Although the patients had a significantly higher total incidence of false positives than the controls ($t = 3,31$, $df = 26$, p 0,01), there was no significant difference in the incidence rate of false positives over the seven presentation trials for the two groups ($t = 1,26$, $df = 26$, $p > 0,05$). The slopes were beginning to diverge, however, (see Figure 21) and perhaps if there had been more trials, a significant difference would have emerged.

8c. Geometric vs Nonsense Designs: As can be seen from Table 21, the patients made significantly fewer correct recognitions of both geometric and nonsense designs than did the controls, and made significantly more false positive recognitions of both geometric and nonsense designs. Both groups made more false positive recognitions on the nonsense than on the geometric designs.

TABLE 21: Differences in Correct Recognitions and False Positive Errors on Geometric and Nonsense Designs for Patients and Controls.

Score	Design	Statistic	Bilaterals (27)	Controls (27)	t	p
CORRECT RECOGNITION	Geometric	$\bar{X}$ SD	21,74 5,28	26,11 2,96	4,28	<0,01
	Nonsense	$\bar{X}$ SD	18,78 6,55	25,96 2,52	5,73	<0,01
FALSE POSITIVES	Geometric	$\bar{X}$ SD	7,04 6,15	3,00 2,08	-3,04	<0,01
	Nonsense	$\bar{X}$ SD	12,56 7,84	8,04 5,59	-2,49	<0,01

9. Faces: The procedure of insisting upon a choice of 12 faces made it difficult to detect differences in strategies. If, out of a choice of 12, the patients made significantly fewer correct recognitions than the controls ($t = -8,46$, $df = 26$, $p < 0,001$), then it is evident that they also made significantly more false positive recognitions, but it is difficult to say where the defect lies. It seemed to be a matter of both: more patients than controls made less than 12 choices (some correct, some false) before giving up and then having to be persuaded to guess the rest. This giving up suggests a failure of correct recognition. Their choices at this point did not include more false positives than did those of the controls, but then some of them made very few choices before giving up.

III RELIABILITY

Preliminary evidence of reliability is provided by the consistency of the test results over the patient and control groups (Yates, 1954).

Split-half reliability

The Verbal Tests

(i) On the Lion Story the split-half reliability coefficient for the patients was $r_{tt} = 0,65$ and for the controls was $r_{tt} = 0,79$ (Spearman-Brown formula).

(ii) On the Supraspan Digits, the split-half reliability coefficient of list a and list b was $r_{tt} = 0,76$ for the patients, and $r_{tt} = 0,81$ for the controls (Spearman-Brown formula).

The Visual Tests

(iii) On the Faces, the split-half reliability coefficient is $r_{tt} = -0,45$ for the patients, and $r_{tt} = -0,63$ for the controls (Spearman-Brown formula). This negative reliability coefficient is produced by a negative correlation between the halves which is possibily an artefact of the small range of scores obtained.

(iv) On the Supraspan Blocks, the split-half reliability coefficient of list a and list b was $r_{tt} = 0,77$ for the patients, and $r_{tt} = 0,65$ for the controls.

(v) Interscorer Reliability: The interscorer reliability coefficient on a random sample of 16 patients and 16 controls was $r = 0,9976$, $df = 30$, $p < 0,01$.

CHAPTER 9

DISCUSSION

I CRITERION VALIDITY

The validity of the Experimental Memory Battery as a test of memory impairment receives confirmation from its success in differentiating individuals with diagnoses implying limbic lobe disorders from those without such disorders. These individuals come from the White, Coloured and African racial groups which tend to vary widely in regard to cultural, educational and socioeconomic factors. Race was not found to exert any significant influence on the test results, however; but it should be noted that the sample of Africans was too small to permit generalizations about the usefulness of the test with this racial group to be made with any confidence.

Performance on the verbal memory tests significantly differentiated the patients with bilateral temporal lobe damage from those without such damage. Discriminant analysis produced a linear combination of verbal test variables which resulted in a 100% correct classification of subjects into either the "brain damaged" or "normal" categories. Performance on the visual memory tests also significantly differentiated those with bilateral temporal lobe damage from those without such damage. Discriminant analysis produced a linear combination of visual test variables which resulted in a 100% correct classification of patients as "brain damaged", but which misclassified 3% of the normal controls.

The patient sample comprised individuals with clearly diagnosed organic impairment, and it is to be expected that the discriminating power of the EMB will drop when the test is used clinically with less clearly diagnosed cases (Yates, 1954).

The association of verbal memory impairment with left temporal lobe damage has been shown in studies by Meyer and Yates (1955), Milner (1958, 1970, 1971), Blakemore and Falconer (1967) and Weingartner (1968). Similarly, the hypothesis that right temporal lobe damage is associated with an impairment of visual memory has been supported in studies by Kimura (1963), and Milner (1968, 1971). A clear trend for patients with left temporal lobe lesions to perform poorly on the EMB verbal tests, while patients with right temporal lobe lesions

did not, thus provides preliminary support for the hypothesis that these tests are valid indices of verbal memory ability. Similarly, the clear trend for patients with right temporal lobe lesions to perform poorly on the EMB visual tests while patients with left temporal lobe lesions did not, supports the hypothesis that these tests are specific measures of visual memory ability.

The discriminant analysis on the verbal tests correctly classified all the patients with left temporal lobe damage as "brain damaged" while those with right temporal lobe lesions were correctly classified as "normal", ie. not having verbal memory impairment. The discriminant analysis on the visual tests correctly classified all the patients with right temporal lobe lesions as "brain damaged", and two of the three patients with left temporal lobe damage as "normal", ie. not having a visual memory impairment. However, one of the left temporal patients was "misclassified" as brain damaged in terms of her visual memory. Since this particular patient had developed a tension headache by the time she came to do the visual tests, it seems advisable not to overinterpret this misclassification.

As there were so few patients in these unilateral damage subgroups, it would be unwise in any case to place much confidence in the predictive validity of the verbal and visual tests in diagnosing left or right temporal lobe lesions. Furthermore, using a rigid theory of hemispheric specialization of psychological functions as a basis for diagnosing the laterality of lesions, is an approach which has been questioned by several authorities (Geschwind, 1968; Sperry, Gazzoniga and Bogen, 1969; Vincken and Bruyn, 1969; Milner, 1971, and Marshall, 1973).

In establishing the clinical usefulness of a test, it is not sufficient to show that there is a significant difference between the mean scores obtained by the criterion groups (Yates, 1954). Data is therefore presented in the Results section suggesting the optimum cut-off points and percentage of misclassifications for each test. These will be discussed more fully when the construct validity of each test is discussed. However, it is evident that the discriminant analysis was more effective in classifying subjects accurately than the use of any single test score.

The variables of age, sex, race and intelligence were controlled by the matched

pairs design. Preliminary evidence was provided that neither verbal nor visual test performance was affected by age, intelligence, race or sex. However, it would be necessary to carry out an analysis of variance on a far larger sample, holding all other factors constant, before the effect of each of these factors could be fully determined.

The most important of these variables for the present study is race as it tends to be correlated with so many other factors which could have affected test performance (eg. poor education and socioeconomic level, as well as cultural differences). That the test results were not significantly affected by the race of the subject augurs well for the usefulness of the test in this multi-racial hospital, although, as already mentioned, a larger sample of Africans will be needed before generalizations can be made about the suitability of the test for this group.

That test performance was also not significantly affected by intelligence, as measured on the Raven's Progressive Matrices, has considerable practical significance as it is the finding of low intelligence in so many of the patients referred for psychometric assessment that has made the use of tests such as the Modified Word Learning Test (Walton and Black, 1959) and the Memory for Designs (Graham and Kendall, 1960) unreliable. Occasionally this "low intelligence" is a cultural artefact of the test used to measure intelligence. When this is the case, though, it seems likely that the MWLT and the MFD will also be affected by such cultural variables as these tests have not been standardized for local population groups.

II CONSTRUCT VALIDITY

Primary evidence of the construct validity of the test battery (ie. that it is in fact measuring memory), is provided by its success in differentiating people who on organic grounds should have an impairment of memory from those who should not. Criterion validity is evidence of construct validity. Each of the tests will now be discussed in terms of which aspects of memory they measured and the extent to which certain theories about the nature of memory impairment account for performance on the tests.

The Verbal Memory Tests

The hypothesis that these tests are measuring verbal memory receives support from the fact that patients with left temporal lobe damage were significantly impaired in their performance on them, while patients with right temporal lobe damage did not differ significantly from normal controls.

Lion Story:

a. Immediate recall strategies: Whereas almost all of the controls were able to integrate the story as a continuous sequence, almost half of the patients tend to concentrate on either the first or the second part of the story. Thus there was a significantly greater number of patients than controls who obtained scores on one half of the story that were double or more than double those they obtained on the other half. About as many patients received higher scores on the second half as received higher scores on the first half. (This is in contrast to Talland's 1965 finding that his Korsakoff alcoholics tended to remember the first few items of the story best).

Those who concentrated on the second part, remembered mostly that the woman begged the lion to return her baby, and thus achieved fortuitous points in the first part for their mention of the lion. Some remembered the lions name as well, which suggests that perhaps they rehearsed these first pieces of information, and then simply recited the acoustic traces of the last part. Those who concentrated on the first part, seemed to have rehearsed the bit about the lion escaping from the cage, but to have absorbed either nothing of the second part, or just elements such as that

there was a woman and a baby in the story, but not what happened or how they were involved with the lion. Cermak (1976) noted that his amnesic patient could retain the first part of a story quite adequately, but could answer no questions on it at all if required to listen to the second part as well.

