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# The Relative Utility of Implicit Memory Tasks and a Forced-Choice Memory Test for the Detection of Simulated Brain Injury Deficits

by

Kimberly Gail Fisher
B.A. (Hon.), Simon Fraser University, 1986
M.A., Simon Fraser University, 1989

A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree of

DOCTOR OF PHILOSOPHY

in the Department of Psychology

We accept this dissertation as conforming to the required standard

Dr. Esther H. Strauss, Supervisor (Department of Psychology)

Dr. Roger E. Graves, Department Member (Department of Psychology)

Dr. Michael E. J. Masson, Department Member (Department of Psychology)

Dr. Max R. Uhlemann, Outside Member (Department of Psychological Foundations in Education)

Dr. Grant L. Iverson, External Examiner (Neuropsychiatry Program, Riverview Hospital)

University of Victoria

Supervisor: Dr. Esther H. Strauss

## ABSTRACT

Clinical neuropsychologists are often called upon to make decisions on the genuineness of cognitive deficits following a head injury. This is a difficult task, particularly when deficits are subtle, as there are few reliable tools to aid the clinician in his or her decision making process. In the present study, normal participants instructed to feign brain injury (M), traumatically brain-injured individuals (BI), and normal controls (C), completed a series of computer-administered implicit memory (IM) tasks. Results were compared to those for the Victoria Symptom Validity Test (VSVT; Slick, Hopp, Strauss, & Pinch, 1994; Slick, Hopp, Strauss, & Thompson, 1997), a commercially available forced-choice recognition task. All IM tasks included items which had been previously presented once, twice or four times, as well as foils (items not previously presented). Previous exposure to test items was expected to be associated with increased accuracy (Hits) and decreased Response Latency. Participants in the BI and C groups were expected to perform equally well and better than the M group participants with respect to Hits. Response Latency on incorrect items (Misses) was also expected to discriminate M participants from BI and C participants because the conscious decision to provide an incorrect response was expected to increase decision making time. Results with respect to overall Hits were confirmed (*M*=127.87, *M*=129.72, and *M*=107.10 for the BI, C, and M groups, respectively). Increased accuracy with repetition of items in the priming phase was not confirmed, likely because both BI and C participants performed close to ceiling levels. Discriminant function analysis based on total Hit rates, resulted in correct classification of 85 percent (46 out of 54) of the participants. This was comparable to the results for Hard items combined on the VSVT. Response Latency measures did not effectively discriminate among groups, while results did indicate a main effect of Presentation Level (priming) on Response Latency with participants, independent of Group Membership, tending to respond most quickly (Hits only) to items presented 4 times during the priming phase and least quickly to items presented only once. Overall, results suggest that further investigation of IM tasks for the detection of conscious malingering is warranted as these tasks appear to tap the dimensions on which the general population hold misconceptions about the effects of brain injury, i.e., overall ability/performance and response latency.

**Examiners:**

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Dr. Esther H. Strauss, Supervisor (Department of Psychology)

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Dr. Roger E. Graves, Department Member (Department of Psychology)

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Dr. Michael E. J. Masson, Department Member (Department of Psychology)

---

Dr. Max R. Uhlemann, Outside Member (Department of Psychological Foundations in Education)

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Dr. Grant L. Iverson, External Examiner (Neuropsychiatry Program, Riverview Hospital)

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# DEDICATION

For my father, Jerry M. Nixon (1936-1992),
who always had his nose in a good book.

# INTRODUCTION

Malingering or dissimulation refers to the conscious attempt to feign or exaggerate physical, psychological, or cognitive impairment. The Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV; APA, 1994) differentiates malingering from the Factitious Disorder. In the case of malingering incentives are present, such as "avoiding military duty, avoiding work, obtaining financial compensation, evading criminal prosecution, or obtaining drugs", while for Factitious Disorder, external incentives are absent (p. 683). The DSM-IV proposes that malingering should be strongly suspected in medical-legal contexts, in situations where there is a marked discrepancy between subjective complaints and objective findings, when there is a lack of cooperation during assessment or treatment, or when Antisocial Personality Disorder is present (p. 683). In the course of their daily work, neuropsychologists may encounter any or all of these situations. In particular, neuropsychologists are frequently involved in personal injury cases in which litigation is an issue. Because compensation is often largely dependent on measured impairment, malingering/dissimulation is an important consideration when making decisions about the presence or absence of cognitive deficits. Indeed, consideration of malingering is imperative given that valid neuropsychological assessment is dependent on effort on the part of the participant and faking or exaggerating deficits on neuropsychological tests is widely acknowledged. Unfortunately, established neuropsychological measures do not include validity scales designed to tap deviant response sets, such as are included in some of the more reliable and widely used personality tests, including the Minnesota Multiphasic Personality Inventory (MMPI; Hathaway & McKinley, 1943) and its revision, the Minnesota Multiphasic Personality Inventory - 2 (MMPI-2; Butcher, Dahlstrom, Graham, Tellegen, & Kaemmer, 1989). Moreover, it is unclear what construction of validity scales or items would entail for many of the wide variety of neuropsychological measures available today.

## The Assessment of Malingering

Over the past three decades, a number of researchers have attempted to develop reliable tools to aid the clinician in differentiating between genuine and feigned cognitive impairment. There has been a recent explosion in interest in this area and a number of promising developments that have propelled the field of detection of malingering forward.

The malingering phenomenon has been widely studied for many years. It was Miller (1961, cited in Pankratz, 1988), a neurologist, who described the persistence of "pseudo-neurological" symptoms until the resolution of compensation issues and focused attention on psychological and legal factors in the emergence and maintenance of head injury sequelae. Clinicians and researchers who have followed in Miller's footsteps have recognized the difficulty inherent in attempting to disentangle the relative contributions of pre-existing disorders, dissimulation, and genuine impairment in patients' symptom presentations. Nonetheless, a number of potential indicators of dissimulation have been proposed and evaluated in the literature. To date, there have been two main approaches to detecting malingering in neuropsychological assessment: 1) the establishment of "fake bad" profiles on existing neuropsychological measures and 2) the development of new measures specifically designed to detect malingering.

## ***"Fake Bad" Profiles***

In the past three decades, a number of researchers have attempted to identify "fake bad" profiles on widely used neuropsychological measures, including the Benton Visual Retention Test (Benton & Spreen, 1961; Spreen & Benton, 1963), the Bender-Gestalt (Bruhn & Reed, 1975), the Halstead-Reitan Neuropsychological Test Battery (Faust, Hart, & Guilmette, 1988a; Goebel, 1983; Heaton, Smith, Lehman, & Vogt, 1978), the Luria-Nebraska Neuropsychological Battery (Mensch & Woods, 1986), the Wechsler Intelligence Scale for Children (WISC-R)(Faust et al., 1988a), the Rey Auditory Verbal Learning Test (RAVLT)(Bernard, 1990; 1991), the Rey Complex Figure Test (Bernard, 1990), the Wechsler-Memory Scale-Revised (Bernard, 1990; Iverson & Franzen, 1996;

Mittenberg, Azrin, Millsaps, & Heilbronner, 1993), the Test of Nonverbal Intelligence (TONI; Frederick & Foster, 1991) and Warrington's Recognition Memory Test (RMT; Millis, 1994). Some of these researchers have focused on single tasks or measures, while others have employed multiple measures in an attempt to determine which measures are the most sensitive to feigned impairment. For simplicity, the single and multiple measure studies will be reviewed separately.

