ASSESSMENT OF VISUAL MEMORY AND LEARNING BY SELECTIVE REMINDING

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Shirley Jean Cummins, M.A.
Denton, Texas

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A test of free recall visual memory and learning was developed for the present study. The purpose of the study was to determine the utility of the Visual Selective Reminding Test and the Verbal Selective Reminding Test for differentiating among groups of patients having memory impairments with organic etiologies. It was hypothesized that neurologically impaired patients would perform differently on the Visual and Verbal Selective Reminding Tests, the difference depending on the location of the underlying brain damage. Forty right handed male patients at a Veterans Administration hospital served as subjects. The patients were grouped according to the location of their brain damage; left hemisphere, right hemisphere, diffuse damage, and no brain damage. There were 10 patients in each group. Each patient was given the verbal and the visual memory tests in counterbalanced order and the Shipley estimate of intelligence. In order to determine if there were differences in performance among the groups, the data from the Visual Selective Reminding Test and the Verbal Selective Reminding Test were analyzed with a MANOVA. Results show that the Visual Selective Reminding Test and the Verbal

Selective Reminding Test discriminate between subjects without brain damage and brain damaged subjects. The verbal test discriminates among brain damaged subjects. The visual test does not discriminate among brain damaged groups, possibly because of the difficulty level of the test. It is concluded that the Visual Selective Reminding Test, in its present form, cannot be used to discriminate between brain damaged groups. Further research is needed to locate possible sources of difficulty.

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ASSESSMENT OF VISUAL MEMORY AND LEARNING BY SELECTIVE REMINDING

The assessment of memory functioning and ability to learn new material is of concern to the clinician from both a diagnostic and a rehabilitative point of view. Deficits in memory functioning are frequent concomitants of both organic and functional disorders. Memory is a complex higher order process which includes the acquisition, storage, and retrieval of information in several modalities. Although the research concerning memory comprises a vast body of literature, there is no unitary theory that can account for all aspects of memory functioning. Even so, a great deal of knowledge and experience has been accumulated by memory researchers.

Applications of this experience to the clinical assessment of memory functioning has lagged far behind the research technology. As pointed out by Erickson and Scott (1977) in their review of clinical memory testing, the field of mental measurement has virtually ignored the very important area of memory functioning. After reviewing the assessment instruments available, they concluded that, while available tests may each offer some advantages, they are also subject to criticisms which suggest the need for further work in the area. By documenting the gap between research and clinical memory testing, these authors hoped to stimulate the application of the wealth of research theory and technology to clinical populations. Erickson and Scott (1977) suggested the need for an extensive battery of tests for analyzing the complex process of acquisition, storage, and retrieval, which would provide more refined information about the patient's deficits, and would provide the precision and controls that are lacking in current clinical testing procedures. They also concluded that there is a need for a brief screening device that would provide a cost-effective, reliable, and valid estimate of current and future patient behavior. The screening device should include repetition of stimuli until the task is learned, a retest for retention after a delay, and assessment of both verbal and visual modalities (Erickson & Scott, 1977).

Lezak (1976) has stated that memory assessment requires a detailed examination of the many different aspects of memory and points out the importance of identifying modality specific impairments. She also stressed the importance of attempting to separate retrieval from storage problems when a patient has difficulty with recall, and mentions the methods of selective and restricted reminding (Buschke, 1973) as facilitating the differentiation of retention, storage, and retrieval. In regard to modality specific memory, most non-verbal memory tests involve visual memory. One of the difficulties in assessing visual memory is the virtual impossibility of designing tasks that do not elicit verbal associations.

Another problem in testing visual recall without resorting to verbalization is the necessity of including a praxic response, usually drawings, which complicates interpretation as a poor performance may reflect a praxic disability or impaired visual or spatial memory. Therefore, it is important to assess praxic ability in order to estimate its contribution.

The selective reminding technique developed by Herman Buschke and his associates (Buschke, 1973, 1974a, 1974b, 1974c, 1974d, 1975, 1979; Buschke & Fuld, 1974; Buschke, Goldberg, & Lazar, 1973; Fuld & Buschke, 1976; Fuld, 1976) appears to have potential for use as a brief screening test for clinical memory assessment. Selective reminding was developed as a method for analyzing several components of memory and learning in verbal free recall simultaneously. In the usual free recall paradigm, the subject is presented with a list of words and is then asked to recall the items in any order. Then, the whole list is presented again for recall, and the process continues in this manner until criterion is reached. Selective reminding involves presenting the whole list on the first trial, then presenting only those items which were not recalled on the immediately preceding trial on each subsequent recall trial. The method distinguishes between retrieval from long term storage and recall from short term storage, because recall of an item which was not presented on that trial demonstrates retrieval from long term storage (Buschke, 1973). This follows from research which shows that such recall without presentation after interference due to presentation and recall of other items indicates retrieval from long term storage (Glanzer & Cunitz, 1966; Craik, 1968; Tulving & Cotlotla, 1970).

Long term storage is estimated by the cumulative number of items which have been retrieved from long term storage at least once (Buschke, 1973, 1974a, 1974c). Retrieval from long term memory is shown most directly by spontaneous retrieval without further presentation, which also permits straightforward evaluation of storage and retention in long term memory.

Buschke has shown that the most direct way of demonstrating true retrieval from long term memory, without contamination by immediate recall from short term storage is to restrict the presentations so that retrieval from long term memory can be demonstrated by spontaneous recall without further presentation (Buschke, 1973, 1974a, 1974b, 1974c, 1974d). This can be done by selective reminding, by restricted reminding (presenting each item only until it has been recalled just once), by using only a single presentation of the list before repeated attempts at spontaneous retrieval, or by any other kind of selective reminding that allows recall without presentation. Spontaneous retrieval of an item which was not presented on that trial after the interference due to the recall of other items demonstrates retrieval from long term memory. Spontaneous retrieval also shows previous storage since retrieval from long term memory on any subsequent attempt shows storage on or before the trial on which that item was last presented (Buschke, 1974b).

Buschke (1974c) has shown that recall failures during free recall verbal learning represent retrieval failures rather than loss of information about items from long term storage. Subjects learned lists of 20 items by restricted reminding in which only those items not yet recalled at all were presented on each trial. Most of the recall failures were retrieved again on some subsequent trial without further presentation, indicating that the item had been stored in long term memory, and that most recall failures represented retrieval failures rather than loss of items from long term storage.

Retrieval of items can be increased by extended recall in which the subject is given enough time, and is encouraged to recall some more items after additional retrieval seemed difficult or impossible (Buschke, 1974b; Fuld & Buschke, 1976). Buschke has used lists of items from single categories (animals, clothing) in order to facilitate retrieval from permanent storage, and also lists of unrelated items. There is little difference between findings for related and unrelated items (Buschke, 1974c). When aggressive recall procedures are used and many of the lists are drawn from single categories, the question is raised as to whether subject responses represent learning or guessing. Increased guessing did take place under forced recall conditions (Ritter & Buschke, 1974), however, subjects were able to recognize their own intrusions, which indicated that retrieval difficulty was due more to finding the items in the memory store than to difficulty in discriminating items belong to the list. In a study designed to address the question of guessing, (Buschke, 1974) 10 young adults learned a list of 20 animals with the restricted reminding technique. Intrusions were elicited by requiring forced recall of 20 items on each trial. No feedback was given to confirm correct recall of list items or to correct intrusions. Twelve trials were given in all. Since all items were recalled at least once by the third trial, there was no presentation of items on the last nine trials. Retrieval of list items increased spontaneously and the number of intrusions decreased. Retrieval of related items from the same category does not require on guessing, because subjects do not require feedback to distinguish items belonging to the list and delete their intrusions. The findings also seem to indicate that such learning does involve retrieval from permanent storage and that the difficulty in retrieval is due to difficulty in finding the target items, which are correctly discriminated when found.

Buschke and Fuld (Buschke, 1973, 1974a, 1974b, 1974d; Buschke & Fuld, 1974; Fuld & Buschke, 1976) have also analyzed their data in terms of a two stage process of item and list learning, which can account for increasing retrieval from long term memory during verbal learning. This kind of analysis does not depend on the distinction between storage and retrieval, but on the empirical distinction between random retrieval from long term storage (item learning) and consistent retrieval of an item on all subsequent recall attempts. Such consistent retrieval of that item apparently indicates that the item has been learned as part of the list; that is, the retrieval of that item has been integrated with the retrieval of other items so that it can always be retrieved. Since a list is considered to have been learned when all the items on the list can be recalled on every recall trial with no further presentations, the consistent retrieval of some proportion of the items on every recall attempt should indicate that those items have been learned as a list. This makes it possible to estimate the amount of list learning during verbal free recall by counting the number of items consistently retrieved as learning progresses (Buschke, 1973).

Buschke's contention that consistent long term retrieval or list learning indicates a separate stage distinct from item learning is supported by his finding that retrieval from long term memory does not improve prior to the abrupt onset of consistent retrieval, but remains relatively constant (Buschke, 1973, 1974b, 1974d; Buschke & Fuld, 1974; Fuld & Buschke, 1976). It seems that list learning requires the subject to use more direct search strategies and to subjectively organize the material for consistent retrieval.