It seems clear that the patients cannot adequately integrate material in excess of span. A difficulty in sequential integration in amnesics was postulated by Talland (1965). Whether the basic defect is one of information processing, or whether there is a failure of consolidation related to interference from other similar material, cannot be concluded from the patients' performance on the story.

Those patients who did not concentrate on one or the other half, tended to give a very sketchy account of the whole (eg. "A lion escaped - I can't, it's too long for me - a woman - a woman and a child - and the lion tackled her"). Talland (1965) noted this tendency amongst his Korsakoff patients to report the story in its barest outlines, retaining the gist rather than the phrases.

On Immediate recall, 83% of the controls score above 15, whereas 93% of the patients have scores of 15 and below.

b. Forgetting: In spite of the fact that they registered less of the story in the first place and therefore had less to remember, the patients showed a significantly greater degree of forgetting than did the controls. Seven of the patients, when asked at the end of the test battery to retell the story, had completely "forgotten" what the sotry had been about. This could suggest a lack of access cues (Cermak et al, 1973). Given the prompt "was it about a dog, a lion or a policman?", one patient continued to deny that there had been a story; four decided it had been about a lion, but two of these could add nothing further; while two chose the dog, but added other correct items.

There was an impression that the delayed story given by the controls was more integrated than their immediate story, even though odd details were missing. In contrast, the delayed story of the patients seemed less

cohesive than their original recall of the story. This suggests that there was some process of integration or consolidation for the controls that did not occur for the patients. It is not possible to determine, however, whether this apparent failure of integration was due to decay of traces (Talland, 1965), interference, or disinhibition in storage (Warrington and Weiskrantz, 1970). It can be seen from the bar diagram p. 123 , that delayed recall of the story was one of the most successful measures of impaired memory, in terms of its ability to differentiate patients from controls: 100% of the patients score above 11, whereas 93% of the patient score 11 and below.

c. Confabulation: There is some support in the examples of confabulation seen amongst the patients that the amnesic memory defect is related to a lack of temporal markers for experience (Huppert and Piercy, 1976) and is the result of disinhibition of material in storage (Warrington and Weiskrantz, 1968a, 1970).

Some of the confabulations were related to a casualness in telling the story, eg. "The lion gave the child a lick and a promise", and "the people, all flummagated and shocked ....". Others, which provide another setting for the story, suggest a loss of memory for context, eg. "die leeu het in the bosse gestaan", ("the lion stood in the bushes") and "iemand het die leeu gejag", ("someone was hunting the lion"). Others seem related to the patients bank of personal experiences and ideas, eg. "'n Vrou het in the bos gestap. Sy skrik vir die Kaffirs wat snaaks aangetrek is" ("A woman was walking in the bush. She was startled by Kaffirs who were oddly clothed"); "The woman, a Jew ....", and "Daar's 'n swart man daarby and hy het die kind uit die mond van die leeu gered" ("There was a black man there and he rescued the child out of the mouth of the lion").

None of the controls introduced any details, characters of incidents not in the story. Four of the patients introduced such confabulations in their immediate recall and seven of the patients in their delayed recall. Confabulations were conspicuously further removed from the original story at delayed recall, eg. "Was it about a bloke on a ship?" That there was a statistically significant difference in the number of patients

and controls introducing confabulations on delayed recall, provides support for the principle of subtracting confabulations from correct recall scores in order to increase the discriminating power of the test.

The Shopping List:

Primary evidence suggesting that the shopping list is measuring memory is supplied by its ability to differentiate individuals with organic memory impairment from those without such impairment. Of all the tests, there was the least overlap on this one, particularly on delayed recall. On the five learning trials, 97% of the controls scored above 40, while 93% of the patients scored 40 and below. No patients scored above 50. On delayed recall, no controls scored below 10, and no patients above 10.

a. Rate of Learning: As predicted, there was a significantly slower increase in the rate of list learning over trials in the patients than in the controls. A detailed analysis of which items patients retrieved consistently and which they retrieved only randomly, revealed a pattern consistent with that noted by Bushke and Fuld (1974) and Fuld (1976). The patients recalled fewer items than did the controls on each trial, and the number of items recalled showed little increase from one trial to the next. Nonetheless, there was considerable encoding for storage amongst the patients as evidenced by the number of items they recalled at least once, but there was no consistent retrieval of items. For example, one patient retrieved a mean of about 7 items per trial, yet actually recalled a total of 14 of the items at least once; while another patient recalled a mean of 8 items per trial, but recalled a total of 17 items at least once. This pattern of the number of items ever retrieved being approximately double the number recalled on any one trial appeared to be consistent for the patients. In contrast, the total of items ever recalled by the controls was only a few points above that recalled per trial, and often not above the number recalled on the final trial. As Fuld (1976) also found, however, the number of items recalled at least once was lower for the patients than the controls, suggesting an impairment of storage (or encoding for storage) as well as a failure of consistent retrieval.

That the patients' strategies for learning and retrieval were not as

effective as those of the controls is inferred from their haphazard recall of items and their tendency to repeat items they had already given. In contrast, controls used several strategies, which included: beginning their recall list with the same items each time, beginning their recall list with the items first in order on the list just presented, beginning with items they had left out the time before, and grouping items by category. Most controls used several of these strategies and might change their approach as learning proceeded. Several controls visualized their local supermarket and would have an imaginary walk around it, checking the sections for items on the list that they might have forgotten.

It is not possible to determine whether the patients' failure was one of encoding for consistent retrieval, or was the result of inefficient search strategies and/or interference from items in storage. That it was a combination of all these factors seems likely. A failure of encoding was suggested by their inadequate use of clustering by category; interference in storage and a loss of context for items was suggested by their high incidence of confabulations , and inefficient search strategies were suggested by the fact that far more patients than controls "gave up" before the two minute time limit in their recall attempts on each trial. Encouraged to keep trying, the patients would still be able to recall items. This observation is consistent with that of Fuld (1976), and provides support for Talland's hypothesis that poor activation and premature closure of search cycles is one of the root causes of amnesic memory impairment. In contrast, when the controls "gave up" before the time limit, they recalled very few items thereafter, even with encouragement.

b. Clustering by Category: While all of the controls grouped some items at some time according to their category membership, eg. "vegetables", "staples", "cleaning materials", etc., significantly fewer of the patients did. This provides support for the theory of Cermak et al (1973) that there is a deficit of semantic encoding in amnesics. These authors found that, even though amnesics could use such category cues when instructed to do so, they failed to do so spontaneously. It is not possible to say whether this deficit is produced by an impairment in an underlying process such as information processing, as has been suggested by Oscar-Berman, (1973) and Glosser et al (1976), or not.

That the patients did use some clustering or, at least, were stimulated by associations, is shown by the fact that significantly more of them than of the controls grouped confabulated items by category, eg. "onions and tomatoes", "bread and butter", or associated one item on the list with another item not on the list, eg. "oranges and bananas", Vim and Omo", "Sunlight soap and varnish". It should be noted that some of these associations were often acoustic as well as semantic, eg. "groen boontjies en groen gemmer," ("green beans and green ginger") and "kerrie, kaneel, en karamel," ("curry, cinnamon and caramel"). A tendency in amnesics to encode along acoustic dimensions, which decay more rapidly than do semantic associations, has been reported by Cermak et al (1973), and Brooks and Baddeley (1976).

c. Confabulation: As was predicted, significantly more of the patients than of the controls introduced confabulations in learning the list and in their delayed recall. Controls introduced fewer items than the patients, however, and these confabulations tended to disappear as presentation of the list continued. In contrast, most patients perseverated the same confabulations across all five trials. Some patients had different confabulations on the different trials, but usually in association with a few that commonly recurred. Confabulations which were dropped by the patients as list learning continued, would often recur again on the Delayed Recall

The nature of the confabulations provides support for theorists who attribute the amnesic defect to a loss of temporal context (Huppert and Piercy, 1976) and disinhibition of items in storage (Warrington and Weiskrantz, 1970). (It should be noted that these theories may be complementary, rather than mutually exclusive). Both patients and controls introduced items that would commonly be on their own shopping lists, eg. bread, sugar, butter and coffee. Thus there was competition in recall from items learned on a previous occasion that were poorly discriminable from the present items. An abnormal sensitivity in amnesics to this type of interference has been postulated by Huppert and Piercy (1976), and Winocur and Weiskrantz (1976). This inability to differentiate the temporal context of this list from other shopping lists was very clear in some of the patients, "Now what on earth did I have on there? I must get to the supermarket before it closes. I've confused mine and yours!"

Besides the common confabulations, patients also introduced more exotic items that seemed to have personal significance, eg. the hawker's assistant who introduced parsley, green ginger, green beans, curry powder, etc,, and the hospital cleaner who introduced steel wool.

d. Forgetting: As predicted, the patients forgot significantly more of what they had learned than did the controls. The controls actually forgot very little between Trial 5 and the Delayed Recall at the end of the battery ($\bar{X}$ number of items forgotten = 0,5). In contrast, the patients, although their mean score on Trial 5 was lower than that of the controls, forgot more of what little they had learned ($\bar{X}$ number of items forgotten = 1,89).

As already suggested, this forgetting may be attributed to a combination of poor encoding for retrieval (Cermak et al, 1973), interference from previous learning,and a lack of discriminable context for the items (Warrington and Weiskrantz, 1970; Huppert and Piercy, 1976; and Winocur and Weiskrantz, 1976); and inefficient search strategies (Talland, 1965).

Digit Span and Supraspan Digits:

(i) Digit Span: The prediction that digit span would not be significantly different in patients than controls was confirmed. Since the patients and controls were matched for intellibence and discrepant with respect to their memorizing ability, this finding offers support for those theorists who regard digit span as a test of intelligence rather than one of memory (eg. Zangwill, 1943; Eysenck and Halstead, 1945).