## *Single Task Studies*

### *The Benton Visual Retention Test.*

Among the early malingering research are two studies by Spreen and Benton (Benton & Spreen, 1961; Spreen & Benton, 1963) that examined "fake bad" profiles on the Benton Visual Retention Test (BVRT), a brief, immediate visual memory task. These researchers found that individuals instructed to simulate brain damage overestimated the deficits displayed by individuals with genuine brain damage and made qualitatively different errors, as well as more overall errors on this task than did individuals with genuine impairment (Spreen & Benton, 1961). When controls were instructed to feign moderate mental retardation, similar results were found (Spreen & Benton, 1963). Further investigation of qualitative error differences (errors of commission versus errors of omission) was suggested as a method of detecting malingerers, but has yet to be validated with this test.

### *The Rey Auditory Verbal Learning Test (RAVLT).*

Bernard (1991) evaluated the ability of participants to fake believable deficits on the Rey Auditory Verbal Learning Test (RAVLT). He included four groups: normal controls, a group of individuals who had sustained a closed head injury, a group of normal controls instructed to malinger and offered a financial incentive for credible performance, and a group of neurologically normal individuals instructed to malinger for whom no financial incentive was offered. No significant difference was observed between the two malingering groups and the groups were therefore combined for analysis. Results indicated that the malingerers did not perform below the closed head injury group on any one trial or on overall performance. In addition, all groups demonstrated some improvement in performance across repetition trials. There was, however, a significant serial position of items (position of items in the list) by group interaction, with participants in the malingering group demonstrating a smaller primacy effect (recall of the first 5 of 15 items) relative to recency effect (recall of the last 5 of 15 items), on all trials combined, than either the control or closed head injury participants. In short, the control group demonstrated the expected "U-shaped" recall performance characteristic of primacy and recency effects, while the closed head injury group demonstrated a primacy effect but little recency effect and the pattern of performance for the malingerer group was reversed, i.e., a recency effect but little primacy effect.

Based on the results of this study, Bernard (1991) suggested that profile analysis rather than determination of cut-off scores may be a useful tool in discriminating individuals with genuine memory impairment from both malingerers and normal controls. However, a more recent study by Bernard, Houston, and Natoli (1993) reported "U-shaped" performance curves for both malingering and control groups, suggesting that suppression of the primacy effect may not be a useful indicator of malingering.

### ***The Test of Nonverbal Intelligence (TONI).***

Frederick and Foster (1991) employed two equivalent test forms comprised of items from the Test of Nonverbal Intelligence (TONI), a test similar to the Raven's Standard Progressive Matrices (RPM; Raven, Court, & Raven, 1983) that requires the examinee to identify the missing component from a multiple-choice array by determining the relationships among increasingly challenging abstract figures.

Three groups of participants, a control group, a group of cognitively impaired forensic patients, and a group of simulating malingerers, were employed. Participants instructed to malinger were expected to perform below chance levels ($p<.05$; 42 items or fewer correct out of 100), show a distorted item difficulty curve (slope), and respond inconsistently to item pairs of equal difficulty. Although only 14 of the 84 individuals in the malingering group scored below the cut-off for chance performance, 51 of the 84 simulators were correctly classified using decision criteria derived from slope and consistency of performance expectancies. In addition, a discriminant function analysis based on slope and consistency ratios resulted in correct classification of 81 of 84 malingerers (high sensitivity), but the misclassification of 47 of 86 controls (poor specificity). Because of the high false positive error rate, a modified decision rule was employed and tested on a new sample of participants, 32 controls and 30 individuals instructed to malinger. The new decision rule, based on a mathematical relationship between the slope and consistency ratios of "sophisticated malingerers" (those whose slope matched that of controls, i.e., poorer performance on more difficult items), resulted in correct classification of 93 percent of the malingerers and 100 percent of the controls.

More recently, Frederick, Sarfaty, and Houston (1994) employed a 2-alternate forced-choice modified version of the TONI and reported that their simple mathematical decision rule demonstrated greater sensitivity than other measures of response bias in differentiating college students from neuropsychological and forensic evaluees.

### ***The Warrington Recognition Memory Test (RMT).***

Millis (1992) investigated the ability to discriminate individuals who had experienced mild head trauma and were seeking financial compensation from individuals who had experienced moderate and severe head trauma and were not seeking compensation based on performance on the Warrington Recognition Memory Test (RMT; Warrington, 1984). The RMT is a forced-choice recognition test comprised of two subtests: words and photographs/faces. Results indicated that subjects with mild head trauma who were seeking financial compensation performed worse on both subtests (words and faces), on average, than participants who had sustained more severe brain trauma but were not seeking financial compensation. A discriminant function analysis based on word and faces scores resulted in correct classification of 76 percent of their 30 participants. In a replication of this study, Millis and Putnam (1994) reported an overall classification rate of 83 percent of their sample 86 participants basic on the discriminant function derived in the Millis (1992) study.

Similarly, Millis (1994) compared performance on the RMT of individuals who had sustained mild head injuries and were seeking financial compensation with individuals who had sustained moderate and severe brain trauma, and with individuals who had sustained mild head injuries but had returned to work.

As hypothesized, there was a significant main effect of group for both the Words and Faces subtests of this test and paired comparisons indicated that the mild head trauma group seeking compensation performed significantly worse than did either participants in the severe brain trauma group (moderate and severe brain trauma groups combined) or participants with mild head injuries who had returned to work. In addition, a high proportion of the litigating mild head trauma group (.29) obtained scores lower than chance (less than 50 percent correct). A discriminant function analysis correctly classified all of the mild head injury patients who had returned to work (n=12) and 15 of 17 litigating mild head injury participants. Severe brain trauma individuals were not included in the discriminant function analysis.

### ***Summary of Single Task Studies***

Although some the well-known neuropsychological measures have shown promise with respect to detection of malingering, a number of caveats and limitations are clear: 1) although many researchers have suggested employing cut-off scores based on below chance performance, these scores have generally led to false negative error rates that are unacceptably high; 2) many of the studies have not been replicated and therefore caution is warranted against generalizing or drawing conclusions from a single instance; and 3) control groups and simulation instructions have been varied and therefore direct comparison of task sensitivity is not possible.

Despite these limitations, a few important conclusions can tentatively be drawn from this group of studies. Firstly, whether or not a financial incentive is offered, at least in simulation studies, does not appear to affect the performance of individuals instructed to malinger. Secondly, discriminant function analyses appear to be very useful in differentiating simulated malingerers from controls and individuals with genuine impairment, warranting further research with this statistical technique. Thirdly, further analysis of qualitative errors may offer some assistance in discriminating genuine from feigned impairment. Finally, these studies suggest that a variety of cognitive tasks can be employed to discriminate malingerers from controls and from individuals with genuine cognitive impairment and, hence, a combination of measures derived from a variety of neuropsychological measures might lead to enhanced ability to discriminate among these groups.

## *Battery and Multiple Measures Approaches*

A number of researchers have employed multiple measures derived from commonly used neuropsychological batteries and/or a combination of a number of well-known cognitive tasks to identify malingerers. Multiple measures have been employed for two general purposes: 1) to determine which measures best discriminate malingerers, simulated malingerers, or both, from normal controls and individuals with genuine cognitive impairment, and 2) to enhance overall ability to detect malingerers by including multiple measures in decision-making rules and discriminant function analyses.