The method of selective reminding in free recall verbal learning allowed the simultaneous analysis of initial storage, retention, and retrieval from long term storage. The data may also be analyzed in terms of a two stage process of item and list learning. Buschke's techniques appear to have provided certain advantages over the usual free recall procedure in which the entire list is presented before each trial. In conventional free recall, the total number of items recalled on each trial can be determined, but there is no way to determine when an item, or when the list of some part of it, has been learned. Selective reminding focuses attention upon those items which have not yet been learned, maximizing the opportunity to learn them, while conventional free recall masks items not yet learned among items already learned. The continuing presentation of all items throughout learning has been shown to conflict with the development of subjective organization of retrieval (Mandler & Dean, 1969). By minimizing the presentation of items, selective reminding allows the maximum opportunity for subjective organization of the list and its retrieval (Buschke, 1973). From this research, it appears that it is neither necessary nor desirable to present all items before every trial of verbal learning unless there is some prescribed order for recall.

Selective reminding seems to be a more efficient technique for studying verbal learning and memory than conventional free recall because it allows the examiner to obtain more information about the nature of the subject's memory and learning at the same time, with the same test. Selective reminding also appears to resemble more closely the process of memory and learning in a natural setting. It seems likely that a person, setting out to learn something on his own, will set aside parts of the material as they are learned and concentrate his or her time and effort on that part which has yet to be learned, rather than repeatedly going over the entire set of material. Buschke (1974a, 1974b, 1974d; Buschke & Fuld, 1974) proposed that his methods have significant applications in the evaluation of learning disordered children and neurological patients with disturbances of memory and learning, in the investigation of the development of memory and learning and its decline with aging, and in increasing understanding of normal memory and learning.

Most of Buschke's research in developing the selective reminding techniques and studying their properties used young normal adults as subjects. However, some work has been done using other subject groups. Buschke (1974a) used selective reminding to analyze verbal learning in children. Ten 8-year-old and eight 5-year-old children learned a list of 10 animals by selective reminding. The 5-year-olds showed slower acquisition than the 8-year-olds and also lower recall, which was due to less effective retrieval from long term storage. Ten third graders (mean age 8.5 years) and 10 adults (mean age 24.4 years) learned a list of 20 animals by selective reminding in a second experiment. These children showed less effective long term storage and less efficient retrieval, particularly consistent retrieval or list learning, than adults. Another group of 10 children (mean age 9.4 years) was compared to 10 adults (mean age 22.9 years) in learning the same list of 20 animals by restricted reminding. These children appeared to store almost as many items as the adults, but again showed less effective retrieval. These results indicate that children are less efficient than adults at formulating and/or applying idiosyncratic organizational systems for effective retrieval.

Restricted reminding was used to compare verbal learning by 10 children (mean age 9.4 years), 10 young adults (mean age 22.9 years), and 10 older adults (mean age 42.2 years) in another experiment (Buschke, 1974d). The young adults learned faster than the older adults and children. Retrieval by the young adults was best, followed by the older adults, then the younger children. The young adults were the most efficient at consistent retrieval and the children were least efficient. The young adults initially included 13.6 items for consistent retrieval from long term storage and increased to 19 items over trials. The older adults initially learned 10.9 of the items as part of the list and increased their list learning to 16 items over trials. The children were also able to transfer items from random retrieval to the second stage of consistent retrieval. Their initial list learning was 5.2 items, which subsequently increased to 12 items. This research showed two distinct stages of learning by children as well as by adults.

Buschke and Fuld (1974) used both selective and restricted reminding to analyze the impaired learning and memory of a 55-year-old patient with chronic alcoholism. In comparison to a normal adult, the patient's initial storage seemed somewhat impaired as she required six trials to recall each item at least once as opposed to three trials for the normal subject. However, retention in long term storage was intact (demonstrated by spontaneous recall of items without presentation) and her recall failures were due to difficulty with retrieval rather than storage failure. The patient was initially able to recall only two items consistently and no further list learning occurred until the sixth trial. Even after 12 trials, only six of the nine items retained in long term storage had been transferred to the second stage of learning and were consistently recalled as a list. The normal adult was able to consistently retrieve seven items initially and was able to retrieve all 10 items consistently as a list from the third trial onward.

Fuld (1976) used restricted reminding to study storage, retention, and retrieval in three patients with Korsakoff's syndrome. The three patients were 48, 53, and 54 years old and had normal IQ's. They were age-matched with three normal control office workers. Patients retrieved from long term storage only about half as many items as retrieved by controls, patient's retrieval failures were more than twice as frequent as controls, and patients were able to encode a smaller number of items in long term storage. All differences were significant at $p < .05$, indicating that the patient's retrieval, as well as their storage of verbal information, was impaired. For patients, only 33% of items known to be in storage showed list learning, as compared to 77% of items for controls ($p < .05$), indicating that patients did a high proportion of storage of individual items which are retrieved at random and retained these items in random storage instead of transferring them to the list of items consistently retrieved. Fuld was able to demonstrate verbal learning in Korsakoff's patients, even though they had serious impairment in both storage and retrieval, and to give some indication as to the nature of the impairment in terms of item and list learning.

Levin and his associates (Levin & Grossman, 1976; Levin & Eisenberg, 1979; Peters & Levin, 1977, 1979) used the selective reminding procedure in studying memory deficits in patients with neurological impairment. Levin and Grossman (1976) studied the effects of closed head injury in 10 adolescents, who were compared with a group of 30 normal high school students matched as to age and sex. Learning and memory of new information was analyzed by using the selective reminding procedure to present a list of 12 words of AA or A frequency (Thorndike & Lorge, 1944) for 12 recall trials. Control subject's retrieval from long term storage was significantly greater than for head injured subjects. The head injured adolescents continued to rely upon short term recall dependent upon repeated presentation of information to a significantly greater extent than did controls. Once the head injured adolescents managed to store items, their access to the information was uncertain. Retrieval failure was particularly characteristic of patients who had prolonged coma. Levin and Grossman concluded that the selective reminding technique yields data concerning the question of capacity for learning and memory following head injury and can supplement intellectual assessment by pointing out specific memory deficits which may provide a focus for remedial instruction. They suggested that fading techniques might be useful in remediation because they might provide retrieval cues and therefore enhance acquisition.

Levin and Eisenberg (1979) investigated neuropsychological impairment during the first six months after closed head injury in 64 children and adolescents. The selective reminding procedure was included as part of the battery of tests used, for the specific assessment of verbal learning and memory. Results were grouped as to neuropsychological function (Language, Memory, Visuo-spatial Ability, Somato-sensory, Motor), age (6-12, 13-18), and three grades of severity of injury. Memory was the most frequently affected neuropsychological function as nearly one-half of the total series evidenced a deficit on the selective reminding and/or continuous recognition memory tasks. The authors suggested that a persistent memory deficit may go undetected in a young patient whose functioning on neuropsychological tests is otherwise intact or only mildly abnormal. From their experience with assessment and planning for the return to academic studies, the authors suggested that the degree of improvement over time in verbal learning and memory on the selective reminding test provides an indication of the patient's readiness to handle the memory demands of school-work.

Peters and Levin (1977) developed four alternate forms of the Selective Reminding Test, using unrelated words selected from the American Heritage Word Frequency Book (Carroll, Daries, & Richman, 1971). The forms were comparable in word length, frequency, and initial letter. A cued recall trial, using the visual presentation of initial or first two letters of the word, was used in addition to the 12 free recall trials. These materials were used to study memory improvement after treatment with physostigmine in an 18 year old women with an amnesic syndrome two years after having herpes simplex encephalitis. After six daily practice sessions to establish baseline performance on the assessment procedures, the patient was given physostigmine or a control substance and then tested. Mean scores of nine female high school students, ages 17-18 years, were also used for comparison. Performance on the Selective Reminding Test was significantly improved after administration of 0.8 mg. of physostigmine.

Peters and Levin (1979) used the Selective Reminding Test in a study comparing the effects of lecithin, physostigmine, or lecithin plus physostigmine on the memory of five Alzheimer's disease patients. While neither physostigmine nor lecithin alone consistently improved long term memory processes, their combined action enhanced long term storage and/or long term retrieval in Alzheimer's disease patients.

Ten Alzheimer's disease patients were given memory training under lecithin and placebo conditions in a study by Brinkman, Smith, Meyer, Vroulis, Shaw, Gordon, and Allen (1982). Alternate forms of the Selective Reminding Test were employed to determine baseline memory performance after each treatment condition. The subjects were given memory training consisting of visual imagery techniques and exercises designed to facilitate a semantic level of processing. The assessment with selective reminding provided no evidence of a therapeutic lecithin effect.

Miller, Cornett, and McFarland (1978) employed the method of restricted reminding in a study of the effects of marijuana on storage and retrieval processes in memory. Twelve male subjects, who served as their own controls, were given marijuana and placebo in two separate sessions. After smoking marijuana or a placebo cigarette, each subject was presented a 30 item word list by restricted reminding and was required to complete 12 written recall trials. Although the same number of items were eventually stored under both conditions, the rate of acquisition into storage was much slower with marijuana. Marijuana exerted its most deleterious effect on the retrieval of information from long term storage, as exhibited by the intermittent lapses in retrieval which occurred during intoxication, and the highly consistent recall in the placebo condition. The authors concluded that these lapses may reflect a reduced capacity for integrating material in memory for efficient recall while intoxicated with marijuana.