(ii) Supraspan Digits: The patients' inferior performance on this task appeared to be related to their inability to integrate material in excess of span (Drachman and Arbit, 1966) and their sensitivity to interference (Cermak and Butters, 1972). Strategies varied between patients and controls. Controls soon discovered that concentrating on the last few digits made it difficult for them to remember the earlier ones, and they then usually changed strategy and tried to rehearse the first digits and add a few onto them each time. In contrast, the patients either seemed to have no strategy, or would quickly recite the last few digits, then try to start at the beginning, and by then they had lost the last digits as well. Patients

perseverated incorrect digits without seeming to notice the discrepancy between what they had said and the actual digit-list when it was next read to them. This may support the hypothesis that the defect in encoding is related to a limited ability to process information (Glosser et al, 1976). Certainly the patients perseverated incorrect strategies, (Oscar-Berman, 1973) and showed an inflexibility in changing set (Tallend, 1965).

Proactive Inhibition: That the patients did not perseverate list a in their learning of list b to a greater extent than did the controls, is probably related to the fact that they learned so little of list a in the first place. Support for the theory that amnesics are abnormally sensitive to interference from previous learning, P.I., as postulated by Cermak and Butters (1972), Winocur and Weiskranz, (1976) is provided by the fact that the patients showed significantly more perseveration of their own version of list a in their learning of list b than did the controls. (Such perseveration was scored if the digits commonly used to begin list a, although not the actual list a, were used to begin list b; if digits commonly used to end list a were used to end list b; and if any favoured sequence of 3 digits on list a recurred on list b).

This supraspan learning task proved difficult and tiring for several of the patients. The controls usually quite enjoyed the task and were eager to improve their scores. Differentiation of patients and controls on the task was good, 87% of the patients scored below 40 over the 10 trials, while 90% of the controls scored above 40.

The Visual Memory Tests

Continuous Recognition:

a. Rate of Learning: Although the patients recognised significantly fewer of the designs than did the controls, their rate of learning across trials was not significantly different from that of the controls. This seems to be attributable to both groups having reached their ceiling level early on and showing little increase generally over trials (see Figure 21).

b. False Positives: Both groups seem to have become increasingly confused by the nonrecurring designs as presentation continued. After an initial drop in false positives, there is a rise at Trial 4, a decline, and then an increase again. Some of this confusion came from a loss of temporal context, affecting both groups. For example, subjects thought they had seen the design before, but perhaps not in Pack A. If they hesitated or asked questions, all they were told was to decide whether they had seen the design before or not. Many subjects failed to realize that only a limited number of designs were recurring and thought that the new designs still being presented would also be recurring. As Shepard and Techtsoonian (1962) found with digits, continuous presentation of recurring stimuli builds up proactive inhibition. After a point, it seemed to several subjects that many of the designs were similar to something they had seen before,and deciding with any certainty whether it was an exact match or not became increasingly difficult. It can be seen from Figure 21 that the two curves were beginning to diverge, and perhaps the difference would have been significant if presentation had continued.

The tendency of the patients generally to recognise more false positives than the controls is support for the theories postulating amnesic sensitivity to interference, (Warrington and Weiskrantz, 1968a, 1968b and 1970; Cermak and Butters, 1972; de Luca et al, 1976; Huppert and Piercy, 1976, and Winocur and Weiskrantz, 1976). The similarity and low discriminability of material would have fostered such interference, and the fairly rapid continuous presentation technique would have made processing and categorising for retrieval from storage difficult.

c. Geometric and Nonsense Figures: The patients had fewer correct recognitions and more false positive recognitions of both geometric and

nonsense designs than the controls. It is possible that defects in input coding were responsible for these findings. Poor encoding could cause both fewer correct recognitions and a greater sensitivity to interference from similar material. A deficit of verbal mediation or verbal encoding strategies, as postulated by Sidman et al (1968), Butters et al (1973), and Cermak et al (1973) could account for the poor performance on geometric designs; while an impairment in the use and retention of visual images (Baddeley and Warrington, 1973; Jones, 1974; and de Luca et al, 1975) could account for poor performance on the nonsense designs. However, other explanations are also possible: eg. inefficient search strategies (Talland, 1965), or a basic deficit in the processing of information (Oscar-Berman, 1973; Glosser et al, 1976).

Although several subjects became confused as to what was required of them on this test, most subjects commented that they found it easier than the previous tests. The differentiation of patients and controls was not as good on this test as on the other tests as there was more overlap. Nonetheless, 97% of the patients achieve corrected scores under 40, while 78% of the controls achieve scores above 40.

Faces:

In order to determine which variables contributed to producing the inferior scores of the patients on this test, it would have been better to have used a technique which left it to the subject to decide the number of faces chosen. It would then have been possible to differentiate the number of false positives spontaneously chosen from those that were the result of the forced-choice technique. It would also have been easier to assess the strategies used.

More patients than controls chose less than 12 faces before giving up or saying "that's all". Both groups increased their number of correct recognitions, as well as their false positives, when forced to make further choices. That more patients gave up after fewer choices than the controls, may provide support for Talland's theory that the amnesic defect is due to a premature closure of search cycles (1965).

More patients than controls showed sensitivity to interference from the multiple-choice recognition. Apart from choosing more false positives than the controls,

the patients also had a tendency to become confused as to which faces on Set II they had already indicated as having occurred on Set I. An extreme example of this was the patient who kept on giving the same numbers (as on the photographs) over and over as if he was choosing ones he had not already "recognised". The examiner stopped trying to obtain a choice of 12 after he had given the same 10 numbers more than forty times. This tendency for some patients to repeat, seemingly without awareness, what they had already said, was similar to that observed in their recall of the shopping list.

Controls generally showed the effect of better planning at the time of learning than did the patients: that is, more of them had observed the number of faces and the distribution of males and females on the presentation set. A few patients and one of the controls made the mistake of studying all the Set II faces before choosing the old ones. The result was that all the faces then looked familiar.

It cannot be said whether the higher false positive rate of the controls was due to interference from the similarity of the material (Cermak and Butters, 1972; Huppert and Piercy, 1976) or to a lack of restraint upon the alternatives available (Warrington and Weiskrantz, 1968b, 1970), as the technique used does not permit excessive recognition of false positives to be differentiated from a failure of correct recognition. One patient who rattled off a choice of 17 faces, was obviously more sensitive to interference, but this was not a common occurrence.

Most subjects were involved with their performance on this test; that is, several had comments to make on how good or bad they usually were at recognising faces. (This subjective comment probably had little to do with their actual ability: many controls said how bad they were at this, while the most Korsakoffian lady in the sample commented "I'm usually good at this.")

This test has been shown to be useful in principle, as the mean scores of the patients are significantly inferior to those of the controls. However, there is a very small discrepancy between the means of the two groups and, with the test's low reliability, misclassification of individuals could easily occur. Of the controls, 94% had scores above 7, while 84% of the patients had scores of 7 and below. What is needed is a similar test with a wider range of possible scores.

Spatial span and Supraspan Block Tapping:

(i) Spatial span: The discrepancy between the spatial span of the patients and the controls was statistically significant at the 5% level. However, this finding does not have much meaning in terms of the differentiation of individuals as the means of the two groups were so close ($\bar{X}$ = 4,95 for the patients; $\bar{X}$ = 5,41 for the controls) and there was considerable overlap, as can be seen from Figure 14, p. 127.

It is interesting that, while there is no significant difference in digit span between patients and controls, there is in spatial span. Several authors, however, have noted a deficit in amnesic retention of brief nonverbal memoranda for immediate recognition or reproduction (Sidman et al, 1968; Warrington and Taylor, 1974; and de luca et al, 1975). The suggestion has been made that this is due to a failure of verbal mediation (eg. Sidman et al, 1968; de Luca et al, 1975), but it is not possible to determine whether this was the case in the present study.

(ii) Supraspan Block Tapping: As on the Supraspan Digits, the patients' inferior performance on this task appeared to be related to their inability to integrate sequences in excess of span and their sensitivity to interference. Here again, controls soon devised the strategy of first learning the starting sequences, and then adding on to them, but also noticing where the sequences ended. They also were quicker than the patients to notice that there were 8 taps in the series. Patients were far less efficient. They seemed to try and absorb the whole sequence, and then could not remember where it started. Several patients learned the first few, but seemed unable to add any to this basic span, except perhaps the last one. Several others merely perseverated the same sequence, occasionally throughout both sequence a and b, without awareness that it was incorrect.

Proactive Inhibition: More patients than controls showed perseveration of sequence a in learning sequence b, but this difference did not reach statistical significance. Most patients, however, learned so little of sequence a that it would have been suprising if there had been perseverations of it on sequence b. Significantly more patients than controls showed perseveration of their own version of sequence a in learning

sequence b. This provides support for theory that amnesics are sensitive to interference from their previous learning (Cermak and Butters, 1972; and Winocur and Weiskrantz, 1976) or for Talland's theory that amnesics are inflexible in changing their set, and therefore perseverate inappropriate strategies (1965).

III RELIABILITY

Preliminary evidence of the reliability of the test is provided by the consistency of the test results over the patient and control groups (Yates, 1954). The reliability of the results will need to be verified by applying the test to new groups that are independent of the original criterion groups and, ideally, the findings should be confirmed by other workers in other settings. The present study used patients from three different hospitals, but the tester was always the same person.

Fairly satisfactory split-half reliability was established for the Lion Story, and the Supraspan Digits and Blocks (Anastasi, 1968). On the Faces, a negative reliability coefficient resulted, but this was attributed to an artefact of scoring. The low range of scores obtained would cause differences on the two halves to be magnified.