### *The Wechsler Memory Scale - Revised (WMS-R)*

Mittenberg et al. (1993) employed discriminant function analyses to differentiate performance on the Wechsler Memory Scale - Revised of head injured individuals from age-matched controls instructed to malinger head trauma symptoms. Two separate analyses were performed, one including all subscale scores from the WMS-R and one simply employing a General Memory Index-Attention/Concentration difference score. General Memory Index scores were comparable for the two groups, but there were significant differences between the groups on a number of the other indexes and 91 percent of the sample of 78 individuals (7.7 percent false positives and 10.3 percent false negatives) were correctly classified using a combination of WMS-R index scores. The discriminant function analysis which employed the General Memory - Attention/Concentration difference score as the independent variable correctly classified 83 percent of the sample (10.3 false positives and 23.1 percent false negatives).

Most recently, Martin (1997, in press) examined the utility of employing a "magnitude of response error" approach to detecting malingering on modified subtests of the WMS-R. Both "analog" malingerers (university students instructed to fake believable deficits) and clinical malingerers (suspected malingerers obtained from clinical practice) were included in this study. This researcher reported that both groups of malingerers were more likely to select low probability multiple-choice items than either controls or non-litigating individuals with moderate to severe closed head injuries. Applying error magnitude scores, based on probability of various selections, 86 percent of the analog malingerers (26/30) and 100 percent of the suspected clinical malingerers

(7/7) were correctly identified. All of the controls were also correctly identified. These researchers did not report on the utility of overall cut-off scores based on standard WMS-R indices.

### ***The Luria-Nebraska Neuropsychological Battery (LNNB)***

Mensch and Woods (1986) administered the Luria-Nebraska Neuropsychological Battery (LNNB) to a group of 32 normal controls. All participants completed the battery twice, once under instructions to simulate brain damage and once under instructions to give their very best effort. Conditions were counter-balanced. All scores for participants under non-faking instructions fell within normal limits, while 31 of the 32 participants obtained impairment scores indicative of brain damage under instructions to simulate brain damage. These researchers suggested that although overall performance of malingerers is consistent with genuine brain impairment, the pattern of results obtained, particularly results on the Pathognomic scale (a scale highly sensitive to the presence or absence of brain injury), may be very useful in differentiating genuine from feigned impairment.

McKinzey, Podd, Krehbiel, Mensch, & Trombka (1997) applied and cross-validated a discriminant function formula on a samples of experimental malingerers and heterogeneous samples of patients seen in a neuropsychology practice. They reported an overall hit rate, cross-validated, of 88 percent, with 23 percent false negative error rate and a 9 percent false positive error rate.

### ***Summary of Single Battery Approaches***

Taken together, the findings from single battery studies suggest that overall cut-off scores are likely to lead to high false negative error rates, while measures based on performance patterns appear to have considerable promise as discriminative variables. These results are in keeping with the results of some of the individual neuropsychological tests reviewed above.

### ***Multiple Measure Studies***

Since the 1970s, researchers have been investigating clinicians' abilities to identify malingering profiles on various combinations of well-known neuropsychological measures compared to the discriminative ability of a variety of statistical techniques. In general, these studies have focused on the utility of performance pattern analysis. Among the first of these studies is the work of Heaton et al., (1978) and Goebel (1983).

Heaton et al. (1978) administered the Wechsler Adult Intelligence Scale (WAIS), the Halstead-Reitan Battery (HRB), and the Minnesota Multiphasic Personality Inventory (MMPI) to 16 simulated malingerers and 16 non-litigating head injury patients. They found that normal individuals instructed to malinger showed a comparable level of overall impairment to the sample of individuals with head trauma. However, the pattern of deficits across component tasks was different for these two groups, particularly scores on the HRB. Malingerers tended to perform most poorly on motor and sensory tests and within normal limits on many of the cognitive measures that were sensitive to actual brain impairment. The only statistically significant difference between groups on the WAIS was performance on the Digit Span subtest for which the malingerers, on average, performed well below the individuals with genuine head injuries. Significant group differences were also reported for 7 of the 13 clinical and validity scales comprising the MMPI.

Heaton et al. (1978) had the resulting profiles evaluated by 10 experienced neuropsychologists who were asked to judge whether each profile was likely produced by a malingerer or a patient with a genuine head injury. Diagnostic accuracy was very poor, ranging from a chance level to approximately 20 percent above chance. The relationship between accuracy and the neuropsychologists' confidence ratings on their judgments was generally low, suggesting that neuropsychologists do not have a accurate conceptions about their ability to discriminate genuine from feigned impairment. On the other hand, a discriminant function analysis based on HRB and WAIS variables was able to correctly classify all of the participants. It should be noted, however, that there were more variables than subjects included in the discriminant function; therefore, error free classification was inevitable.

In a second study, Faust et al. (1988), examined clinicians' abilities to identify malingerers. These researchers instructed children to "fake bad" on a battery of neuropsychological tests, including the Wechsler Intelligence Scale for Children - Revised (WISC-R) and the Halstead-Reitan Neuropsychological Battery (HRB). These researchers did not attempt to identify specific patterns of scores reflective of malingering, however. Their main hypothesis was related to the experienced clinician's inability to detect unsophisticated malingerers.

None of their 42 clinician respondents indicated malingering as a possible explanation for the profiles that they determined to be "abnormal" and despite inaccurate identification of abnormal profiles, the majority of these clinicians (31 of 42) indicated at least moderate confidence in their decisions. Although these results appear very discouraging, it should be noted that these clinicians were given false background information on the children, including information about a motor vehicle accident and brief loss of consciousness. Had information been less misleading, clinicians may questioned these performances. A more recent study by Trueblood and Binder (1997) clearly suggests that when clinicians are given accurate information they are able to accurately detect malingering based on neuropsychological test performance, at least in obvious cases. They reported a false negative error rate of zero to 25 percent, averaging 10 percent, for profiles produced by malingerers. The false positive error rate for the genuine head injury profiles was 8 percent. Sixty clinicians reviewed one of two profiles produced by a clinical malingerer (supported by surveillance data and results of forced-choice testing), while 26 clinician's reviewed one of two profiles produced by individuals who had suffered a severe head injury.

### *Qualitative Error Analyses*

Although these early studies suggested that clinicians' judgment based on profile analysis is poor, the results of several more recent studies (e.g., Goebel, 1983; Bernard, 1990, Bernard, 1993) have suggested that there are qualitative differences in performance between genuine and "faked" profiles that may be of some utility in accurately differentiating between individuals in these groups. If a characteristic malingering pattern of performance is discernible, clinicians could perhaps be trained to identify this pattern with some accuracy. In this vein, several studies have focused on delineating qualitative performance differences.

Bernard (1990) evaluated participants' ability to fake believable deficits on a variety of neuropsychological measures, including the Wechsler Memory Scale - Revised (WMS-R), the Rey Auditory Verbal Learning Test (RAVLT), and the Rey 15 Item Memory Test. Two groups of malingerers were employed, one offered a financial incentive and the other offered no financial incentive. A main effect of Group was obtained for 20 of the 22 measures derived from the memory tests. The only measures that did not show significant group differences were Rey 15 Item Memory Test total scores and the total score on the Mental Control subtest of the WMS-R.