The selective reminding procedure is compatible with current theories of memory. Buschke (1974a) pointed out that the empirical points in learning to recall items consistently without presentation shown by selective reminding (first recall, first recall without presentation, consistent recall without any further presentation) may be regarded as indications of different degrees or levels of processing (Craik & Lockhart, 1972). The levels of processing approach hypothesizes that differences in the level of initial processing of to-be-remembered material result in different memory codes. Superficial processing induces an acoustic or phonetic memory trace which is transitory, while depth processing results in a more enduring semantically coded memory trace. Effective encoding of information for consistent retrieval in selective reminding requires an individual to change retrieval strategies rapidly and to use semantically related information from permanent storage (Buschke, 1974b).

Buschke's selective and restricted reminding techniques seem to have proven useful in the analysis of separate components of the memory process under varied research conditions. Randt, Brown, and Osborne (1980) have included the selective and restricted reminding techniques in the list and paired associate learning tasks in their memory test in order to direct attention to items not yet learned, avoid overlearning by repetition, and provide a more accurate estimate of the rate of acquisition. The technique of selective reminding has been successfully applied in verbal memory and learning tasks in order to differentiate retention, storage, and retrieval. To date, very little research concerning the psychometric properties and the utility of the Verbal Selective Reminding Test as a clinical memory assessment instrument has accumulated. No instrument utilizing this technique is available to assess memory deficits in the visual modality.

A test of free recall visual memory and learning utilizing the selective reminding procedure was developed for the present study. The purpose of the study was to determine the utility of the Visual Selective Reminding Test and the Verbal Selective Reminding Test for differentiating among groups of patients having memory impairments with organic etiologies. Levels of performance on the two tests were expected to vary among patients having different lesion locations.

If the two instruments were shown to be useful as clinical tests, they should provide advantages over other memory assessment instruments by assessing memory in two modalities, and by including the repetition of stimuli until the task is learned, along with a retest for retention after a delay. The tests also have the advantage of separating retrieval and storage problems in the same test at the same time. These features make possible a more detailed description of the memory deficit, which has implications for the planning of treatment and rehabilitation strategies. Techniques designed to remediate a storage problem (stimulus pacing, etc.) are likely to be different from those designed to remediate retrieval deficits (fading, cuing, etc.). In those cases where improvement in memory functioning does not seem likely, it may be desirable to design environments which facilitate the patient with impaired memory functioning. Again, environmental aids will be most effective when planned to facilitate a specific type and modality of deficit.

It was hypothesized that neurologically impaired patients would perform differently on the Visual Selective Reminding Test and the Verbal Selective Reminding Test, the difference depending on the location of the underlying organic condition.

Method

Subjects

All subjects were right handed male patients at a large Veteran's Administration Hospital in the Chicago area. The patients ranged in age from 24 to 84 years, and were diagnosed as being free from psychotic disorders.

Patients who were diagnosed by a physician as having neurological impairments were grouped according to the location of the brain damage (see Patient Data Sheet, Appendix A). Three groups, each having 10 brain damaged patients, were formed. The groups were left hemisphere damage, right hemisphere damage, and diffuse brain damage.

The left hemisphere group ranged in age from 24 to 69 years, with a mean age of 57.6 years (SD = 12.80). Education ranged from 8 to 13 years, with a mean of 10.2 years (SD = 1.75). The group included eight white and two nonwhite patients. The group had a mean premorbid IQ of 97.8 (SD = 6.90) estimated with the index of premorbid intelligence of Wilson, Rosenbaum, Brown, Rourke, Whitman, and Grisell (1978). Current IQ ranged from 80 to 107, with a mean of 89.9 (SD = 7.16). Eight patients had strokes, one had surgical removal of a brain tumor, and one had a head injury with a skull fracture. All but one of the patients had aphasia of some type: conduction = 1, mixed = 3, motor = 2, anomia = 3. The duration of impairment ranged from 10 to 154 months, with a mean of 73.5 months (SD = 53.87).

The right hemisphere group had an age range of 35 to 84 years, with a mean age of 56.6 years (SD = 14.46). Education ranged from 8 to 16 years, with a mean of 10.9 years (SD = 2.64). Nine white patients and one nonwhite patient were included in the group. The mean premorbid IQ was 101.2 (SD = 8.4). Current IQ ranged from 70 to 107, with a mean of 94.2 (SD = 11.74). One patient had suffered transient ischemic attacks, one had had a ruptured aneurysm, seven had suffered strokes, and one had had a brain tumor. None of the patients in this group were aphasic. Duration of impairment ranged from 7 to 132 months, with a mean of 53 (SD = 43.29).

The diffuse brain damage group ranged in age from 30 to 70 years, with a mean of 51.7 (SD = 12.97). The group had a range of 10 to 18 years of education, with a mean of 13.2 years (SD = 2.20). The group had eight white and two non-while patients. The premorbid IQ was 105.2 (SD = 7.17). Current IQ ranged from 76 to 119, with a mean of 100.5 (SD = 15.61). The causes of brain damage were five strokes, one brain tumor, one cerebrovascular insufficiency, one carbon monoxide poisoning, one head injury, myocardial infarction, and heart failure. Seven patients in this group were not aphasic. One patient had mild mixed aphasia, and two had mild anomic aphasia. Duration of impairment ranged from 1 to 132 months, with a mean of 48.9 months (SD = 38.91).

A fourth group was formed with 10 subjects who were diagnosed as nonpsychotic and without brain damage. The group had an age range of 26 to 56 years with a mean of 40 years (SD = 11.79). Education ranged from 8 to 18 years, with a mean of 13.7 years (SD = 3.40). This group included eight white and two nonwhite patients. Current IQ ranged from 98 to 124, with a mean of 108.7 (SD = 8.63). The patients were being treated for back injuries, back pain, allergies, ulcers, a leg fracture, stress, hypoglycemia, arthritis, and hypertension.

Materials

The Visual Selective Reminding Test consisted of a series of 12 1.5 by 1.5 inch black and white block designs, each on a separate 3 by 5 inch card. Each design had a 3 by 3 grid with three black squares in different patterns. The patterns were designed so as not to be easily labeled. After the series was presented, one card at a time at a rate of one card every two seconds, the subject was asked to draw the designs in a response booklet by filling in the appropriate squares on a 3 by 3 grid with a pencil. Any response in which the three squares of the design were clearly indicated was counted as correct. On each subsequent trial, only those items which were not recalled on the previous trial were presented in the same relative order. The subject was instructed to try to recall all of the designs on each trial. The subject's responses were recorded on a score sheet by the examiner. Administration and scoring instructions are contained in Appendix B.

Form 1 of the Verbal Selective Reminding Test developed by Peters and Levin (1977) was used for the study. The 12 unrelated words on this form were selected so as to be comparable in frequency of occurrence in the English language.

The test was administered and scored in the manner stated in the instructions (Appendix C).

Both of the Selective Reminding Tests provided six scores per trial. The first of these was the sum of items recalled on that trial. A score was also obtained for long term storage (LTS), which occurs on the trial before an item is retrieved without presentation. Thus, the number of items that were recalled on two consecutive trials represented LTS. Short term retrieval (STR) or recall from short term storage was demonstrated by the number of items that were recalled immediately after the design had been presented. Retrieval from long term storage (LTR) was demonstrated by the sum of items which were recalled without presentation on that trial. Consistent long term retrieval (CLTR) represented the cumulative number of items which were consistently retrieved from long term storage on all subsequent recall attempts without further presentation. This score indicated the proportion of items that were learned as a list. Random long term retrieval (RLTR) was represented by the number of items which were inconsistently retrieved on all subsequent recall attempts. Examples of the administration and scoring instructions and score sheets are contained in Appendices B and C.

The Shipley Institute of Living Scale (Shipley, 1940) was used as an estimate of intelligence (Paulson & Lin, 1970). The correlation between the Shipley and WAIS was .78 for the sample of 290 psychiatric patients. The scale is a paper and pencil test consisting of two parts, a multiple choice vocabulary test and an abstraction test. Each part has a 10 minute time limit. The reliablity coefficients reported for the scale were .87 for the vocabulary test, .89 for the abstraction test, and .92 for the two combined. The test was also used as interpolated material to prevent rehearsal of the items of the Selective Reminding Tests during the interval for delayed recall.

Procedure

Seventy potential subjects were referred for the study. Seven of these did not choose to participate in the study when approached. Three of the referrals were not included because they were left handed. Six subjects were excluded because the diagnositc information was incomplete. Two were excluded due to very low intelligence scores. Twelve patients were not included because they did not complete the testing. Three of these were unable to focus and maintain attention or comprehend the tasks. Two patients had severe aphasia, to the extent that their responses to the verbal test were unintelligible. Two patients were unable to respond to the visual test because they could not manage the drawing response required (one was using his non-dominant hand and was extremely tremulous; the other had lost the use of his fingers from severe burns). Five patients did not complete the tasks because they became frustrated, tired, angry, agitated, and/or tearful and chose not to finish. Forty subjects were included in the study.