A high level of interscorer reliability was established for the Lion Story, suggesting that dividing the test into 30 units instead of the usual 20 has removed the "notorious difficulty" in scoring and standardizing reported by Zangwill in 1943 as the main draw back to the use of such memory tests.

Now that support for the validity of the EMB in detecting memory impairment has been provided,and the test has been shown to be suitable for use with the patient population typically referred for psychometric assessment, the ideal form of reliability to attempt to establish will be an alternate form, used to assess the degree of response variation over time,as well as variation due to content sampling.

CHAPTER 10

CONCLUSIONS AND INDICATIONS FOR FURTHER RESEARCH

This study has provided preliminary evidence of the validity of the BMB in detecting organic memory impairment. The differentiation achieved by both the verbal and the visual memory tests is of such a high order as to recommend the test for further cross-validatory and predictive studies. There is evidence that the test will be useful with the population for whom it is intended, many of whom are from the lower socioeconomic levels and often poorly educated. It appears not to be affected by racial group membership, although further sampling is necessary to establish whether it will be reliable with less educated Africans, as well as those with higher education. (Only representatives of the latter group were included in the research sample).

The verbal and visual tests seem to have the potential to differentiate individuals with left or right temporal lobe lesions, but further investigation, (bearing in mind the limitations of this approach), is needed to substantiate this.

The basic theory underlying the validation of the test was that damage to the limbic system results in disturbances of memory. Yates (1954) has postulated that the difficulty with validating most tests of brain damage is that "brain damage" is regarded as a unitary factor producing deterioration of function, yet, from an anatomical and physiological standpoint, there is no reason why all brain damaged individuals should behave alike. A high incidence of misclassification has resulted from the use of this unitary concept, and of an empirical rather than a theoretical approach as to what will constitute brain damaged behaviour.

In this study it was postulated that certain test techniques, capitalizing upon what is known of the nature of the memory defect in amnesics, would be useful in enhancing its manifestation. These techniques included using the rapid presentation of materials which were in excess of immediate memory span, were not easily discriminable, and which called for encoding strategies. Distraction tasks in the same modality as the learning task were introduced. In retrieval, judgment by context was required, and facilitatory cues were minimized and interference from a range of alternatives fostered. Errors from such interference were penalized where they occurred. Delayed as well as immediate recall

and recognition was assessed.

Developing a theory of memory functioning and determining which processes are impaired when there is a disorder of the limbic system, is beyond the scope of this study. There is a need for a theory which will integrate the experimental findings of the various groups of workers in the field. Theories such as those of Baddeley and Warrington (1970), which postulate a dichotomy of STM and LTM and place the amnesic defect in LTM only, do not seem able to explain all the experimental findings. It is not clear from the present study whether the defect is at the encoding stage, as postulated by workers in the Boston group (eg. Cermak et al, 1973) or is at the retrieval stage and related to disinhibition in storage, as postulated by workers in the British group (eg. Warrington and Weiskrantz, 1968b, 1970), or is in the middle stage of consolidation, as postulated by Milner, (1970). These theories are not mutually exclusive, however, and there was support for Talland's position that several processes may be impaired and that there is a failure to sustain an activating function in perception, registration, consolidation, and retrieval (1965).

There was evidence of a failure of encoding, as postulated by Cermak et al (1973), particularly on the Shopping List and the Continuous Recognition. It cannot be said whether or not this was related to a basic deficit in the rate of information processing as has been postulated by Oscar-Berman (1973) and Glosser et al (1976). These workers and Talland (1965) observed the amnesics' tendency to use a limited number of strategies and to perseverate these strategies even when they were found to be inappropriate for problem-solving. A similar pattern was observed in the patients participating in this study, particularly in their performance on the Supraspan Digits and Supraspan Blocks.

Consolidation and storage cannot be measured operationally. If recall or recognition are deficient, it is a matter of inference whether this deficiency is due to inadequate consolidation and storage, or whether retrieval and search processes are impaired. Performance on the delayed recall of the Lion Story suggested a failure of integration and consolidation of material in the patients, but other interpretations are also possible.

Support for the theory that amnesics are abnormally sensitive to interference

from previous learning or experience (Cermak and Butters, 1972; Winocur and Weiskrantz, 1976), particularly where material is poorly discriminable and judgment by context is required (Huppert and Piercy, 1976), was provided by the patients' performance on Continuous Recognition and Faces, and by their confabulations on the Lion Story and the Shopping List. Interference from perseveration of previous learning was evident on the second lists (list b) of both Supraspan Digits and Supraspan Blocks.

Limitations in retrieval strategies were evident on the Lion Story, where a clue was needed to facilitate further recall, and on the Shopping List and the Faces, where patients tended to "give up" prematurely. Whether this failure in retrieval is attributable to inadequate encoding strategies, which would mean few access cues at the time of retrieval, (as is postulated by Cermak et al, 1973), or to poor activation and premature closure of search cycles (as is postulated by Talland, 1965), or to both, cannot be determined.

It is also not possible to determine whether the poor retrieval is attributable to a failure of dissipation and disinhibition of material in storage, as has been postulated by Warrington and Weiskrantz (1968b, 1970, 1974, 1975). This implies that there will be a high incidence of false positives when there are no cues to limit competing responses. The forced-choice technique used on the Faces did not allow scores to be attributed to either a failure of correct recognition or confusion from competing alternatives. The high incidence of false positives on the Continuous Recognition may be attributed to sensitivity to the lack of restriction on alternatives afforded by the yes-no recognition technique. However, it seems that false positives and confabulations can as well be explained by other theories postulating interference from similarity of material, loss of temporal context, and so forth as by the loose concept of "disinhibition in storage". Such disinhibition could in any case be attributed to poor categorization in storage, and thus related to impaired encoding strategies at the time of input.

Indications for Future Research

A primary need is that of developing a theory of memory functioning which can adequately incorporate the various findings on impaired processes in individuals with brain damage. Future research with the Experimental Memory Battery will include investigating its usefulness in detecting brain damage in individuals

where lesions are not limited to the limbic system. Memory impairment is a common early feature of dementia (Miller, 1975). It will be interesting to investigate whether psychiatric patients will be misclassified and whether it will be possible to attribute impairment in such patients to a defect of registration rather than of retention, as has been postulated by Cronholm and Ottosson (1961) and Sternberg and Jarvik (1976).

In its present form, the EMB takes rather long, which can be tiring for the elderly or the sick. Possible ways to overcome this are to use the verbal tests alone (their discriminating power is good enough to allow this), or to consider shortening the tests. For example, statistical analysis showed the patient and control groups to be significantly different on their 3-Trial total as well as their 5-Trial total on the Shopping List, and on the 5-Trial mean as well as the 10-Trial mean on both the Supraspan tests. The possibility of shortening the test will be further considered when an alternate form is developed. This is necessary to provide information on the tests' reliability of measurement.

A further area for investigation is to determine the dependence or independence of the various tests. The intercorrelation of tests scores was undertaken as an afterthought to the present study, but the interpretation of the results is a matter for future consideration. There were insufficient patients with unilateral damage to interpret the patterning of nonsignificant and negative correlations between their verbal and visual scores. Many of the intercorrelations between tests, obtained for both the bilaterals and their control groups, appeared spurious, resulting from an interdependence of scores (eg. story recall, delayed story recall, and forgetting of story). The highest positive correlation between independent test scores was that between the Supraspan Digits and Supraspan Blocks. This could make them very useful as comparable measures of verbal and visual memory processes. Otherwise, the only significant correlation between tests for the controls was between the Lion Story and the Shopping List. Performance on several of the tests was intercorrelated for the brain damaged patients, however. This raises the question of impaired memory processes having more in common than do the strategies of remembering used by normals: a fruitful area for further research.

The most immediate research needed relative to the EMB is to standardize it on a larger sample of Africans, and to have it cross-validated by other workers in other settings.

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APPENDICES

APPENDIX A

DESCRIPTION OF THE DIFFERENT RACIAL GROUPS

(Statistics from the 1970 Population Census; Information from Encyclopaedia Britannica, 1971)

A) The Cape Coloureds: have evolved over the past three hundred years by admixture of African, Xhoisan (Bushman and Hottentot), Malay and Caucasian peoples. They are concentrated in the Cape where there are some 2 million of them. They form a group socially intermediate between the Whites and the Africans. They speak Afrikaans and English, are Christians (except for a subgroup of Muslims) and live in a Western manner.

The majority are casual labourers (particularly in the rural areas) or factory workers, with a small middle class of artisans, shopkeepers, clerical and other skilled workers. Only some 4% are in the professional, technical and managerial bracket. Education levels tend to be low: about 40% have no education, about 20% have had only 4 years of education, another ± 25% finish primary school, about 15% junior high school, and under 20% finish high school and go on to obtain a degree or diploma.

B) The White population: have lived in South Africa over the past 300 years and are of European extraction, mainly Dutch (the Afrikaner) and British. There are some 4 million of them, spread over the whole country and constituting approximately 18% of the total population. They are Christian and Western in their orientation. They tend to have a higher material standard of living than the other racial groups. Some 15% are uneducated, 10% finish primary school, a further 40% junior high school, 20% more matriculate, and a further 8% obtain degrees or diplomas.

C) The Africans: are a negroid people constituting almost 70% of the total population. There are only about a million of them in the Western Cape, however. They are mostly members of the Southern Nguni tribe which is composed of a number of distinct tribal groups, whose home is in the Transkei and Eastern Cape and who speak dialects of the Xhosa language. The culture of the urban African is oriented to Western forms, but in many current behaviour

patterns and belief continuity with traditional African culture may be discerned (eg. in lobola, circumcision rites and other customs, and in attitudes to witchcraft, sorcery and antidotes for sickness). They may attach value to their tribal identity and there is much movement between urban and rural communities - apart from that of the migrant labour system in which the men leave their families in the rural areas and work for contracted periods in the towns.