Paired comparisons revealed no significant differences between the malingering incentive and no incentive groups on 16 of the 20 measures for which there was a significant main effect of group. A discriminant function analysis correctly identified 75 percent of controls (12/16) and 75 percent of malingerers (18/24; incentive and no incentive groups combined).

Bernard et al.(1993) conducted a similar study to the one described above, this time including the Rey 15 Item Memory Test, Hebb's Recurring Digits, the Wechsler Memory Scale - Revised (WMS-R), the Rey Complex Figure Test, and the Rey Auditory Verbal Learning Test (RAVLT). Performance of controls was compared to that of individuals instructed to malinger. Although participants instructed to malinger performed significantly worse on the Rey 15 Item Memory Test than individuals in the control group, they did not fall below the recommended cut-off of less than 9 out of 15. On the RAVLT, the participants in the malingering group performed below individuals in the control group, but the pattern of performance ("U-shaped" curves reflective of primacy and recency effects) did not differ for the two groups. Two separate discriminant function analyses, one employing measures from the WMS-R (Figural Memory and immediate Visual Reproduction scores) and the other employing measures from the RAVLT and the Rey Complex Figure Test (3 measures), resulted in correct classification of 100 percent of the controls (n=26) and 77 percent and 75 percent of the malingerers (n=31), respectively.

Greiffenstein, Baker, and Gola (1994) reported performance on popular "malingering" measures, the Rey 15 Item Memory test, the Portland Digit Recognition Test, a Digit Span measure, and Rey's Word Recognition List, to better differentiate probable malingerers from a large sample of both compliant post-concussive patients and individuals who were traumatically brain injured, than scores derived from traditional memory measures such as the Wechsler Memory Scale - Revised and they Rey Auditory Verbal Learning Test. The only "malingering" measure which failed to differentiate between probable malingerers, individuals with persistent post-concussive syndrome, and individuals with documented traumatic brain injury was the Rey Dot Counting Test.

More recently, Iverson and Franzen (1996) examined the performance of a group of experimental malingerers on a number of frequently used assessment tasks, some of which were specifically designed to detect malingering and some of which are commonly used memory measures, including the Digit Span subtest of the Wechsler Adult Intelligence Scale - Revised (WAIS-R), the 16 Item test (a revision of the Rey 15 Item Memory Test), the Logical Memory subtest of the Wechsler Memory Scale - Revised (WMS-R), and a supplemental forced-choice addition to the Logical Memory subtest.

A group of students and a group of psychiatric patients were tested under instructions to malinger memory deficits, as well as under instructions to perform to the best of their abilities. A monetary incentive was offered for believable performance. Significant differences were observed between the two conditions (malingering and non-malingering) for 9 of the 10 measures employed. A third group of individuals, those with genuine memory impairment instructed to perform to the best of their abilities, performed significantly better on 8 of the 10 measures employed than both students and psychiatric patients under malingering instructions.

Cut-off scores selected for zero false positive error rates resulted in correct classification of malingerers (student and psychiatric participants combined) ranging from 5 to 85 percent, depending on the task employed. The total number of subjects correctly classified ranged from 62 to 94 percent. In other words, the tasks were differentially sensitive to malingering. The forced-choice addition to the Logical Memory subtest of the WMS-R was the best discriminator. Combining all measures together yielded a correct classification rate of 92.5 percent for malingerers when the false positive error rate was set at 0 percent.

Iverson and Franzen (1996) further noted that only 12.5 percent of the malingerers performed below chance levels, while none of the participants (memory impaired, controls, or psychiatric patients)scored below chance levels when instructed to give their best effort.

Finally, recent studies employing multiple measures, including the Wechsler Adult Intelligence Scale - Revised and the Halstead-Reitan battery, e.g., Reitan and Wolfson (1996; 1997) suggest that dissimulation indices, based on consistency of performance over 2 testing sessions (test-retest performance) may be very sensitive indicators of malingering, as in nearly every case individuals involved in litigation were less consistent across test administrations than individuals not involved in litigation.

Although much of the research suggests that performance pattern analysis is useful in discriminating malingers from individuals putting forth their best effort, not all research has supported the utility of pattern analysis. For example, Rawlings and Brooks (1990) used the WAIS-R and WMS to differentiate between individuals who had suffered head injuries (post-traumatic amnesia duration of at least 2 weeks) and "simulators" who were defined as individuals with post-traumatic amnesia durations of 24 hours or less. They examined group differences on each of the subtests composing these two tests and were unable to find any scores that consistently differentiated participants in the two groups. An error analysis also failed to discriminate between these two groups. Limitations of their samples may have been in large part responsible for the failure to find differences, however. Their definition of simulator does not match the standard interpretation of this term.

### ***Summary of Multiple Measure Approaches***

Although multiple measure approaches have generally led to better correct classification rates than single measure studies, a number of limitations remain. Perhaps most importantly, because of the variety of measures employed, it is difficult to determine which measures are the most sensitive to feigned impairment. Post hoc decision rules may only apply to the sample under investigation. Therefore, although clinicians' suspicions of malingering may be heightened by unusual or inconsistent patterns of performance, it is not clear exactly what an abnormal profile entails. Simple decision rules based on overall scores appear to be inadequate in detecting malingering, but better decision rules that clinician's can use with confidence are lacking. Moreover, since assessments are often tailored to the client's reported difficulties, there is no standard battery of tests on which researchers can focus their efforts. Because of these limitations, a more fruitful approach to detecting malingering has been the development of brief supplemental assessment measures specifically designed to detect malingering.

## ***Measures Designed Specifically for the Detection of Malingering***

The most productive line of research for identifying dissimulation has been the development and adaptation of measures specifically for the assessment of malingering. A review of the most common techniques follows.

### ***Dot Counting***

Rey (1941, 1964) developed two simple memory tests for the detection of malingering: the Dot Counting Test (1941) and Memorization of 15 items, also known as the Rey 15 Item Memory Test (Rey, 1964). The former test involves the presentation of six cards, each with a different number of dots printed on it (7, 11, 15, 19, 23, and 27). The cards are presented in pseudo-randomized order so that there is no systematic change in task difficulty. The participant's task is to count the dots as quickly as possible. It is expected that counting time will increase gradually with the number of dots presented on the card. Response times are compared with norms derived from the performance of normal participants and brain-injured individuals. Deviations from normative values are interpreted as indicative of poor motivation or dissimulation.

Rey created grouped and ungrouped stimulus cards (i.e., neatly organized versus randomly spaced dots) to further vary task difficulty. Paul, Franzen, Cohen, and Fremouw (1992) examined the utility of the grouped and ungrouped dots for discriminating between optimal or "best" performance and suboptimal performance (performance under simulating instructions) with three participant groups: normal community volunteers, psychiatric inpatients, and a group of individuals with brain disorders of various etiologies. Under simulating instructions, participants in both the normal volunteer and psychiatric group made significantly more errors on both grouped and ungrouped dots than participants in the brain disorder group (Paul et al., 1992). Response times were not as useful as the error score in differentiating among groups. False positive and false negative error rates, based on cut-off scores were reported to be 8 percent and 40 percent, respectively.