Each subject was tested individually. Each subject was asked to read and sign a consent form (Appendix D) if he agreed to participate in the study. The Visual Selective Reminding Test was then administered. The series of designs was presented to the subject at the rate of one card every two seconds. The subject was then asked to draw all of the items he could remember. The subject was encouraged to try to remember all of the items and to continue trying even after recall became difficult. The examiner then presented only those designs which were not recalled on that trial in the same relative order as the first presentation. The subject was again asked to draw all of the items, both the ones just presented and those recalled on the previous trial. This procedure was repeated until 12 trials had been completed. This was followed by a 15 minute interval during which the subject was interviewed as to age, educational, vocational, and medical history and given the Shipley vocabularly test. At the end of the delay interval, the patient was asked to draw all of the items he could remember from the Visual Selective Reminding Test. Subjects had not been told prior to this time that they would be asked to reproduce this material.

The Verbal Selective Reminding Test was then administered in the same manner as the visual test, except that the words were read to the subject and he was asked to recall them orally. After 12 trials had been completed, the subject was given the Shipley abstraction subtest and interviewed for the remainder of the 15 minute delay interval. The patient was then asked to recall the words from the Verbal Selective Reminding Test.

The order of administration of the two tests was counterbalanced so that five patients in each group were given the verbal test first and five were given the visual test first. This was done to control for any effects that might be due to the order of administration.

Results

In order to determine whether the four groups of patients are essentially the same in age, education, premorbid IQ, current IQ, and duration of impairment, a one-way analysis of variance was performed on each of these variables. The results show a significant difference among the groups for age ($F = 3.83$, $df = 3/36$, $p < .05$). A multiple comparison using the Newman-Keuls procedure (Winer, 1971) shows that the no brain damage group is significantly younger than the left hemisphere group and the right hemisphere group, but not significantly different from the diffuse brain damage group. There are no significant differences in age among the brain damaged groups. The analysis of variance for education by group is also significant ($F = 4.42$, $df = 3/36$, $p < .05$). The multiple comparison procedure indicates that the left hemisphere group has significantly less education than the diffuse group and the no brain damage group. The left hemisphere group and the right hemisphere group do not differ significantly. The groups differ significantly in terms of premorbid IQ (F = 3.42, df = 3/36, $p < .05$). The left hemisphere group has significantly lower premorbid intelligence than the no brain damage group. The brain damaged groups do not differ significantly from one another. The right hemisphere, diffuse, and no brain damage groups do not differ significantly in premorbid IQ. There is a significant difference for current IQ among the groups (F = 5.31, df = 3/36, $p < .05$). The left hemisphere group is significantly lower in current IQ than the no brain damage group and the right hemisphere group is significantly lower in IQ than the no brain damage group. There are no significant differences among the brain damaged groups in duration of impairment (F = .8285, df = 2/27, $p < .05$). Table 1 shows the results of the multiple comparisons tests. Table 2, (Appendix E) shows the means and standard deviations of the demographic variables.

A one-way multivariate analysis of variance for group by scores is used for each of the Selective Reminding Tests in order to test for differences among the four types of brain damage on the five test scores (Sum of Recall, LTR, LTS, CLTR, and Delayed Recall). The STR and RLTR scores are not included in the multivariate analysis, but are shown in Figures 1 and 2. Table 3, Appendix F, and Table 4, Appendix G, give the means and standard deviations for the scores on the two tests for each group.

Table 1

Summary of Mutiple Comparisons for the Demographic Variables

Variable	Brain Damage Group[a]			
Age	No BD[b]	Diffuse	Right	Left
Education	Left	Right	Diffuse	No BD
Premorbid IQ	Left	Right	Diffuse	No BD
Current IQ	Left	Right	Diffuse	No BD
Duration of Impairment	Left	Right	Diffuse	

[a]n = 10 per group.

[b]No BD = no brain damage.

Note. Groups underlined by a common line do not differ significantly from one another. Groups which are not underlined by the same line differ significantly from one another.

The multivariate analysis of variance for group by Sum of Recall, LTR, LTS, CLTR, and Delayed Recall total (12 trials) scores on the Visual Selective Reminding Test is significant (F = 2.325, df = 15/88.74, p = .008) by the Wilk's Lamba Criterion (Hull & Nie, 1981). Table 5 shows the univariate test results, which are all significant. Multiple comparison tests using the Newman-Keuls procedure on each of the univariate F's show that the no brain damage group scores significantly higher on each of the five scores than the right hemisphere, diffuse, and left hemisphere brain damage groups on the visual test. There are no significant differences among the brain damaged groups.

Table 5

MANOVA Univariate and Multiple Comparison Results

Variable	Univariate F (df = 3/36)	Significance of F	Newman-Keuls
Visual Selective Reminding Test			
Sum of Recall Total	10.397	.001	R D L N
LTR Total	7.598	.001	R D L N
LTS Total	5.899	.002	R D L N
CLTR Total	7.404	.001	R D L N
Delayed Recall Total	9.159	.001	R D L N
Verbal Selective Reminding Test			
Sum of Recall Total	25.163	.001	L D R N
LTR Total	23.201	.001	L D R N
LTS Total	19.330	.001	L D R N
CLTR Total	21.530	.001	L D R N
Delayed Recall Total	7.089	.001	L D R N

Note. L = left hemisphere, R = right hemisphere, D = diffuse, N = no brain damage group. LTR = long term retrieval, LTS = long term storage, CLTR = consistent long term retrieval. Groups underlined by a common line do not differ significantly from one another.

The multivariate analysis of variance for group by the five scores on the Verbal Selective Reminding Test is significant (F = 5.614, df = 15.88.74, p = .001) by the Wilk's Lambda Criterion. The univariate F test for each of the scores is significant (Table 5). The Newman-Keuls procedure for the Sum of Recall score shows that the no brain damage group recalls a significantly greater number of items than the left hemisphere, right hemisphere, and diffuse brain damage groups. The right hemisphere group has significantly higher scores than the left hemisphere group. The diffuse brain damage group also scores significantly higher than the left hemisphere group. The right hemisphere and diffuse groups do not differ significantly from one another.

The no brain damage group retrieves from long term storage (LTR) a significantly larger number of words than each of the brain damaged groups. The right hemisphere group retrieves a significantly larger number of words than the left hemisphere and the diffuse group. The left hemisphere and diffuse groups do not differ significantly from one another. The same pattern of significance occurs for the long term storage scores as for the long term retrieval scores.

For the consistent long term retrieval and the delayed recall scores, the no brain damage group scores significantly higher than each of the brain damaged groups. There are no significant differences among the brain damaged groups.

The mean performance of each of the groups on the Visual Selective Reminding Test is shown in Figure 1. As can be seen from the graphs, the rate of correct responses for the visual test is somewhat low for all groups. The no brain damage group recalls 23% of the items on Trial 1 and increase to 60% of the items on Trial 12.

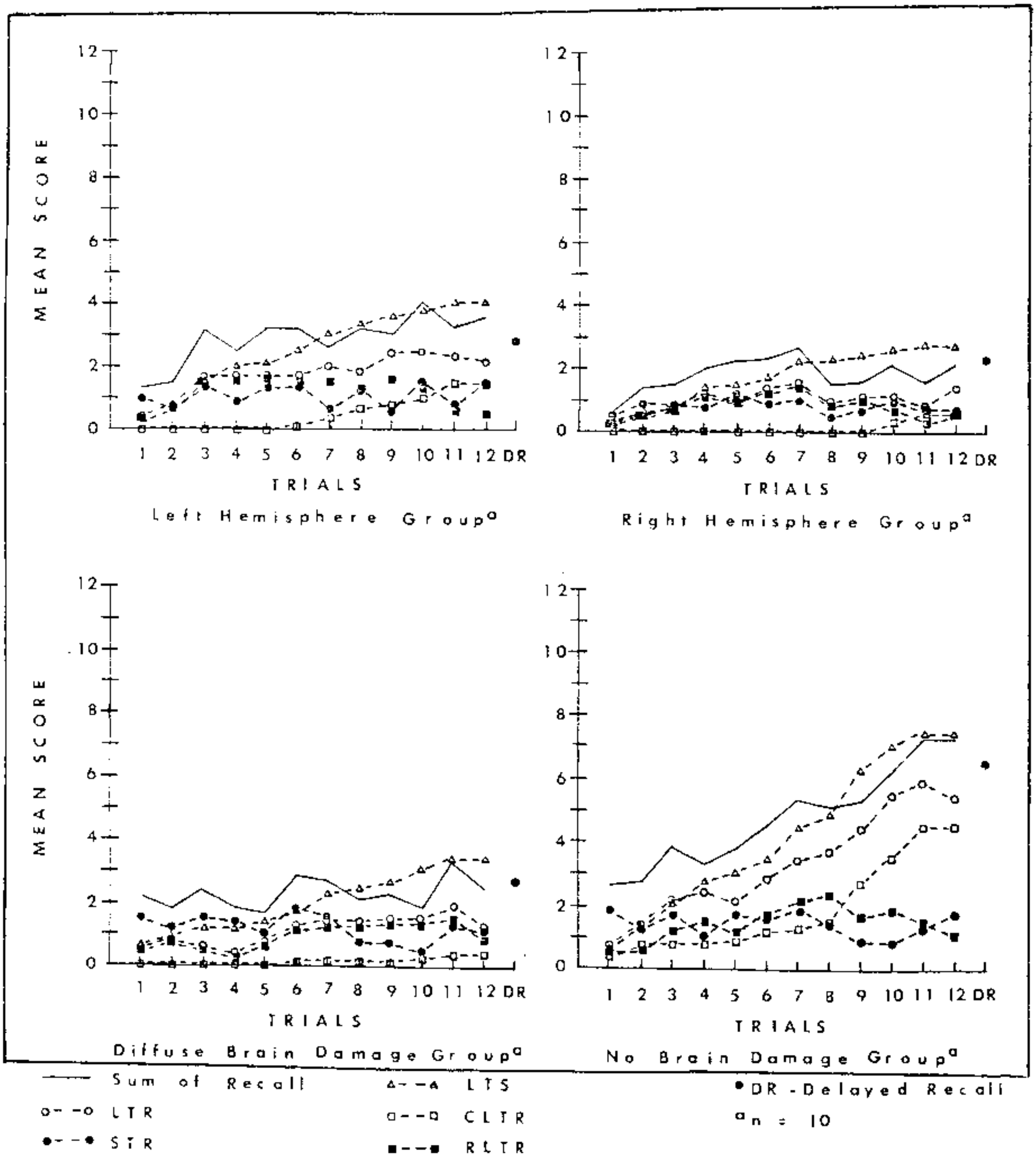


Figure 1. Mean performance of the four groups on the Visual Selective Reminding Test.