Africans tend to have a low income and low material standard of living. Some 80% of those employed are labourers, with only 2% in the professional, technical and managerial class. In the 1970 census, almost 60% had no education; 20% had 4 years of education (literacy); a further 15% finished primary school, 7% finished junior high, fewer than 1% matriculated, and less than 0.5% obtained a degree or diploma.

APPENDIX B

DIAGNOSIS AND DESCRIPTION OF PATIENTS

Patients are grouped according to diagnosis, each group age ranked. The first line gives the computer number for this study, initials of name, initial of race (A = African, C = Coloured, W = White), sex (M = Male, F = Female), education level achieved and hospital number.

The second line gives their current status (eg. working, housewife, patient, etc.)

The next section gives their diagnosis and any clinical details available.

The final sentences comment on their orientation and mental state at the time of testing. Comments of patients or others on the state of their memory are also given.

A. Nutritional Deficiencies: 11

12. P.B. 38 CM Std. 5 GSH[a] 0-2260289
Works for printing firm, will continue on discharge.
△ Korsakoff's syndrome (alcoholism) and Peripheral neuropathy.

Chronic alcoholic initially admitted to GSH 3 years ago and diagnosed Wernicke's encephalopathy. Transferred and treated at VMH[b] for Organic Brain Syndrome and Alcoholism. Readmitted GSH 1976 complaining of headaches and memory loss for the past few months. Disoriented and clinically obvious memory defect.

Oriented for everything except the time of day at testing. Felt his memory was much better and he now knew what was going on.

---

13. V,B. 40 WF Std. 8 GSH 3-1200818
Disability grant; lives with parents. Used to do clerical work.
△ Korsakoff's syndrome (alcoholism).

Drawn from computer print out. Previously chronic alcoholic. Admitted to VMH for several months 2 years ago for depression and alcoholism. No alcohol for 2 years.

[a]GSH = Groote Schuur Hospital.
[b]VMH = Valkenberg Mental Hospitel.

Fully oriented. Does not complain of her memory. Gives a vague history of past dates. Her mother says she is perfectly normal ("she plays the piano and writes nice letters"), except that she is forgetful. She will ask the same things over and over again and not remember why they have come to hospital.

---

20. A.A. 51 CM Std. 5 VMH

Was maintenance worker in factory, now mental hospital patient.

△ Organic brain damage. Korsakoff's psychosis.

In VMH for the last 5 months. Two previous admissions since 1970 for alcoholism. Previous history of epilepsy. Assaulted 1973, AEG: communicating hydrocephalus. V.A. shunt 1974.

Fully oriented. Initially denied that he was forgetful, but complained during testing that his brain had not been thinking so well since the operation.

---

19. A.S. 51 WM Std. 8, Trade Certificate III

GSH 9-2227295

Boilermaker. Likely to be given disability grant.

△ Korsakoff's psychosis, Wernicke's encephalopathy.

Chronic alcoholic. Treated for Wernicke's encephalopathy on admission. Initially confused, disoriented, poor memory. Improved.

Oriented for everything except month of year. Mentally clearer: recognises examiner and remembers actions and earlier conversations.

---

21. F.D. 53 WM Std. 8 GSH 3-2222465

Guard/plumber/driver. Unemployed.

△ Korsakoff's psychosis, Wernicke's encephalopathy, Bronchial carcinoma with metastases.

Chronic alcoholic with previous history of withdrawal seizures. Admitted

with Wernicke's encephalopathy. Improvement in global confusional state on therapy to predominant memory defect. In addition found to have carcinoma of bronchus.

Disoriented, but no longer confabulating. Knew that he did not know the date and could not remember things properly.

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22. R.R. 54 WF Std. 10, Domestic Science Diploma

GSH 9-2254632

Housewife. Only worked as domestic science teacher for 6 months before her marriage.

△ Korsakoff's syndrome (alcoholism).

Drawn through computer print out. Chronic alcoholic. Admitted confused and debilitated with pneumonia 4 months ago. Improved, and retrograde amnesia has shrunk. Has remained disoriented with defective memory. No alcohol for 4 months.

Disoriented: gave the year as 1946 or 1956 and said she never looked at the clock or calendar. Gives a vague history, particularly for events of the past year. Husband reports she is an apathetic housewife and her memory is bad.

---

23. B.M. 55 AM Std. 7 VMH

Carpenter's assistant.

△ Korsakoff's syndrome (alcoholism).

First admission. Chronic alcoholism. Noted to have poor memory on admission four months earlier.

Fully oriented. Intelligent and pleasant. He said he had suffered from memory loss and the ward sister confirmed this.

---

24. J.W-S. 56 WF Std. 10, Nursing Diploma
GSH

Psychiatric nursing sister.

△ Chronic alcoholism.

History of chronic alcoholism. Unreliable and memory poor at work.

Fully oriented. Knows her memory has not been so good recently.

---

25. M.A. 62 CM Std. 2 VMH MCC4512

Was labourer, gardener, now mental hospital patient.

△ Chronic alcoholism with brain damage.

Admitted to mental hospital 6 months ago as he apparantly became violent when drunk. Previously admitted for 5 months, end of 1974/beginning 1975.

Fully oriented. Noted by medical staff to have impaired memory.

---

26. S.S. 62 AM Std. 8, Teaching Diploma
VMH MNC1361

Mental hospital patient.

△ Chronic alcoholism, Korsakoff syndrome.

Third admission for alcoholism. Previously diagnosed schizophrenic as he was deluded and hallucinating. Admission note of 6 months ago reads "very confused and toxic old soak who has full score on the AA rating". On admission he denied hallucinations and paranoid ideas, but was disoriented for time and place, recent and remote memory were noted to be defective, and he was confabulating. A week later he was noted to be "very Korsakoff now", and a month later he was noted to be still confabulating.

Fully oriented. Denies more than "a little" alcohol and says he is in hospital for his health. Says he has a "retentive memory".

---

27. I.H. 63 WF Std. 3 GSH 8-2269380

Housewife for many years.

Δ Korsakoff psychosis. Peripheral neuropathy.

Chronic alcoholic, disorientated and forgetful with no insight into her disability. Recently had a grand mal seizure.

Disoriented for month and year. Vague historian with no idea of dates, ages of her children, etc. Euphorically obliging. Says her memory is very good " my husband thinks so too, people often compliment me on it". Confabulating?

B. Neoplasm/Surgery: 9

1. D.M. 17 CM Std. 3 GSH 605277

Never worked, helps mother at home.

Δ Craniopharyngioma.

At the age of 12, he presented at GSH with a 5 month history of headaches with recent vomiting and deterioration in vision. Right fronto-temporal craniotomy and biopsy confirmed craniopharyngioma. Radiotherapy.

Fully oriented. Says forgets very quickly. "My mother send me to the shop and I forget what to buy - I go back and she must write it down".

---

2. A.J. 19 CM Std. 6 GSH 5-2881227

Taken out of school through illness.

Δ Craniopharyngioma.

Symptoms started at the age of 17. Loss of balance, headaches, bilateral hemianopia.AEG showed craniopharyngioma extending upwards and posteriorly into pontine cistern. Craniotomy about a month before testing. Partial removal of tumour fixed to optic nerve and carotid artery. Awaiting radiotherapy.

Fully oriented. In reply to questioning, he says he is forgetful and was not always so.

8. B.C. 25 WF Std. 8 302319

Typist. Working part-time.

Δ Colloid cyst of Third Ventricle.

Sudden onset headache and vomiting, l.o.c. 3 years ago (1973). Maintained for a few days on intraventricular drainage. Colloid cyst removed by right transfrontal approach. Some dysphasia in the immediate post-operational period.

Fully oriented. No dysphasia. Complains that she is forgetful "on and off", that she has to write everything down, eg. groceries needed, dates and appointments.

---

32. P.B. 28 WM Std. 8 GSH 2-2084209

Completed apprenticeship as printer. Job hunting.

Δ Right temporal lobectomy.

Patient states that at the age of 12 he had a viral infection, following which a right temporal abscess was removed. Since then has had "three lobectomies", the last in November, 1972 when the calcified remains of an old abscess were removed. EEG shows a right temporal focus. He has a left homonymous hemianopia.

Fully oriented. Slightly emotionally labile. He states he has some personality problems: no friends, difficulty in holding onto jobs, and he becomes violent at times and smashes thing. He says his long-term memory is "A1", but his short-term memory is hopeless at times and that memory blocks occur all too frequently. He has particular difficulty in finding his way around, even to places he visits frequently, and is always forgetting where he has parked his car. He is not sure who people are from their faces.

---

33. E.S. 32 CF Std. 4 GSH 63-024242

Was Examiner in clothing factory; disability grant since 1974.

Δ Intracranial epidermoid, right temporal and subtemporal area. Right temporal lobectomy.

Operated 1972 following epilepsy of late onset with fluctuating left-sided hemiparesis, left homonymous hemianopia. Tumour enveloping posterior cerebral artery and superior cerebellar artery and expanded deep into temporal lobe removed.

1975 readmitted with convulsions, advancing left hemiparesis and left homonymous hemianopia. AEG showed changes consistent with previous operation. No recurrence of tumour.

Fully oriented. Complains she is very forgetful. Proselytizing religiosity.

---

34. E.M. 56 CF Std. 5 GSH 2-1201431

Cashier before operation. Had disability grant. Now job hunting.

△ Double Right frontal meningioma.

11 year history of generalized convulsions. Prior to operation 1973 had incontinence and occasional retention of urine, occipital headaches, loss of balance and dragging of left leg. Children had noticed deteriorating memory over several years. Large right frontal meningioma removed. Pressure effects, direct and indirect, were clearly present.