More recently, Binks, Gouvier, and Waters (1997) examined the utility of the Dot Counting Detest in discriminating simulators (both uncoached and coached) from normal controls and individuals undergoing neuropsychological evaluation. They reported that simulators performed significantly more poorly, on average, on six separate measures derived from performance on this test than non-simulators (normal controls and neuropsychological patients combined), supporting the utility of the Dot Counting Test as a tool in the detection of malingering.

### ***Memorization of 15 Items***

Rey's second memory test, known as Memorization of 15 items or Rey 15 Item Memory Test, is described in detail in Lezak (1995). This test consists of 15 well-known/over-learned items that are arranged in 5 sets of 3 (e.g., a, b, c as one set). The items are displayed simultaneously for 10 seconds. Following removal of the display, the examinee is asked to produce as many of the items as he or she can remember.

Goldberg and Miller (1986) reported performance at or above 9 items for their entire sample of psychiatric patients, while performance for a sample of individuals diagnosed as mentally-handicapped was generally below 9 out of 15 (Goldberg & Miller, 1986), while Millis and Kler (1995) reported that a cut-off score of 7 resulted in a true positive detection rate of 57 percent for their group of 7 clinical malingerers and no false positive identifications, and Boone, Savodnik, Ghaffarian, Lee, and Freeman (1995) reported that only 4.5 percent of their sample of 156 participants obtained a score of less than 9 on the this test. Results for Bernard and Fowler (1990) were much more promising, with a cut-off score of 9 resulting in correct classification of 88.8 percent (16 of 18) of their sample of brain damaged individuals and 100 percent of their controls, and a cut-off score of 8 resulting in correct classification of 100 percent of individuals in each of these groups; however, a group of simulated or suspected malingerers was not included in this study, so sensitivity of these cut-off scores in detection of feigned deficits is unknown.

Poor performance in the mentally-handicapped sample in Goldberg and Miller's (1986 study) suggests that this test may have limited utility in differentiating malingerers from low functioning individuals, at least when it is used in isolation. However, these researchers indicated that type of errors committed by malingerers and low functioning individuals (omission versus commission errors) may be useful in discriminating between these two groups. Errors of commission among neurological patients have also been reported by Morgan (1991), although he suggested that the state of our knowledge at present is insufficient to suggest clear interpretive guidelines.

More recently, Arnett, Hammeke, and Schwartz (1995) reported some success in discriminating simulated malingerers from individuals with genuine neurological impairment based on cut-off scores derived from qualitative errors, i.e., number of rows in proper location. In their two experiments, sensitivity was reported to be 47 and 64 percent, respectively, while specificity was reported to be 97 and 96 percent, respectively.

### *Current Procedures for Assessing Malingering*

Although researchers and clinicians have reported some success detecting malingerers with specifically designed techniques such as the Rey 15-item memory test, for the most part, unacceptably high false positive and false negative error rates have been reported, especially when simple cut-off scores are applied. Clearly, the early simple tasks are not "foolproof" as was hoped, and a need for the development of measures sensitive to dissimulation has remained. Much of this void has been filled by the application and refinement of Symptom Validity Testing (SVT).

#### *Forced-choice Symptom Validity Testing (SVT).*

The majority of the malingering assessment literature to date, both descriptions of clinical cases and controlled research studies, has focused on Symptom Validity Testing (SVT), introduced by Brady and Lind (1961), employed in the evaluation of hysterical blindness by Grosz and Zimmerman (1965) and Theodor and Mandelcorn (1973), and advanced by Pankratz, Fausti, & Peed (1975) and Pankratz (1979, 1983). This technique uses a forced-choice format that compares responses of suspected or simulated malingerers with expected probabilities based on binomial or multinomial probability theory. It can be applied to a variety of cognitive tasks, including memory recall, as well as sensory abilities, such as hearing loss (Pankratz et al., 1975) and tactile sensation loss (e.g., Binder, 1993).

The most common symptom validity testing procedure requires participants to identify a previously presented item from between two possibilities (2-alternative forced-choice testing). Scores significantly worse than chance (significantly below 50 percent correct, the expected random response rate) are presumed to be the result of deliberate production of wrong answers --malingering, according to Binder. The Portland Digit Recognition Test (PDRT) (Binder, 1990; Binder & Willis, 1991), Hiscock and Hiscock's (1989) Symptom Validity Test, and the Recognition Memory Test (Warrington, 1984) all employ this procedure. Although the latter test was not specifically designed for the detection of malingering, it is used for this purpose (see Millis, 1994, reported above).

Early SVT testing (e.g., Pankratz et al., 1975; Pankratz, 1979, 1983) was tailored to the patient's specific complaint(s) and determination of malingering hinged on below chance performance with variable success. A number of improvements have been made to these simple two-alternate forced-choice tests since their introduction.

***Portland Digit Recognition Test (PDRT).***

The Portland Digit Recognition Test (PDRT) (Binder, 1990; Binder & Willis, 1991) is a 72-item forced-choice test (4 sets of 18 items). Participants are presented, auditorially, with a 5-digit number and are then instructed to count backwards, aloud, for 5, 15, 30, and 30 seconds, depending on the set (1, 2, 3, or 4). After completion of the distracter task (counting), participants are shown a small card with the target item and an incorrect, foil, item presented one above the other. The examinee is asked to select the item that was presented immediately before the distracter task and to make a selection even if uncertain of the correct response. The 72 items are divided into easy trials (Trials 1-36) and hard trials (trials 37-72) (Binder, 1990). After the first and second set of trials, participants are told that the test will become more difficult because they will have to remember the target number for a longer period of time (longer distracter tasks). Estimated time for administration is 45 minutes.

Binder (1990) reported 5 case studies in which the PDRT was employed to clarify whether individuals were malingering. Four of the five individuals performed below chance (less than 50 percent correct), suggesting that they had deliberately made incorrect selections.

In a more comprehensive study, Binder (1993) reported the ability to differentiate between a mild head injury group seeking compensation, a brain-damaged group seeking compensation, and a brain-damaged group not seeking compensation, based on PDRT scores. He hypothesized an inverse relationship between severity of trauma among the patients seeking financial compensation which was supported by the results. Participants not seeking financial compensation had the best overall performances.

In a second study, similar results were obtained for a group of mild head trauma patients receiving financial incentives, a group of brain damaged patients of various etiologies not receiving financial incentives, and a similar group of brain damaged individuals receiving financial compensation (Binder, 1993). Both of these studies corroborated the findings of an earlier study (Binder & Willis, 1991) in which the results of a group of individuals with affective disorders not seeking compensation were compared to groups of individuals either with mild head trauma seeking financial compensation or well-documented brain dysfunction seeking compensation, and non-patient non-compensation participants. In each of these studies, PDRT totals scores differed significantly between groups. Performance of the brain damage no financial compensation group was significantly better than either the mild head injury compensation or the brain damaged compensation groups. In the 1991 study, the performance of individuals diagnosed with affective disorders did not differ from the group of individuals with brain-damage not seeking compensation, but performance of both groups was significantly worse than the group of non-patient, non-compensation participants. These findings consistently indicate that individuals involved in litigation tend to perform more poorly than expected given the nature of their injuries. This is particularly true of individuals who have sustained mild injuries.