Figure 2 shows the mean performance of each of the groups on the Verbal Selective Reminding Test. The rate of response to this test is higher for all groups than on the visual test. The no brain damage group initially recalls 51% of the items on Trial 1 and increases to 93% of the items on Trial 12. A comparison of the graphs for the two tests indicates that the visual test is more difficult for all subjects than the verbal test.

Score frequencies and ranges for the Visual Selective Reminding Test are shown in Table 6, Appendix H. Frequencies and ranges for the Verbal Selective Reminding Test are given in Table 7, Appendix I. The delayed recall score frequencies and ranges for both tests are given in Table 8, Appendix J.

An analysis of the difficulty level of the items on the visual test shows that the designs are not of equal difficulty (see Table 9, Appendix K). The first design is recalled 45% of the time, making it the easiest design. The most difficult design is Number 2, which is recalled only 10.63% of the time. The analysis of item difficulty includes all 40 patients.

Discussion

The hypothesis that neurologically impaired patients would perform differently on the two tests depending on the location of the brain damage is clearly supported by the results on the Verbal Selective Reminding Test. The performance of the no brain damage group is superior to each of the brain damaged groups in terms of the number of words recalled,

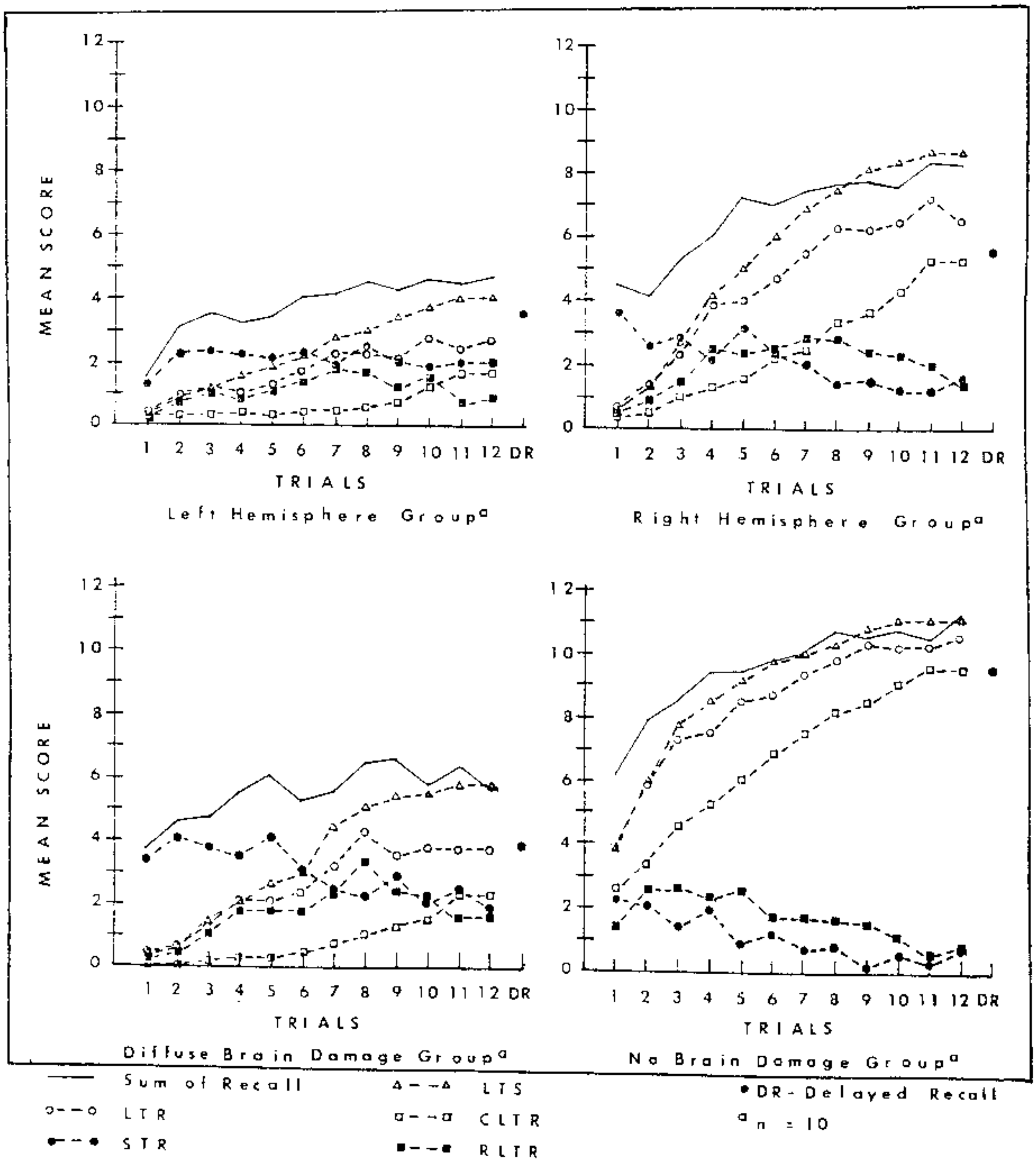


Figure 2. Mean performance of the four groups on the Verbal Selective Reminding Test.

storage in long term memory, retrieval of words from long term memory, and list learning. The no brain damage group is also able to recall a significantly larger number of words after 15 minutes than any of the brain damaged groups, indicating that they were able to learn a larger number of words.

Apparently, the subjects without brain damage have better memory skills than any of the brain damaged groups. Their superior scores on consistent long term retrieval indicate that they are better able to apply subjective strategies for organizing memory stimuli for retrieval than the brain damaged patients. More efficient encoding and retrieval strategies consequently result in larger amounts of material being learned.

The utility of the test for discriminating between subjects with brain damage and those without brain damage is perhaps of less interest than the differences among the brain damaged groups. Both the diffuse and right hemisphere groups are able to recall a significantly larger number of words than the patients with left hemisphere damage. The left hemisphere and diffuse groups do not differ from one another, but are able to store significantly fewer words in long term memory and retrieve fewer words from long term storage than the right hemisphere group.

Patients with left hemisphere damage show greater deficits in recall, storage, and retrieval of verbal material than patients with right hemisphere damage. The patients with diffuse damage were superior to the left hemisphere group in number of words recalled, but not in storage or retrieval. Since the left hemisphere is predominant for verbal functioning in right-handers, these results are not surprising. However, they do show the utility of the Verbal Selective Reminding Test for discriminating between the groups.

The three brain damaged groups do not differ significantly in terms of consistent long term retrieval or list learning and retention after a delay. This can be interpreted as indicating that all brain damaged patients are inefficient in organizing material for retention at a later time. The study supports Buschke's (1974a, 1974b, 1974d; Buschke & Fuld, 1974) proposal that his methods have applications in the evaluation of the learning and memory disturbances of neurological patients, at least with the Verbal Selective Reminding Test.

The Visual Selective Reminding Test developed for this study does not fare so well as the verbal test. The group without brain damage performs significantly better on the test than any of the brain damaged groups, but the brain damaged groups do not differ significantly from one another. The order of performance is in the expected direction, with the left hemisphere group making the highest scores, followed by the diffuse group, and then the right, but the differences are not large enough to be significant. The reasons for this lack of discrimination may be a function of the characteristics of the patient groups or the characteristics of the test.

The analysis of variance results on the demographic variables show that there are significant differences among the groups, which may account for the lack of discrimination. Ideally, one would have matched research groups to eliminate the effects of the variability of factors intrinsic to the subject. Matching was not attempted in the study due to the difficulty in obtaining enough brain damaged subjects and limitations of time and resources. Matching the subjects for intelligence would create an unrealistic situation in which very low functioning normal subjects are paired with very high functioning brain damaged subjects, because brain damage is usually accompanied by losses in intellectual functioning. Because of this relationship between brain damage and intellectual functioning, the premorbid IQ estimate is used as an indication of whether the brain damaged patients were in fact functioning in at least the average range of intellectual ability prior to the brain damage. Statistical control of differences in age and intelligence is not feasible because these variables are related to both the independent variable (brain damage) and the dependent variable (memory scores).