Fully oriented. Says, that she has loss of memory at times and cannot find where she has put things.

---

33. N.W. 67 WM Std.10, BSc. Pharmacy GSH

Pharmacist. Working up to admission.

△ Right Sphenoidal Ridge Meningioma.

3 month history of intermittent incontinence of urine, olfactory hallucinations. On examination: left homonymous hemianopia, slight left-sided weakness with extensor plantar. Investigation showed large right sphenoid ridge meningioma with lateral and upward extension into frontal lobe and into anterior part of temporal fossa. Removed at operation.

Tested pre-operation. Oriented for month and year. Says that he has not noticed memory problems, except that his sense of direction is not good. Nurses and wife report that he is always losing his way.

28. C.S. 17 WM Std. 9 GSH 22577994
School boy until accident.
△ Left temporal lobectomy.

MVA 4/4/76. Unconscious. Relative weakness of right arm. Long fracture left temporal and left frontal regions. Angiography showed swelling of left temporal lobe. Deterioration. Left temporal lobectomy (laceration extending 7 cms. from tip. Necrotic brain and haematoma aspirated). 19/4/76. Conscious but markedly dysphasic.

Tested 4 months later. Fully oriented. Slightly dysphasic. Says his memory is improving.

---

30. F.J. 28 WF Std. 10 GSH 260-669
Secretary.
△ Arachnoid cyst of left temporal region.

Admitted at the age of 21 years with raised Intre-cranial pressure caused by large left temporal arachnoid cyst. Excised at operation. Nature of underlying pathology obscure.

Fully oriented. Says she forgets messages, but her memory is better if she sees what she is supposed to remember. Says she always makes pictures and is a "visual thinker".

C. Trauma: 7

31. J.P. 18 CM Std. 5 GSH 0-2289004
Was labourer in building industry, now factory worker.
△ Head injury. Right temporal contusion.

MVA 7 months ago. Hit on right side of head. Unconscious for 3 days, PTA of 7 days. Post-traumatic epilepsy. EEG, right temporal abnormality.

Fully oriented. Says he is forgetful and does not think as quickly as he used to.

3. D.M. 23 CM Std. 3 GSH 6-2295988

Worked for painter until accident.

△ Severe head injury.

MVA a year ago with multiple injuries. Unconscious for 2 weeks. Thereafter confused and childlike. Still receiving physiotherapy and occupational therapy.

Oriented for time of day and year. One month out on date. Mother says he laughs a lot, and gets cross quickly; knows something the one day and has forgotten it the next. He says he thinks more slowly, does not remember the time he was in hospital, but that he is not otherwise forgetful.

---

7. N.N. 24 AF Std. 10, Teaching Diploma
Conradie 8.10

Was a schoolteacher. Now in rehabilitation unit.

△ Severe head injury.

In MVA 2 years before, told was unconscious for a month and it was several months before she spoke. Persistent neurological defect consisting predominantly of dysarthria and severe ataxia.

Fully oriented. Complains of difficulty in remembering. This is not evident in her conversation, however, as she remembers names of all rehabilitation staff and details of what they did with her the day before.

---

4. K.V. 24 WM Std. 8, Printer NTC III
GSH 9-2122199

Since accident has drifted from printing to other jobs. Presently reception officer in GSH.

△ Severe head injury.

Motor bike accident 2 years before. Unconscious for about 2 weeks and later profoundly mentally disturbed and violent. Good recovery. Limps from leg injury.

Oriented. Casual in manner and speech. Incomplete thoughts in disin-

hibited flow. Impaired judgment (Memory?) "Don't use it - can't trust it - 3 things at a time - fade out, fade in again."

---

9. W.M. 26 CF Std. 6 GSH 506107

Helped in grocery shop before accident and marriage.

△ Severe head injury.

MVA 7 years ago (aged 17). Left parietal depressed compound fracture, probable polar contusions. Noisy and partially conscious for next month. Discharged emotionally labile, disoriented and confused. Readmitted mid-1976 with complaints of tiredness, dizziness, blackouts and poor concentration. Relationship to marital problems vs head injury is queried.

Fully oriented. Husband complains of her forgetfulness and she admits her memory is "not so good."

---

10. D.O. 30 WM Std. 10, Engineering Diploma GSH 2316409

Maintenance engineer in factory.

△ Severe head injury.

MVA December, 1972. Multiple left-sided injuries (fractures). Deeply unconscious approximately 5 days. RA and PTA each approximately 3 months. Initially dysphasic, disinhibited. EEG 1974 showed mild left temporal abnormality.

Returned to work with his old firm, but in clerical capacity. Became depressed, frustrated and difficult and had several months in VMH in 1974. Has changed jobs frequently.

Fully oriented. Says his memory is terrible. Wife and previous employers confirm he is forgetful. Rational and intelligent seeming. Slightly impaired social judgment, disinhibited flow of talk. No longer dysphasic Complains of low drive, frustration and irritability.

---

15. A.W. 41 CM B.A. Honours, Senior Teaching Diploma
GSH 108952 (missing)

Was a schoolteacher. Ordained for the ministry. Disability grant.

△ Severe head injury.

MVA 8 years ago (? 1967). Unconscious about 2 months. Limps.

Fully oriented. Garrulous. Says he is slower than he used to be and he forgets certain things. His father says he is absent minded about where he puts things.

D. Infective: 2

6. E.R. 24 CM Std. I GSH 2225652

△ Syphilitic meningo-encephalitis.

Admitted November, 1975 with severe headache with pyrexia and confusion followed by coma. Diagnoses of syphilitic meningo-encephalitis confirmed serologically. One + month after onset of illness, he was disoriented for time of day and the date, had no knowledge of his time in hospital, and was confabulating. He gave his age as 19, and claimed to have been working up until that day. He could hold a rational conversation, but was restless and full of sighs. He became confused as he tired. He would forget remarks made 30 seconds before it another comment intervened. His family reported gross overeating. He would have no knowledge of having eaten just before and, apart from his memory impairment, hypothalamic damage was queried.

His family were unable to care for him and several months were spent in a mental hospital.

At the time of testing, he was oriented for day of the week, and knew it was the middle of 1976. He thought it was 11 a.m. at 3 p.m. He gave his age correctly. He knew that he had been in VMH recently, that his wife had had a baby, that his brother had brought him that day, and that he had seen the examiner before. Gross memory impairment was no longer evident. He said he had improved greatly, was no longer so restless, but that he could not find where he put things.

17. R.L. 44 WM Std. 7 GSH 9-2257367

Sales representative, now in stores department of old firm.

△ Viral Meningo-encephalitis.

Abrupt onset of pyrexial illness with convulsing coma and CSF pleocytosis. Gradual clinical improvement. Herpes Simplex Virus unconfirmed. Initially grossly disoriented for time date and place. Gave his age as 22, and date as 1930s. Confabulating. Unable to retain anything for a few minutes if distracted. Conversation rational with humourous repartee. Passive and unquestioning obliging. Amiably apathetic. I.Q. and memory scores both initially depressed.

At testing: Still disoriented but no longer confabulating. Knew his age and that he was then not working. His wife reports improvement, but says that he does not remember if they have visitors the night before until she reminds him; that he can ask the same question at 15 minute invervals and that he can repack things he has just done. Otherwise he functions normally, reading and fixing electrical things. It was obvious that she was not aware of how much he did not really remember, but covered by ordinary conversational remarks. A month after memory testing, he gave day, date, and time correctly; remembered topics discussed earlier in the session, and was back at work in the stores department.

E. Vascular: 2

29. M.O. 20 WM Std. 8 GSH 4-1198381

Was machinery operator. Disability grant, but seeking employment.

△ Left posterior cerebral artery occlusion.

December, 1974 developed infective endocarditis on mitral valve replaced $2\frac{1}{2}$ years before. Cerebral embolus caused right hemonymous hemianopia and some mental disturbance. Initially he had visual agnosia and an impairment of verbal memory was noted. Visual agnosia has since disappeared and he has learned to read again.

Fully oriented. (Tested 15 months after illness). Homonymous hemianopia. He says he has to write down things he wants to remember, and that making mental pictures of them helps his memory.

5. J.C. 24 CM Std. 7 GSH 285326
B.10 Conradie

Used to be clerk. In rehabilitation unit and about to return to old job.

△ Arterio-venous malformation, incompletely removed.

MVA age 4, blinded left eye. Epileptic. Sudden loss of consciousness 5 months ago, subarachnoid hemorrhage. Partial excision of large right parietal AVM and subsequent drainage of extradural haematoma. Left arm and leg weakness.

Fully oriented. Complains of memory. Unable to remember time in hospital, but also what he did last week. Occupational therapist reports poor retention.

---

16. F.P. 43 WM Std. 10 GSH 9-2076965

High-ranking police officer.

△ Lipoid Proteinosis with bilateral calcification of hippocampus.

Approximately 8 years history of forgetfulness. Unable to continue B.A. in 1967 because of memory problem. Minor disturbances of awareness interpreted as abscence attacks - epileptic. Recently having grand mal seizures. Skull X-ray shows bilateral hippocampal calcification. Complains of poor memory. He says he cannot remember what he reads, has no knowledge of how to get to places he has visited previously, has no recognition of places he should know; fails to recognise people who know him. He is intelligent, concentrates ferociously, and has never appeared defective on the numerous tests and games carried out on him. He shows retention of stories, patterns, etc. days after presentation with no forewarning that they will be asked for later, but admits he has been rehearsing just in case. However, his response to the hospital staff has often been as to strangers and not as to people with whom he has repeatedly shared his frustrations and his intimate worries. He does not remember the names of staff members whom he sees regularly.