For the 1993 study, Binder reported that cut-off scores established by determining the poorest performance of any individual in the brain damage no compensation group (total score 39) suggested malingering in 33 percent of the mild head trauma compensation group and 36 percent of the brain damaged compensation group. In the 1990 study, 26 percent of the individuals with mild head trauma (8/29) performed below the worst score for the brain damage no compensation group (Binder, 1990). Hence, as predicted, individuals receiving compensation tended to perform worse than participants not receiving compensation. In addition, as anticipated, there was an inverse relationship between injury severity and performance on the PDRT. It should be noted, however, that despite statistically significant group differences, the majority of participants did not perform below chance levels. It should also be noted that in neither of these studies is the base rate for actual malingering known in the compensation groups, so false positive and false negative error rates could not be calculated. Because of the limitation of not knowing true malingering rates, many researchers have focused on the use of "analog" or simulated malingerers in their research.

### ***The Hiscock and Hiscock (1989) Procedure.***

To address some of the shortcomings of simple, 2-alternate forced-choice tasks, Hiscock and Hiscock (1989) developed a method of forced-choice testing which manipulates perceived difficulty. In this procedure, a five-digit number is presented for 5 seconds. The participant is then required to recognize the digit from two choices. Recognition of the first digit alone is usually sufficient for a correct response (i.e., target and foil items rarely share a common first digit). This task takes approximately 30 minutes to administer.

These researchers claim that the key to the sensitivity of this task is that it appears to become more difficult across trials because of increasing delay intervals (5, 10, and 15 seconds) of interpolated mental activity between presentation of the stimulus and the recognition trial. In addition, the examiner informs the patient that the test is becoming harder each time the length of the interpolated activity is increased. The increasing length of interpolated task and the administrators comments are designed to make the task appear to become more difficult, but are assumed not to alter the actual difficulty of the task.

Hiscock & Hiscock (1989) reported that, except for cases of severe Alzheimer's disease, brain damaged individuals perform at a high level of accuracy and their performance is indistinguishable from that of normal controls. Secondly, in support of the greater utility of their task relative to previous simple forced-choice procedures, these researchers reported a case in which the patient did not perform significantly below chance until the longest latency interval (15 seconds).

A number of studies have since supported the utility of this forced-choice recognition task in discriminating individuals either instructed to malinger, or suspected of malingering, from individuals with genuine impairment (e.g., Prigatano & Amin, 1993; Slick et al., 1997). In general, these studies have also supported the utility of the manipulation of perceived difficulty. For example, Prigatano and Amin (1993) reported that only their group of suspected malingerers tended to perform progressively worse with the increasing delay intervals. Suspected malingerers' performance did not fall below chance levels, however.

Finally, the assumption that task difficulty is not altered with increasing delay intervals has been called into question. Slick et al. (1994) evaluated the assumption that extending the delay between presentation and recognition does not increase task difficulty. They found that the performance of individuals with legitimate head injuries declined significantly across delay intervals on their modified version of Hiscock and Hiscock's (1989) procedure.

### ***The Victoria Symptom Validity Test.***

The most recent improvement of forced-choice procedures is the manipulation of item difficulty. Slick et al. (1994) addressed item difficulty in an attempt to reduce the risk of false-negative classification, or in other words to increase sensitivity of their forced-choice procedure. In addition to evaluating Hiscock and Hiscock's (1989) claim that delay interval does not influence actual item difficulty, Slick et al. (1994) modified Hiscock and Hiscock's SVT procedure to include two levels of item difficulty (defined by number of common digits, 0 or 2, in the target and foil items). This test is now known as the Victoria Symptom Validity Test (VSVT; Slick et al., 1997). The performance of simulated malingering subjects has been found to be significantly worse than head-injured subjects at both difficulty levels, but head-injured subjects only performed worse than controls on the difficult items (2 common digits). These findings suggest that item difficulty is an important consideration for discriminating genuine from feigned impairment. A discriminant function analysis based on performance on difficult items resulted in correct classification of 83 percent of participants (all 22 controls; 16 of 20 simulated malingerers; and 5 of 10 brain-injured patients).

Slick, Hopp, Strauss, and Spellacy (1996) further evaluated the utility of the VSVT by employing a three-level cut-score system for classifying participants. They evaluated a large group of compensation seeking patients, a group of controls, a small group of patients not seeking financial compensation, and a group of experimental ("analog") malingerers. Convergent and divergent validity of the VSVT were also assessed.

Results indicated that participants in the malingering group obtained significantly lower scores than participants in all other groups on both easy and hard items. The control group and the brain-injury no compensation group scored close to ceiling on both the easy and hard items. Cut-off scores based on below chance performance (probability of less than .05) resulted in valid profiles for all of the controls and non-compensation patients, 95 percent of the compensation patients, and only 61 percent of the participants instructed to malinger. Because the false negative error rate was unacceptably high, a new three level scoring system (valid, questionable, and invalid) was employed. The questionable classification included individuals scoring within the 90 percent confidence interval around chance performance. In other words, valid profiles were those in the upper 5 percent and invalid profiles fell below 5 percent probability, while the remaining 90 percent were considered to be of questionable validity. As a result of this new scoring system, only 8 of the 43 individuals in the simulated malingering group were now classified as having valid profiles, while 18 (42 percent) had profiles in the questionable range. There was no change in the correct classification rates for controls and patients not seeking compensation (all achieved scores in the valid range), while 20 of the 206 patients seeking compensation obtained questionable performances. Hence, this new classification technique resulted in a substantial improvement in sensitivity.

The VSVT also allows the collection of reaction time data, a variable previously reported to have some utility for discriminating normal from feigned performance (Strauss, Spellacy, & Hunter, 1994). Results of Slick et al. (1996) indicated that participants who produced invalid profiles took approximately twice as long as to respond participants producing valid profiles.

Convergent and divergent validity evaluation was undertaken to clarify whether the VSVT is insensitive to cognitive functioning (Slick et al., 1996). In general, low correlations were obtained for the association between VSVT easy and hard items and the various cognitive measures employed (Wechsler Adult Intelligence Scale - Revised, Wechsler Memory Scale - Revised, Rey Auditory Verbal Learning Test, Rey Complex Figure Test). None of the memory tests employed shared more than 5 percent of its variance with either easy or hard items from the VSVT. Results for the reaction time values were not as encouraging. Moderate correlations were obtained for several of the cognitive measures, including the Trail Making Test, Stroop, and measures of digit span.

In summary, although recent modifications of forced-choice techniques offer promise, especially with respect to false positive rates, false negative error rates remain a problem for clinicians and researchers. For example, Slick et al., 1994 report a 0 percent false positive classification rate using a discriminant function analysis, while their false negative error rate was 25 percent. In other words, they were failing to identify 25 percent of persons instructed to feign head injury. The new classification technique employed by Slick et al. (1996) resulted in improved sensitivity, but a false negative error rate of 19 percent (8 of 43 simulated malingerers).

### *The 21 Item Test.*

The 21 Item Test, Iverson, Franzen, and McCracken (1991) is word list recall and forced-choice recognition task that is based on a refinement of the work of Brandt, Rubinsky, and Lassen (1985) and Wiggins and Brandt (1988). This test is comprised of a list of 21 nouns and a lists of 21 foils used on the forced-choice recognition component. Test administration, free recall, and forced-choice recognition trials combined take approximately 5 minutes to administer.