However, the diffuse group does not differ from the no brain damage group on any of the demographic variables, but there is a significant difference between these two groups on both of the Selective Reminding Tests. If age and intelligence are the critical variables in the memory test performance, then the diffuse group might be expected to perform as well as the no brain damage group, or at least next in order. This is not the case for either of the tests. The diffuse group fell between the left and right hemisphere groups. The right and left hemisphere groups do not differ significantly from each other on the demographic variables, yet their level of performance is in the expected order on both tests. Although differences in age and intelligence (as well as factors such as daily variability in alertness, medication effects, etc.) may contribute to the absence of significantly different performance among the brain damaged groups on the visual test, it seems likely that the results are due to some characteristic of the test.

One possible explanation for the lack of discrimination among the groups may have to do with the difficulty level of the test. As can be seen from Figure 1, the subjects without brain damage initially recall an average of 2.7 designs and increase to an average of 7.2 designs on Trial 12. None of the brain damaged groups recall an average of more than four designs on Trial 12. Only one of the 10 subjects in the no brain damage group manages to recall all 12 designs correctly, and this occurs on the twelfth trial. In contrast, three patients from this group were able to recall all 12 words on the verbal test from Trials 4, 6, and 8 onward. When the best performers on the visual test are able to recall only 60% of the items at the end of 12 trials, as opposed to 93% of the words on the verbal test, it seems that the test is too difficult for the brain damaged patients to have much success at learning to criterion. Rather than increase the number of trials, thus adding to testing time, it seems appropriate to make the test easier.

Many subjects gave voice to complaints about the difficulty of the visual test and expressed frustration while taking it. The frustration of dealing with the difficulty of the test seems to be an important factor for those patients who gave up and refused to complete the test. Perhaps the spread of scores among the groups might be larger if the level of difficulty of the test is lowered.

The difficulty of the test may be due in part to its novelty. The designs are unfamiliar and not a part of everyday experience, unlike the words of the visual test. The task for active memory with common words is not to place the memory stimuli into long term storage, since they are already there in most cases, but rather to discriminate the relevant memory stimuli being used on the particular task from the many other traces in permanent storage. With memory stimuli which are unfamiliar and not overlearned, such as the visual designs, the task for active memory is more complex.

The common words on the verbal test lend themselves to a wealth of associations, meanings, visual images, and personal experiences with the things they represent. All of these can aid in processing the words at deeper levels of memory. The visual designs are not easily labeled. "Tick-Tack-Toe" and "Rubic's cube" were mentioned as associations by the patients, but these are both quite different from the visual memory task. It may be that the designs are not easily processed at deeper levels.

There is also the possibility that the visual task depends on functions of both cerebral hemispheres. However, the right hemisphere is generally considered to be predominant for tasks such as drawings, spatial memory, etc., which require spatial organization and the perception or recall of nonverbal material, especially material that cannot be easily labeled verbally. Therefore, the Visual Selective Reminding Test appears to depend predominantly on functioning of the right hemisphere.

Further research is needed to lower the difficulty level of the visual test. One possible way of lowering the difficulty level is suggested by the analysis of item difficulty. Some of the most difficult designs can be dropped and the test given to groups of subjects using various numbers of designs, in order to find the optimal level of difficulty. The difficulty of the test may not be a function of the designs alone, but may be a function of the order of presentation. Serial position effects should also be investigated, even though the order of presentation changes. When the difficulty level of the test has been adjusted, it can again be studied as to its ability to discriminate between groups.

Other possible areas of research are suggested by the study. One patient attempted to assign numbers to the squares of the grid and rehearse orally the three number codes for the designs as they were displayed. The learning and organizational strategies subjects employ, and their efficiency will perhaps be of interest. Also, it may be of interest to look closely at the various types of errors made, such as rotations, reversals, and repetitions. Some subjects seem to be aware that they have repeated a design, while others do not. In the right hemisphere group, many subjects seem unaware that there are only three black squares per design and fill in four, five, or six squares. Devising qualitative scoring systems in addition to the quantitative system can increase the utility of the test. Reliability and validity studies should be done, as well as research to develop norms or cut-off scores for the test. Such studies will perhaps increase the diagnostic information to be gained from the test.

Research can be done to determine the usefulness of the Visual Selective Reminding Test for assessing memory in other groups of subjects. Some groups of interest are children, the elderly, the deaf, and patients with specific types of memory disorders.

In summary, both the Visual and Verbal Selective Reminding Tests were able to differentiate brain damaged men from those without brain damage in this study. The patients with left hemisphere brain damage have greater impairment of verbal memory than those with right hemisphere damage, with the diffuse brain damage group falling between the two. The

Visual Selective Reminding Test is not able to discriminate among the three groups of brain damaged patients.

In conclusion, the data from this study indicate that the Visual Selective Reminding Test, in its present form, cannot be used to discriminate between brain damaged groups, possibly because of the difficulty level of the test. Further research is needed to locate possible sources of difficulty and to gain information concerning the usefulness of the test with other subject groups.

Appendix A

Patient Data Sheet

S. S. #:____________________ Age:________Date:__________

Sex:_______ Race________ Handedness:________________________

Education:____________________ Occupation:________________

Current medications:______________________________________

Describe the nature of the central nervous system impairment and/or physical condition requiring hospitalization:

Estimate of duration of neurological impairment:

Location of damage:

Left hemisphere_____ Right_____ Diffuse_____ None_____

Describe degree and type of aphasia, if present:

Other neurological symptoms or states:

Psychiatric diagnosis, if applicable:

Bldg:_________ Ward:__________ ___________________________

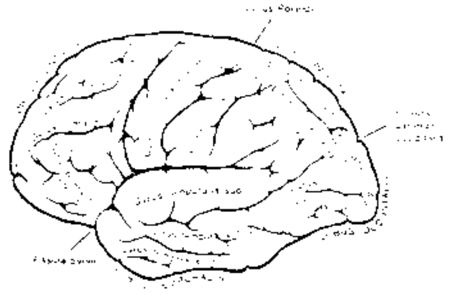
Information obtained from

Appendix A--Continued

Luria's Neuropsychological Investigation

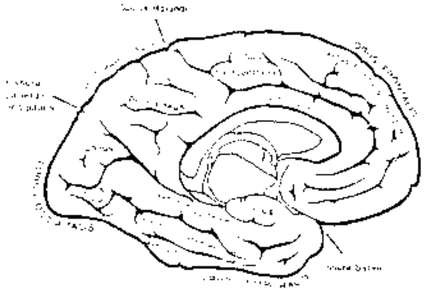
Case no: Name: Date Examined by:

Suggested localization of lesion according to conclusion

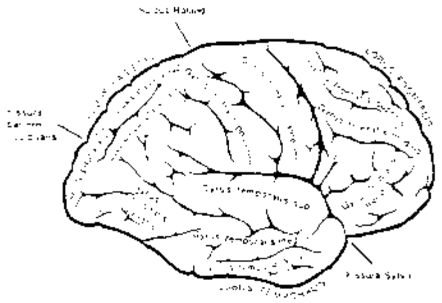


Lateral

LEFT

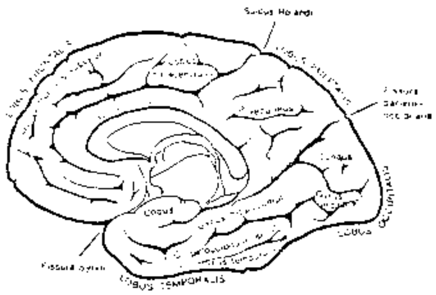


Mesial

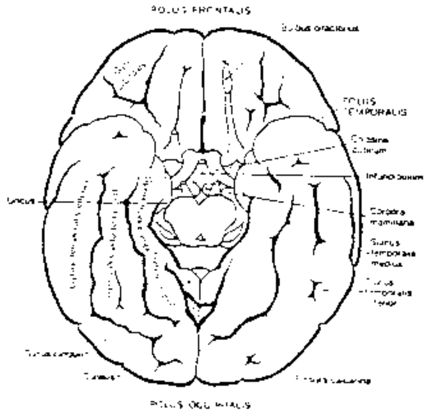


Lateral

RIGHT



Mesial



Basis

Conclusion:

Note. This brain chart is a reduced example of the sample chart for photocopying included in the Luria testing materials (Christensen, A. Luria's neuropsychological investigation. New York: Spectrum Publications, 1975).

Appendix B

Administration of the Visual Selective Reminding Test

Testing Materials

Set of 12 3 by 5 inch stimulus cards with black on white block designs, set of three sample designs, score sheet, 12 trial response booklets, sample booklet, delayed recall booklet, and two No. 2 lead pencils.

General Instructions

Seat the subject comfortably at a table in a well lighted, quiet room that is free from distractions. The test is a free recall visual memory and learning task in which the subject is given 12 trials. This may be followed by a delayed recall trial. On the first trial, the whole series of 12 designs is shown to the subject at a rate of one card every two seconds. The subject is then asked to recall as many of the designs as (s)he can remember by darkening the three spaces corresponding to each design on a separate response page, printed with a 3 by 3 grid. On Trials 2 through 12, the examiner presents _only_ those designs which were _not_ recalled on the immediately preceeding trial. The subject is asked to try to recall _all_ of the designs on every trial, not just the ones left out, but also those designs (s)he has already drawn. It is important to explain this to the subject so that (s)he does not think that the test is an elimination procedure. Also explain to the subject that there is no set order of recall, as an attempt to remember the items in a particular order may needlessly increase the task difficulty.