---

18. S.V. 48 WM Std. 8, Trade Certificate I
GSH 2173357

Motor mechanic.

△ Lipoid Proteinosis with bilateral hippocampal calcification.

Patient with Lipoid Proteinosis. Occasional episodes of confusion of uncertain origin. Complains of defective memory. X-ray skull shows bilateral hippocampal calcification.

Fully oriented. Concerned about his forgetfulness and hiding it from people at work. He says he cannot remember 2 things at a time and that he cannot remember how to put wires back in car engines if he is distracted from reciting "blue, yellow, green". He forgets where he has parked his car. Several months after testing he had an episode of confusion in which he did not know where he was, could not find his way around the house, recognised noone except the family and took his pills over and over again. This resulted in placement in VMH for a few months. Now his wife reports he is quite normal except for his forgetfulness.

G. Epilepsy: 1

11. N.P. 31 CM Std. 3 GSH 638290

Hospital messenger.

△ Temporal lobe epilepsy.

4 year history of "blackouts" with l.o.c. and associated with auditory and visual hallucinations. He hears voices praying in his head, and voices saying "kill the doctor". He sees stars falling and a red colour and he smells blood. He has had brief spells in VMH (evidently for arguing with his voices) where he was diagnosed TLE with psychosis.

He presented recently with a 6 month history of weakness in his right arm and leg and was observed to be dysphasic post-ictally. Investigations revealed little other than a slightly enlarged left temporal horn.

Fully oriented. Slightly thickened speech. He complains that he forgets things quickly and that he talks a lot about religion.

H. Uncertain: 1

14. J.M. 40 AM Std. 7 GSH 403722

Clerk for publishing firm.

△ ? Presenile dementia of unknown origin.

Six month history of loss of memory for recent events. For 3 weeks prior to admission he had been disorientated in time. For about 1 week he had been prone to mood changes and found himself crying frequently.

There was nothing of note in his history or on Neurological examination. Brain scan, EEG and other investigations normal. AEG showed mild cerebellar atrophy. Psychometric testing showed some intellectual fall-off.

Oriented at time of testing. He complains of severe memory loss, eg. he forgets to attend to domestic affairs, does not know where he has put things and forgets what he is supposed to buy when he goes shopping.

APPENDIX C

AFRIKAANS VERBAL TESTS AND AFRIKAANS TEST INSTRUCTIONS

Algemene Instruksie: "Hierdie is 'n toets om te sien hoe goed jy kan onthou. Daar is ses klein toetse daarin. As jy een nie kan doen nie, moenie daaroor bekommerd wees nie, jy sal seker 'n ander een kan goed doen."

A) VERBAL TESTS

1.) Leeu Verhaal

(a) Immediate Recall:

Instruksie: "Ek gan 'n storie vir jou lees. Luister goed, en as ek klaar is wil ek hê jy moet vir my soeveel van die storie vertel as wat jy kan onthou. Luister."

'n Leeu, Simba by naam, het van sy hok ontsnap, want dit was oopgelaat deur 'n agterloosige wagter. 'n Groot klomp mense wat daardie Sondag besoek het, het na die geboue langsaan weggehardloop. 'n Vrou, in blou gekleerd, het haar seuntjie, een jaar oud, laat val. Die leeu het hom bespring. Die vrou het teruggegaan en, met trane in haar oë, die leeu gesoebat om haar baba terug to gee. Die leeu het lank na haar gekyk. Uiteindelik het hy die kind gelos, sonder om hom enige besering aan te doen.

Instruksie: "Nou vertel vir my wat al jy kan onthou."

Vrae: i. "Is daar enige iets nog; enige andere besonderhede wat jy wil byvoeg?"

ii. "Wie nog was in die storie?"

iii. "En toe, wat het gebeur?"; "Hoe het dit geëindig?"

(b) Delayed Recall:

Instruksie: "Daai storie wat ek by die begin gelees het? Kan jy probeer om dit weer vir my te vertel? Net soeveel as jy kan onthou."

Vraag: "Was dit oor 'n hond, 'n leeu, of 'n Polisieman?"

2.) Koopies Lys

(a) Multitrial Learning:

Instruksie: "Nou gaan ek vir jou 'n toekoopie lys lees met die soort dinge

daarop wat jy miskien by 'n supermarket sal koop. Probeer om so veel daarvan te onthou as wat jy kan. Voordat ek vir jou vra wat op die lys gestaan het, gaan ek vir jou vra om agteruit te tel, by 100 of wat al nommer ek vir jou gee begin, en elke keer (byv. 3) trek. Byvoorbeeld 100, (97), (94). Okay, probeer: elke keer (3) afneem, en gaan nog agteruit. Okay, nou luister na die lys en probeer om dit te onthou."

1	2	3	4	5
rys	aartappels	polony	sigaretta	tandepasta
tee	lemoene	margarine	margarine	Vim
polony	margarine	tandepasta	tee	Ideal melk
sigaretta	kookolie	Sunlight seep	wors	rys
Vim	tandepasta	aartappels	kookolie	mealie meal
Ideal melk	jellie	spaghetti	jellie	skoenpolitoer
jellie	polony	gebakte boontjies	Vim	Sunlight seep
wors	skoenpolitoer	lemoene	spaghetti	gebakte boontjies
mealie meal	gebakte boontjies	tee	Sunlight seep	pampoen
kookolie	Ideal melk	Ideal melk	aartappels	margarine
spaghetti	eiers	jellie	lemoen	eiers
eiers	mealie meal	skoenpolitoer	eiers	polony
tandepasta	spaghetti	eiers	polony	sigaretta
aartappels	sigarette	rys	skoenpolitoer	kookolie
gebakte boontjies	pampoen	pampoen	pampoen	aartappels
Sunlight seep	tee	mealie meal	mealie meal	wors
margarine	Sunlight seep	Vim	rys	tee
skoenpolitoer	rys	wors	tandepasta	spaghetti
pampoen	wors	kookolie	Ideal melk	lemoene
lemoene	Vim	sigaretta	gebakte boontjies	jellie

Counting Practice: 100

1. 100
2. 86
3. 72
4. 95
5. 64

TOTAL: CONFABULATIONS: CORRECTED SCORE:

Instruksies: "Daar is nog 'n bietjie tyd oor. Kyk of jy nie aan nog iets kan dink nie."
"Nou sal ek dit weer vir jou lees."

(b) Delayed Recall:

Instruksie: "Nou, die laaste, daai lys goed wat ek vir jou by die begin gelees het wat jy miskien by die supermarket sou gekoop het, kan jy dit nog onthou? Kan jy weer vir my sê wat op die lys gestaan het, asseblief?"

3.) Digit Span and Supraspan

DIGIT SPAN

NAAM: ..... DATUM: ..... TYD: .....

Ek gaan nou n paar syfers vooreê. Ek wil hê jy moet goed luister en hulle herhaal as ek klaar is. Sê net wat ek sê.

i) SPAN:

3) 582	3) 694	3) 317
4) 6439	4) 7286	4) 3582
5) 42731	5) 75836	5) 47186
6) 619473	6) 392487	6) 639158
7) 5917428	7) 4179386	7) 5492736
8) 58192647	8) 38295174	8) 27153964
9) 429386175	9) 594827316	9) 916483752

ii) SUPRA SPAN:

a) Nou gaan ek vir jou n lang nommer gee. Probeer om dit te herhaal. Ek sal dit oor en oor vir jou lees totdat jy dit regkry of tot dat jy 10 keer al probeer het. O.K.? Luister ..(a)., luister weer ....., luister weer.

b) Nou gaan ek n nuwe lang nommer vir jy lees en weer oor en oor lees totdat jy dit regkry, of totdat jy al 10 keer probeer het. (b)

a) 5271849362	b) 4973615847
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
6.	6.
7.	7.
8.	8.
9.	9.
10.	10.

c) 3851469728

B) VISUAL TESTS

1.) Continuous Recognition:

Instruksie: "Hierdie kaartjies (Pack A) het tekeninge daarop. Kyk goed en probeer om hulle te onthou. Later gaan ek vir jou al hierdie klomp kaartjies (Pack B) wys en ek wil hê jy moet "nuwe een" sê as jy die tekening nog nooit gesien het nie, en "ou een" sê as jy die tekening al gesien het.
(a) Okay, kyk eers goed vir hierdie.
(b) Okay, nou gaan ek hierdie vir jou wys. Sê "nuwe een" of "ou een" vir elkeen van hulle."

2.) Faces:

Instruksie: "Nou gaan ek vir jou 'n klomp kiekies van gesigte wys. Probeer om hulle te onthou want later gaan ek vir jou vra om hulle van onder 'n hele klomp kiekies uit te wys. Jy sal nie lank hê om hulle te bekyk nie, so kyk vinnig na almal van hulle."
Instruksie: "Nou kyk na hierdie gesigte en gee vir my die nommers, of wys, na die wat jy al gesien het."

3.) Spatial Span and Supraspan Blocks:

BLOKKIES

NAAM: ..... DATUM: ..... TYD: .....