Iverson et al. (1991) reported that scores from the recognition component of the 21 Item Test could differentiate college students instructed to malinger memory impairment from students performing their best and from participants with genuine memory impairments. Iverson, Franzen and McCracken (1994) provided further evidence of the sensitivity and specificity of this task. The results of a discriminant function analysis employing free recall and recognition memory scores as predictor variables results in correct classification of 90 percent of their sample of 180 participants into malingering (community volunteers and psychiatric patients instructed to malinger memory impairment) and non-malingering (community volunteers, psychiatric patients, and patients seen for neuropsychological evaluation instructed to perform to the best of their abilities). More recent studies by Iverson and Franzen (1996) and Arnett and Franzen (1997) have provided additional support for the sensitivity and specificity of scores derived from the forced-choice recognition trial of this test in detecting malingering.

***The Test of Memory Malingering (TOMM).***

The newest addition to forced-choice testing is the Test of Memory Malingering (TOMM; Tombaugh, 1997). This is a 50-item picture (line drawing) recognition test. Participants are instructed that they are to learn and remember information and they are shown a series of 50 "to-be-remembered" pictures (48 for the 4-alternate forced-choice version). Pictures are presented one at a time for 3 seconds each. During the first and second test phases, targets are presented with either 1 (50-item version) or 3 (48-item version) foils (distracters). The participant is instructed to select the one item presented in the learning phase. Recognition is then tested again following a 20-minute delay during which participants are engaged in a word list learning task.

Tombaugh (1997)conducted a series of 4 experiments to validate the TOMM. In the first experiment, a large sample of community volunteers demonstrated the ease of the 4-alternate task. Mean percent correct for the first test trial was 95, while for the second test trial and the delay trial mean performances exceeded 99 percent correct.

The second study validated the 2-alternate forced-choice version of this test. In addition, the procedure was modified so that participants received feedback on their performance following each decision, as this was expected to be a potential useful manipulation in differentiating optimal from sub-optimal performance. Performance for a small group of community volunteers than employed was virtually identical to performance in the first experiment.

Experiment 3 was designed to validate the TOMM on a mixed sample of neurological patients. Patients were divided into 5 groups: no cognitive impairment, cognitive impairment, aphasic, traumatic brain injury, and dementia. Performance across groups, apart from the dementia group, exceeded 90 percent on trial 1. All groups performed above 90 percent on trial 2 and the delay trial, indicating that this test is insensitive to even severe cognitive impairment. Strong performance was obtained across groups despite the fact that neuropsychological testing indicated severe impairment in memory abilities (California Verbal Learning Test performance and Wechsler Memory Scale - Revised performance) for many of the patients. A cut-off score of 45/50 on trial 2 resulted in correct classification of 95 percent of the non-demented patients and 73 percent of demented patients as non-malingering.

Finally, experiment 4 was an "analog" study. Controls were divided into simulated malingerers and normal controls. A significant group effect was observed with the mean score for malingerers falling at slightly over 50 percent correct across all trials. The Controls performed near ceiling, as in the previous experiments. A cut-off score of 45/50 on the delay trial resulted in 100 percent correct classification (no false positive and no false negative errors). These participants also completed the Hiscock and Hiscock (1989) forced-choice task. Performance resulted in 95 percent sensitivity and 100 percent specificity. However, participants commented that the face validity or apparent difficulty of the TOMM as a test of memory exceeded that of the Hiscock and Hiscock (1989) task.

### *Implicit Memory Techniques*

Although recent refinement of SVT techniques has shown that these techniques have utility in detecting dissimulation, they are not foolproof. In addition, there is some concern that sophisticated malingerers may detect the simplicity of these tasks and therefore alter their performance to avoid detection.

In differential diagnosis, the most clinically useful measures are those that are highly sensitive to the disorder of interest and not sensitive to alternative diagnoses. A measure that results in no score overlap between diagnostic categories would result in error free diagnosis. The ideal measure for detection of malingering of neuropsychological deficits would, therefore, be one which is maximally sensitive to feigned impairment and completely insensitive to genuine brain dysfunction. Unfortunately, such ideal conditions rarely, if ever, exist in the real world. The memory literature does, however, suggest one possible avenue for future research: implicit memory.

## ***The Implicit/Explicit Memory Distinction***

*Implicit* or *incidental memory* is demonstrated when performance on a task is enhanced by a prior event or experience in the absence of the subject's conscious or deliberate attempt to recall that event or experience (Graf & Schacter 1985; Schacter, 1987). This phenomenon was strikingly illustrated by the nineteenth century neurologist, Claparede (1911/1951). In the course of his rounds, Dr. Claparede, while holding a pin in his hand, shook hands with an amnesic patient. Later that day, the patient had no recollection of having met Dr. Claparede but had an "inexplicable" reluctance to shake hands with him. Controlled research studies have produced similar evidence of this "inexplicable" memory.

*Implicit memory* is contrasted with *explicit memory*, the ability to recall information in a deliberate or intentional manner. Explicit memory is typically assessed by recall or recognition tasks which require the subject to make an effort to retrieve learned information, while implicit memory is typically inferred from improvement in performance across trials.

Mandler (1980) proposed that implicit memory results from the activation of a mental representation, or *schema*. With activation, the structure of the representation is strengthened, making it more accessible, but not necessarily more retrievable. On the other hand, explicit memory depends on *elaboration*, the extent to which the activated schema is related to other information at the time of encoding. This additional, related information can serve as a retrieval cue. If cues are inadequate, retrieval may not be possible, yet implicit memory tasks may reveal some retention of information despite failed retrieval. *Activation*, the process presumed to be responsible for implicit memory, is regarded as automatic, whereas *elaborative processing*, the process presumed to underlie explicit memory, is strategic, subject-controlled, and conscious (Graf & Mandler, 1984).

### ***Priming***

*Priming* is an extensively studied implicit memory phenomenon among "normal" and neurologically impaired individuals. In the implicit memory literature, the word "*priming*" is used to refer to both the process of implicit learning (i.e., giving individuals prior exposure to information to enhance performance) and to its effects. In the latter case, priming is inferred from an increase in accuracy or decrease in latency of response following prior exposure to the test stimuli (direct or repetition priming) or following exposure to information that is related to the test stimuli in some manner (indirect, associative, or semantic priming) (Richardson-Klavehn & Bjork, 1988).

Schacter (1992) proposed that priming effects reflect the operation of a perceptual representation system that supports expression of memory that falls outside of conscious awareness. Hence, priming (implicit learning) is viewed as an automatic process, a view similar to that of Graf and Mandler (1984).

### ***Neural Substrates for Implicit and Explicit Memory***

One of the central questions with regard to implicit/explicit memory distinction is whether implicit and explicit memory are dependent on different memory systems, and perhaps different brain structures, as proposed by Schacter (1987) and Tulving and Schacter (1990). Two general lines of evidence are used to support the multiple memory systems proposal: 1) findings of independence between performance on explicit and implicit memory tasks; and 2) selectively impaired performance on explicit memory tasks among neurological patients (Ostergaard & Jernigan, 1993).