The examiner must be familiar with the stimulus designs, score sheet, administration procedures, and scoring criteria before administering the test. As the subject draws the designs, the examiner must be able to record the correct responses accurately and quickly on the score sheet, in order to determine which designs are to be presented on the next trial. Notice that the block designs on the score sheet are printed upside down to the stimulus cards so that they appear on the score sheet in the same orientation as the subject's responses appear to the examiner. This was done so that the examiner, seated facing the subject, can check the design as the subject works, without having to turn the response sheet around. After presenting the stimulus designs, lay them face down so that the subject cannot see them during recall. Shield the score sheet from the subject's view by placing it on a clipboard.

At the end of each trial, give the subject enough time to extend recall. Often, a person will be able to remember a few more designs, if given time and encouragement. When the subject stops drawing say, "Try to remember all of them" or "See if you can remember any more," in order to encourage further effort. Allow about one minute before continuing to the next trial. Do not tell the subject the number of designs or the number of trials.

Administration

Say: "I am going to show you a series of black and white designs. Each one will have a different pattern of black squares. Look at them carefully. When you have seen them all, I'll ask you to draw them by filling in the squares which were black for each design on one of these sheets." (Show the Sample response sheet to the subject.) "Just darken the squares with your pencil for each design. The squares don't have to be filled in perfectly, as long as I can tell which spaces you mean. You may draw the designs in any order you want. After you have drawn all you can remember, I'll show you the ones you left out. Then I'll ask you to draw all the designs again, both the ones you left out and the ones you drew before. It usually takes quite a few chances before a person can remember all of the designs. Do you have any questions?"

After answering the subject's questions, administer the Sample. Say: "Now, we will practice." Give the subject the Sample response booklet, placing the bound edge toward the subject. "I'll show you three designs, then you draw them on your sheets. Ready?" Present the three Sample items, one at a time, at a rate of one card evey two seconds. If it appears that the subject does not understand the task, explain again illustrating with the Sample items, before starting the test.

Give the subject the response booklet for Trial 1, with the bound edge toward the subject. Say: "Now, I'll show you the designs. Look at them carefully and remember as many as you can. You may draw them in any order. Don't start drawing until you have seem them all."

Present the designs one at a time, at a rate of one card every two seconds, in the order indicated by the numbers on the back of the cards. Record the responses in the first column of the answer sheet as the subject draws them. Record the response by making a check mark in the row corresponding to that design on the score sheet. If more than three squares or less than three squares are marked, or the design is so inaccurate that you are uncertain which squares were intended, do not count that response. Any response which clearly indicates the three squares of the design is counted as correct. At the end of the trial, remind the subject of the need to indicate the squares clearly. If the subject repeats a design or draws a design that is not part of the series, say nothing, but record the response on the intrusion grid on the score sheet. Encourage the subject to try to remember more designs when he slows down or says that recall has become difficult after drawing only a few designs.

When you have entered the correct responses on the score sheet, take the cards for the designs that were not recalled from the deck. Keep them in the same order (skipping the ones that were recalled correctly) as the initial presentation. Give the subject the response booklet for the next trial, with the bound edge toward the subject.

Say: "Now I am going to show you the ones you left out. When I'm finished, try to draw all of the designs, including the ones you drew last time. Ready?"

Present the designs that were not recalled on the last trial at a rate of one card every two seconds. Record the responses as the subject draws them. Repeat this procedure until 12 trials have been completed. If the subject recalls all 12 designs correctly on four consecutive trials, testing may be discontinued.

Delayed Recall

After the time interval decided upon for delayed recall has passed, give the subject a response booklet. Ask him/her to draw all of the designs (s)he can remember from the series. Record the correct responses and intrusions on the score sheet.

Scoring

		1	2	3	4	5	6 . . .
	A	✓	✓		✓→	✓	✓
	B	✓		✓	✓		✓
	C		✓		✓→	✓	✓
	D	✓		✓		✓→	✓
(1)	Σ Recall	3	2	2	3	3	4
(2)	LTR	1	1	1	3	3	4
(3)	STR	2	1	1	0	0	0
(4)	LTS	1	1	2	3	4	4
(5)	CLTR	0	0	0	2	3	3
(6)	RLTR	1	1	1	1	0	1

1. Score the protocol by rows, scoring each item across trials. For each item, find the first instance of recall on two successive trials. Underline these trials and all subsequent trials in that row in red through the 12th trial (whether or not the cell has been checked as recalled on all trials). This represents long term storage.
2. To evaluate consistent long term retrieval, go across each row from right to left to find the trial after which the item is recalled consistently on all subsequent trials. Mark that cell with an arrow. There should be no arrows in the 12th column (see example, column 6).
3. Count the number of items recalled on each trial (down the column) and enter the total in the row (1) labeled Σ Recall, for each of the 12 trials.
4. Count the cells with checks (recalled items) that are underlined in red down each column. Enter the total for each trial in the row (2) labeled long term retrieval (LTR).
5. Subtract the LTR score from the Σ Recall score for each trial. Enter the remainder in the short term recall (STR) row (3).
6. Count down each column the cells underlined in red (whether or not a cell was checked). Enter the total for each trial in the long term storage (LTS) row (4).
7. Read the complete instruction before beginning, as this is a cumulative score. Count down the first column only

those checked cells having arrows. Enter the total in the consistent long term retrieval (CLTR) row (5). Count down the second column only those checked cells having arrows. Add the sum to the score for the preceding trial and enter the total in the CLTR row (5). Continue this procedure for the remaining trials. For example: There is no cell with an arrow in the first column of the sample, so a zero was entered in the CLTR row (5). The second column has no arrows, so zero was added to the score for the first column and a zero was entered in the CLTR row for the second trial. The third column had no arrows, so zero & zero was added and entered in the CLTR row. The fourth column had two arrows, so zero & two was added and a 2 was entered in the CLTR row, etc.

8. Subtract the scores in the CLTR row (5) from the scores in the LTR row (2) by column. Enter the remainder in the random long term retrieval (RLTR) row (6).
9. If testing was discontinued before the completion of 12 trials because the subject drew all of the designs correctly on four consecutive trials, all remaining trials should be checked as if all designs had been recalled and scored accordingly.

Visual Selective Reminding Test - Form A

Name: ____________________ Age: ___ Sex: __ Education: ____

Date: __________ Examiner: ______________ Diagnosis: ________

	1	2	3	4	5	6	7	8	9	10	11	12	Dly
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													

Intrusions													

	1	2	3	4	5	6	7	8	9	10	11	12
$\sum$ Recall												
LTR												
STR												
LTS												
CLTR												
RLTR												

Appendix C

Administration of the Verbal Selective Reminding Test

Administration

Say: "I want to find out something about how you learn. I am going to read you a list of words. Listen carefully. When I have read the whole list, I want you to remember as many words as you can and say them back to me. After that, I'll read the words you left out and ask you to repeat all the words you can remember from the whole list. You may say the words in any order you want. Most people need quite a few chances before they can remember the whole list of words. Do you have any questions?"

Do not tell the subject the number of words in the list or the number of trials. Explain to the subject that the order of recall is not important. Also, explain that (s)he is to repeat the whole list on every trial, even though you will remind him/her only of those words missed on the immediately preceding trial.

Say: "Now I am going to read the list of words. Listen carefully and remember as many as you can." Read the list of words from top to bottom at a rate of one word every two seconds.

Say: "Tell me as many of the words as you can remember." Record the responses in the first column of the score sheet as the subject repeats the words. Record the responses by putting a check mark in the cell corresponding to each word. (If the order of recall is of interest, record the responses by writing a number to indicate order or recall in the cell corresponding to the word. For example, if the word 'county' is recalled first on a trial, place a 1 in the corresponding cell. Place a 2 in the cell for the next word recalled, etc.) If the subject says a word that is not on the list, say nothing, just continue testing. Any words that are not on the list should be recorded as intrusions on the score sheet.

On each recall trial, allow the subject enough time (about one minute) and encouragement to extend recall. That is, to continue trying to remember items after recall becomes difficult.

After the first trial, remind the subject only of those words not recalled on the immediately preceding trial.

Say: "Now, I will read the words you missed. When I'm finished, try to give me the complete list, including the words you said last time. Listen carefully."

Read the list of words at a rate of one every two seconds from the top to the bottom of the list, skipping those words which were recalled on the immediately preceding trial. Ask for the subject's recall and record the responses. Repeat this procedure until 12 trials are complete. If the subject recalls the whole list of 12 words on four successive trials, testing may be discontinued.

Delayed Recall

After the time interval decided upon for delayed recall has passed, ask the subject to tell you all the words (s)he can remember from the list. Record these on the score sheet, along with any intrusions.

Scoring

		1	2	3	4	5	6 . . .
	A	✓	✓		✓→	✓	✓
	B	✓		✓	✓		✓
	C		✓		✓→	✓	✓
	D	✓		✓		✓→	✓
(1)	Σ Recall	3	2	2	3	3	4
(2)	LTR	1	1	1	3	3	4
(3)	STR	2	1	1	0	0	0
(4)	LTS	1	1	2	3	4	4
(5)	CLTR	0	0	0	3	4	4
(6)	RLTS	1	1	1	1	0	1

1. Score the protocol by rows, scoring each item across trials. For each item, find the first instance of recall on two successive trials. Underline these trials and all subsequent trials in that row in red through the 12th trial (whether or not the cell has been checked as recalled on all trials). This represents long term storage.
2. To evaluate consistent long term retrieval, go across each row from right to left to find the trial after which the

item is recalled consistently on all subsequent trials. Mark that cell with an arrow. There should no no arrows in the 12th column (see example, column 6).