Ek gaan hierdie blokkies slaan en, as ek klaar is, wil ek hê jy moet hulle in presies dieselfde volg order slaan as wat ek gemaak het. Kyk.

i) BLOKKIES:

3)	582	3)	694	3)	317
4)	6439	4)	7286	4)	2548
5)	42731	5)	75836	5)	17352
6)	619473	6)	392587	6)	863174
7)	5917623	7)	4179386	7)	6893412

ii) SUPRA SPAN:

a) Nou gaan ek 'n lang patroon uitslaan. Probeer om dit te herhaal. Ek sal dit oor en oor doen totdat jy dit regkry, of totdat jy 10 keer al probeer het. Kyk (a), kyk weer -, weer -.

b) Now gaan 'n nuwe patroon uitslaan, en weer oor en oor doen totdat jy dit regkry, of totdat jy 10 keer al probeer het. Kyk (b).

a) 58192647	b) 97531864
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
6.	6.
7.	7.
8.	8.
9.	9.
10.	10.

c) 49631852

APPENDIX D

SCORING FOR LION STORY, SHOPPING LIST CATEGORIES, CONTINUOUS RECOGNITION

Lion Story Scoring System

ITEMS

Lion
named (I forget his name)
Simba
escaped/got loose
from his cage
left open/unlocked
by a keeper
careless
A crowd
of people
visiting
that Sunday
escaped/ran away
buildings
nearby
A woman/mother
dressed in blue
dropped/left behind
her son/baby
1 year old
The lion seized him
The woman went back
with tears in her eyes
begged Lion
to return baby/let child go
Lion stared at her
long while/a moment/for ages
let child go (gave her back child)
without harm/unhurt
large crowd/long while/finally/eventually

SCORING INSTRUCTIONS

1. Score 1 for each of these points.
2. Score details even if they are inversions, eg. the blue dress instead of the woman; or begged Lion to let baby go without harm.
3. Subtract 1 for each obvious confabulation, but not for details implicit in the story, eg. lion in the zoo is not subtracted. New characters introduced, novel settings for the story, or original actions invented are each subtracted.
4. On Delayed recall, do not score a point for Lion, if the subject had to be asked "Is it about a dog, a lion, or a policeman?", but score all other correct details thereafter.

APPENDIX D: CONTINUED

Shopping List Categories

Grouping together any two items from the following groups constituted use of a category. These are admittedly somewhat arbitrarily chosen and other groupings are possible. However, these are the common groupings that emerged from a study of raw data.

Cleaning materials	Fruit and Vegetables	Staples/carbohydrates
Vim	oranges	potatoes
Sunlight soap	potatoes	rice
toothpaste	pumpkin	spaghetti
shoe polish		mealie meal

Meat	Meal	Dairy	Fats	Tinned
sausages	sausages	egg	margarine	spaghetti
polony	eggs	margarine	butter	baked beans
		Ideal milk		

Pudding	Break (a)	Break (b)	Breakfast
jelly	tea	tea	mealie meal
Ideal milk	Ideal milk	cigarettes	Ideal milk

Use of categories was only scored on Trial 5 as by then subjects had developed their patterns of using categories.

APPENDIX D: CONTINUED

Continuous Recognition Score Sheet

CONTINUOUS RECOGNITION TEST

NAME: ..... DATE: ..... TIME: .....

1	O	n	g	21	o	N	g	41	O	n	n	61	O	n	g	81	o	N	g	101	O	n	n	121	O	n	g
2	o	N	n	22	O	n	n	42	o	N	n	62	O	n	g	82	O	n	n	102	O	n	n	122	O	n	n
3	o	N	g	23	o	N	n	43	o	N	g	63	o	N	n	83	O	n	g	103	o	N	n	123	o	N	g
4	o	N	g	24	O	n	g	44	O	n	g	64	o	N	g	84	o	N	n	104	O	n	g	124	o	N	n
5	O	n	n	25	o	N	n	45	o	N	g	65	O	n	n	85	o	N	g	105	o	N	n	125	o	N	g
6	o	N	g	26	O	n	g	46	O	n	n	66	o	N	n	86	O	n	n	106	o	N	g	126	O	n	n
7	o	N	n	27	o	N	g	47	o	N	g	67	O	n	n	87	o	N	g	107	O	n	g	127	o	N	g
8	o	N	g	28	O	n	n	48	O	n	g	68	o	N	g	88	O	n	g	108	o	N	g	128	o	N	g
9	O	n	n	29	o	N	n	49	o	N	n	69	O	n	n	89	o	N	n	109	o	N	g	129	o	N	g
10	O	n	n	30	O	n	n	50	o	N	g	70	o	N	g	90	o	N	g	110	o	N	n	130	o	N	n
11	O	n	g	31	o	N	g	51	o	N	n	71	o	N	n	91	O	n	n	111	o	N	g	131	O	n	g
12	o	N	g	32	o	N	n	52	O	n	g	72	O	n	g	92	o	N	n	112	o	N	n	132	O	n	n
13	o	N	n	33	O	n	g	53	o	N	g	73	o	N	g	93	o	N	n	113	O	n	n	133	o	N	n
14	o	N	n	34	o	N	n	54	o	N	n	74	o	N	n	94	o	N	g	114	o	N	n	134	O	n	g
15	O	n	n	35	o	N	g	55	o	N	n	75	o	N	n	95	O	n	g	115	O	n	n	135	o	N	n
16	O	n	g	36	o	N	n	56	O	n	n	76	o	N	n	96	o	N	n	116	o	N	g	136	O	n	n
17	o	N	n	37	O	n	g	57	O	n	g	77	O	n	g	97	o	N	n	117	o	N	g	137	o	N	g
18	o	N	g	38	o	N	g	58	o	N	g	78	o	N	g	98	o	N	g	118	o	N	n	138	o	N	n
19	O	n	g	39	o	N	g	59	o	N	n	79	O	n	n	99	O	n	g	119	O	n	g	139	O	n	g
20	o	N	n	40	O	n	n	60	O	n	g	80	o	N	g	100	O	n	n	120	O	n	g	140	o	N	n

Number Correct:
False Positive
Corrected Score

False Negative
Nonsense
Geometric

TOTAL CORRECT: TOTAL FALSE POSITIVES: CORRECTED TOTAL:

APPENDIX E

RESULTS OF DISCRIMINANT ANALYSIS OF VERBAL TESTS

Variables Used In Function	Delayed Story	Delayed List	Supraspan 10T $\bar{X}$
Discriminant Function Coeff. (Multiplied by -1000)	7,71	13,31	1,55

RANKED DISCRIMINANT SCORES

Pt.No	Bi.Pts	Controls	C.No.	L.Temps	L. Cs.	R.Temps	R. Cs.
6	-67			(No.)	(No.)	(No.)	(No.)
19	- 8						
21	18						
17	36						
22	44						
25	60						
3	71						
18	78						
20	116			105(29)			
5	120						
4	128						
12	139						
26	150						
8	152						
27	160						
23	170						
9	171						
13	177						
1	182						
14	185						
7	189						
11	191						
2	196			206(28)			
15	225			236(30)			
24	246						
10	277						
16	290						
					Cut Off: 290 and Below.		
		291	14				
		319	19				
		358	23			336(34)	
		360	15			340(31)	
		362	12				
		382	2			367(33)	
		388	1				387(31)
		409	25			398(35)	406(35)
		420	11			416(32)	
		422	26				
		423	5				
		427	7				
		430	9				
		440	17				435(34)
		443	13				
		446	8				
		450	22				
		453	20		452(29)		
		460	6				
		462	27				
		491	16		480(28)		485(32)
		497	18				
		497	4				504(33)
		513	24				
		513	3				
		517	21				
		567	10		540(30)		

RESULTS OF DISCRIMINANT ANALYSIS OF VISUAL TESTS

Variables Used In Function	Corrected Recognition	Faces	Supraspan 10T $\bar{X}$
Discriminant Function Coeff. (Mutiplied by -1000)	3,58	32,43	0,80

RANKED DISCRIMINANT SCORES

Pt.No	Bi.Pts	Controls	C.No.	L.Temps	L.Cs.	R.Temps	R.Cs.
				(No.)	(No.)	(No.)	(No.)
25	159						
26	184						
6	195						
19	233						
3	240						
17	254						
12	264						
21	270						
24	274						
9	281						
5	290						
23	290						
14	292						
18	293						
22	300					296(35)	
27	310						
15	332					312(31)	
20	348					337(34)	
1	355						
13	358						
8	366						
16	366						
4	367						
11	374						
7	390					385(32)	
10	396			391(30)			
		400	1				
2	408					407(33)	
						Cut Off:	410 and Below
		412	13				
		417	26				
		417	6				
		418	25				
		432	11				
		433	23				
		433	3				
		443	27				
		453	17				
		455	14				
		461	8				
		475	22				
		479	2				
		484	19				481(32)
		489	5				
		500	9				492(31)
		501	16				494(34)
		506	4	504(28)			
		507	10				
		508	20				
		513	7		511(29)		
		515	15				
		536	21		529(30)		518(35)
		538	12				
		543	24	542(29)	573(28)		573(33)
		574	18				

APPENDIX F

ANOVA SUMMARY

Summary of ANOVA calculation of the effects of racial group on Discriminant Scores.

TABLE 22: Means and Standard Deviations of Verbal Discriminant Scores for the three racial groups.

Group	N	$\bar{X}$	S.D.
White	24	301,29	190,49
Coloured	22	272,91	162,46
African	8	274,0	115,88

TABLE 23: Summary of ANOVA on Verbal Discriminant Scores for the three racial groups.

Source	SS	df	MS	F Patio	
Between Groups	10528,87	2	5264,44	0,18	ns
Within Groups	1482832,78	51	29075,15		
Total	14933361,65	53			

ns = nonsignificant

TABLE 24: Means and Standard Deviations of Visual Discriminant Scores for the three racial groups.

Group	N	$\bar{X}$	S.D.
White	24	403,42	102,10
Coloured	22	377,95	107,85
African	8	384,25	102,89

TABLE 25: Summary of ANOVA on Visual Discriminant Scores for the three racial groups.

Source	SS	df	MS	F Ratio	
Between Groups	7774,48	2	3887,24	0,36	ns
Within Groups	558134,28	51	10943,81		
Total	565908,76	53			

ns = nonsignificant