3. Count the number of items recalled on each trial (down the column) and enter the total in row (1) labeled Σ Recall, for each of the 12 trials.
4. Count the cells with checks (recalled items) that are underlined in red down each column. Enter the total for each trial in the row (2) labeled long term retrieval (LTR).
5. Subtract the LTR score from the Σ Recall score for each trial. Enter the remainder in the short term recall (STR) row (3).
6. Count down each column the cells underlined in red (whether or not a cell was checked). Enter the total for each trial in the long term storage (LTS) row (4).
7. Read the complete instruction before beginning, as this is a cumulative score. Count down the first column only those checked cells having arrows. Enter the total in the consistent long term retrieval (CLTR) row (5). Count down the second column only those checked cells having arrows. Add the sum to the score for the preceding trial and enter the total in the CLTR row (5). Continue this procedure for the remaining trials. For example: There is no cell with an arrow in the first column of the sample; so a zero was entered in the CLTR row. The second

column has no arrows, so zero was added to the score for the first trial and a zero was entered in the CLTR row for the second trial. The third column had no arrows, so zero & zero was added and entered in the CLTR row. The fourth column had two arrows, so zero & two was added and a 2 was entered in the CLTR row, etc.

8. Subtract the scores in the CLTR row (5) from the scores in the LTR row (2) by column. Enter the remainder in the random long term retrieval (RLTR) row (6).
9. If testing was discontinued before the completion of 12 trials because the subject drew all of the designs correctly on four successive trials, all remaining trials should be checked as if all designs had been recalled and scored accordingly.

Appendix C--Continued

Selective Reminding Test - Form 1

Name:____________________ Age: ___ Sex:__ Education:_________

Date: ____________ Examiner:_____________ Diagnosis:_________

	1	2	3	4	5	6	7	8	9	10	11	12	Dly
bowl													
passion													
dawn													
judgment													
grant													
bee													
plane													
county													
choice													
seed													
wool													
meal													

Intrusions

	1	2	3	4	5	6	7	8	9	10	11	12
Σ Recall												
LTR												
STR												
LTS												
CLTR												
RLTR												

Appendix D

Informed Consent Agreement

Information About: Assessment of Visual Memory and Learning by Selective Reminding

Principal Investigator: Shirley Cummins, M.A. 689-1900 x2673

The purpose of this study is to determine whether patients having different types of neurological disorders will perform differently on verbal and visual memory and learning tasks.

I understand that I will be asked to complete a verbal and a visual memory and learning task and take a short test.

There are no risks associated with these procedures. There may be some inconvenience, in that these procedures take a certain amount of time and attention.

These procedures may provide information about the assessment of verbal and visual memory and learning. If they do, then they may be useful in diagnosisng memory deficits and planning rehabilitation programs for patients who have memory problems.

Authorized investigators may review my medical records. I understand that the results of the study may be published in the medical/psychological literature, but that my identity will not be disclosed.

If I have any questions about this study, the investigators will be glad to answer them for me. I understand that I am free to withdraw my consent and discontinue my participation in this study at any time. My participation in the study or withdrawal from it will in <u>no</u> way effect my continued care and treatment.

I have read the above and understand it and hereby consent to the procedures set forth above.

____________________ ____________________

Date Subject

____________________ ____________________

Witness Principal Investigator

Appendix E

Table 2

Measures of Central Tendency for the Demographic Variables

Group (*n* = 10)	Age	Education	Premorbid IQ	Current IQ	Duration of Impairment[a]
Left hemisphere					
Mean	57.600	10.200	97.800	89.800	73.500
SD	12.799	1.751	6.900	7.162	53.871
Right hemisphere					
Mean	56.600	10.900	101.200	94.200	53.000
SD	14.455	2.644	8.400	11.736	43.287
Diffuse damage					
Mean	51.700	13.200	105.200	100.500	48.900
SD	12.970	2.201	7.170	15.608	38.911
No brain damage					
Mean	40.000	13.700	108.700[b]	108.700	
SD	11.785	3.401	8.629[b]	8.629	

[a] In months

[b] Current IQ was used because these subjects had no brain damage or psychotic illness.

Appendix F

Table 3

Means and Standard Deviations of Scores on the Visual Selective Reminding Test

Brain Damage Group (n = 10)	Total Scores for Twelve Trials				
	Sum of Recall	LTR	LTS	CLTR	Delayed Recall
Left					
Mean	34.400	20.900	31.100	6.000	2.900
SD	18.686	18.058	18.363	9.978	2.079
Right					
Mean	22.200	12.300	21.400	1.600	2.300
SD	12.227	9.753	16.043	2.503	1.636
Diffuse					
Mean	27.500	13.000	23.500	1.600	2.800
SD	11.188	8.313	17.790	2.413	2.044
No BD*					
Mean	57.700	39.900	50.900	22.700	6.500
SD	17.852	19.513	17.742	20.790	2.273

*No BD = No brain damage.

Appendix G

Table 4

Means and Standard Deviations of Scores on the Verbal Selective Reminding Test

Brain Damage Group (n = 10)	Total Scores for Twelve Trials				
	Sum of Recall	LTR	LTS	CLTR	Delayed Recall
Left					
Mean	45.600	20.900	28.700	7.700	3.600
SD	21.485	20.475	24.811	12.928	2.914
Right					
Mean	81.400	55.300	68.500	31.100	5.700
SD	20.255	29.360	28.822	28.262	4.296
Diffuse					
Mean	66.000	30.600	41.400	9.800	3.900
SD	16.391	22.416	28.246	9.864	2.998
No BD*					
Mean	114.500	101.700	108.900	80.900	9.500
SD	14.191	21.474	18.970	32.996	2.369

*No BD = No brain damage.

Appendix H

Table 6

Frequencies and Ranges for the Visual Selective Reminding Test

	Scores							
	0-19	20-39	40-59	60-79	80-99	100-119	120-139	Range
				Sum of Recall Total				
L	1	7	1		1			18-84
R	4	6						2-37
D	2	7	1					7-40
N		1	6	1	2			39-89
				Long Term Retrieval Total				
L	6	3		1				3-69
R	7	3						0-26
D	8	2						0-27
N	2	5	1	2				19-75
				Long Term Storage Total				
L	1	8		1				9-78
R	3	3	4					0-42
D	2	5	3					0-34
N		2	5	2	1			29-87
				Consistent Long Term Retrieval Total				
L	9	1						0-33
R	8	2						0-7
D	8	2						0-7

Consistent Long Term Retrieval Total								
	0-19	20-39	40-59	60-79	80-99	100-199	120-139	Range
N	6	4						2-57

Note. L = left hemisphere, R = right hemisphere, D = diffuse, and N = no brain damage groups.

Appendix I

Table 7

Frequencies and Ranges for the Verbal Selective Reminding Test

	Scores							
	0-19	20-39	40-59	60-79	80-99	100-119	120-139	Range
	Sum of Recall Total							
L	1	3	5		1			7-88
R			2	3	3	2		53-111
D		1	2	4	3			39-93
N					2	4	4	93-137
	Long Term Retrieval Total							
L	5	4		1				0-67
R	2	1	2	2	3			13-97
D	4	4	1		1			4-82
N				1	4	2	3	63-134
	Long Term Storage Total							
L	4	4	1	1				0-77
R		2	2	2	2	2		22-108
D	2	3	3	1		1		8-104
N				1	2	4	3	70-135
	Consistent Long Term Retrieval Total							
L	9		1					0-41
R	4	2	2	1	1			0-81
D	8	2						0-27

	Consistent Long Term Retrieval Total							
	0-19	20-39	40-59	60-79	80-89	100-119	120-139	Range
N		1	2	2	2	1	2	35-132

Note. L = left hemisphere, R = right hemisphere, D = diffuse, and N = no brain damage groups.

Appendix J

Table 8

Frequencies and Ranges for the Delayed Recall Scores

Brain damage group	Scores 0	1	2	3	4	5	6	7	8	9	10	11	12	Range
						Visual Selective Reminding Test								
Left		2	4	1	2				1					1-8
Right	2	1	2	3	1	1								0-5
Diffuse	2	1	1	2	2	1	1							0-9
No BD*		1			1	1	1	2	2	2				2-9
						Verbal Selective Reminding Test								
Left	2	1	1	1		3	1			1				0-9
Right	2		1	1			1	1	2			1	1	0-12
Diffuse		3	1	1	2		1	1			1			1-10
No BD*						1	1			2	2	2	2	5-12

*No BD = No brain damage.

Appendix K

Table 9

Analysis of Item Difficulty for the Visual Selective Reminding Test

Design	% Correct Recall	Rank
1	45.00	a
2	10.63	l
3	11.46	k
4	28.96	e
5	21.88	f
6	21.04	g
7	13.96	j
8	37.50	c
9	15.63	i
10	17.92	h
11	31.04	d
12	41.67	b

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