Numerous researchers, have reported independence between performance on explicit and implicit memory measures (e.g., Graf, Squire, & Mandler, 1984; Jacoby & Dallas, 1981; Jacoby & Witherspoon, 1982; Tulving, Schacter, & Stark, 1982; Warrington & Weiskrantz, 1970). Ostergaard and Jernigan (1993) caution that although this finding is consistent with the hypothesis of separate memory systems, separate memory systems are not the only explanation for observed independence. Scaling differences on tasks and varied demands on cognitive processes, such as attentional processes, can also result in independence (Ostergaard & Jernigan, 1993). Indeed, statistical independence has also been reported for different implicit measures (e.g., Butters, Heindel, & Salmon, 1990; Gabrieli, Fleischman, Keane, Reminger, & Morell, 1995; Gabrieli, Keane, Stanger, Kjelgaard, Corkin, & Growdon, 1994; Keane, Gabrieli, Fennema, Growdon, & Corkin, 1991; Schacter & Graf, 1986; Witherspoon & Moscovitch, 1989), indicating that the separate systems/structures explanation may not be parsimonious or accurate. The dissociations observed would require sparing and impairment of a number of memory systems/brain structures within this model.

In keeping with the multiple systems model, some researchers (e.g., Gabrieli et al., 1995; Keane et al., 1991; Tulving, Hayman, & Macdonald, 1991) have suggested a distinction between perceptual priming, which is likely dependent on a structural-perceptual memory system mediated by occipital lobe regions and is therefore spared in Alzheimer's disease, and a conceptual priming that may reflect a semantic memory system dependent on temporoparietal association areas that is compromised in Alzheimer's disease.

Evidence obtained from amnesic patients, who by definition have severely impaired explicit memory performance, is often regarded as the most compelling evidence for multiple memory systems. Many researchers have reported normal range performance by amnesics on a variety of implicit memory tasks (see the Implicit Memory Research with Neurological Patients section below).

Based on what is known about the etiology and tissue involvement of various neurological disorders, explicit or declarative memory is thought to be dependent on mesial temporal structures (in particular the hippocampi and parahippocampal gyri), as well as a variety of diencephalic structures and basal forebrain structures, including the mammilary bodies, the anterior and dorsomedial nuclei of the thalamus, and hypothalamic structures. This proposition is based on the finding that amnesic patients typically have bilateral lesions in medial temporal or diencephalic brain regions. Implicit memory, on the other hand, is thought to be dependent on a number of less well-defined subsystems and structures that are spared in amnesia (Butters & Stuss, 1989).

With respect to brain structures involved in different aspects or forms of implicit memory, Butters, Heindel, and Salmon (1990) proposed that association cortex must play a critical role in lexical priming while motor skill learning may be mediated by the corticostriatal system, as lexical priming was spared in Huntington's disease but not in Alzheimer's disease. The opposite pattern of results was observed on motor skill learning tasks. Other researchers (e.g., Gabrieli, Milberg, Keane, & Corkin, 1990) have also suggested that a dissociation among priming tasks themselves implies that a number of brain structures are likely involved in different types of priming.

In short, localization of implicit and explicit memory structures is far from clear. Modern imaging techniques may help to solve the localization issue, however. Jernigan and Ostergaard (1993) employed magnetic resonance imaging (MRI) to reveal amount the of tissue loss in three main areas: the caudate nuclei, the mesial temporal lobes, and the posterior temporo-parieto-occipital cortex. They found that only temporal limbic tissue loss was associated with poor recognition memory on a tachistoscopic threshold recognition task, while caudate volume was associated with increased priming and temporal limbic loss was associated with reduced priming. Ostergaard and Jernigan (1993) suggested that at least two factors influence measured priming: one related to memory and one related to processing efficiency. The memory-related component is revealed by removing the variance due to processing efficiency (baseline) from the priming measure. This memory-related component of priming is related to recognition memory and, like recognition memory, is affected by the extent of mesial temporal lobe damage. The aspect of priming related to processing efficiency appears to be independent of mesial temporal lobe volume.

In summary, although the dominant theoretical interpretation of the dissociations between performance on implicit and explicit tasks has been that these tasks tap different memory systems in the brain, this may not be so. Different processing demands within a single memory system may account for the dissociations observed. A memory subsystems model would require the inclusion of multiple memory systems, even within the domain of implicit memory, to account for the patterns of performance observed. Processing accounts may be less cumbersome.

### ***Implicit Memory Research with Neurological Patients***

Considerable evidence suggests that amnesics possess some learning abilities and that some automatic aspects of learning, such as priming, are not sensitive to even severe organic impairment. For example, Perfect and Downes (1982), using an anagram task, found that Alzheimer's patients were just as able as control subjects to solve primed anagrams, despite poorer free recall of target words (explicit memory performance) than controls. In addition, intact priming among amnesics has been found for a threshold duration word identification task (Cermak, Talbot, Chandler, & Wolbarst, 1985), for word-stem completion tasks (e.g., Gabrieli et al, 1994; Graf et al, 1984; Warrington and Weiskrantz, 1970), as well as for a word list generation task (Graf, Shimamura, &

Squire, 1985), while impaired priming has been reported for Alzheimer's patients on some word priming/completion tasks (e.g., Shimamura, Salmon, Squire, & Butters, 1987). Priming effects have been found even for unrecalled (failed) items (Perfect & Downes, 1982). Thus, although the Alzheimer's patients and patients with other forms cognitive impairment frequently demonstrate profound explicit memory deficits (poorer free recall than controls), they often do not demonstrate an implicit memory deficit relative to controls.

These implicit memory findings are, however, far from consistent. Priming effects have been reported to be task dependent. For example, Verfaellie, Gabrieli, Vaidya, Croce, and Reminger (1996) found that participants with Korsakoff and non-Korsakoff amnesia showed intact priming on a picture naming task but impaired priming on a fragment-completion task when fragmented pictures were presented during the priming phase. In addition, these researchers found that non-Korsakoff amnesics showed normal priming on a fragment-completion task when whole pictures were presented during the priming phase and impaired performance when picture fragments were presented during the priming phase, while Korsakoff amnesics demonstrated impaired priming in both conditions. Other researchers have also reported dissociations among performances on various implicit memory tasks (see the Neural Substrates for Implicit and Explicit Memory Section above).

In short, numerous studies have reported priming in amnesic patients who have demonstrated severely impaired explicit memory performance for the same material, but clearly the etiology, e.g., Korsakoff's disease versus Alzheimer's disease, may mediate the extent and nature of priming effects. Furthermore, Ostergaard and Jernigan (1993) caution that although many studies do report evidence of priming with amnesic patients, evidence of impaired priming is also common, though often left unacknowledged. Even in early studies, such as the work of Warrington and Weiskrantz (1970), although there was clear evidence of priming in the performance of amnesic patients, the magnitude of priming did not match that of normal controls. Similar results were found for repetition priming with mirror reversed words (Cohen & Squire, 1980), as well as a spelling test using primed homophones (Cermak, O'Connor, & Talbot, 1986). Squire, Shimamura, and Graf (1987) also reported lower priming effects for amnesics than for normals on word-stem completion tasks and word fragment tasks for which items had only one possible solution. Finally, Ostergaard (1993) compared priming effects for Alzheimer's patients to those of normal controls on a tachistoscopic word task. When the fact that the Alzheimer's patients required longer exposure times to correctly identify words was taken into consideration, significantly less priming was evident for the Alzheimer's patients than for controls. Clearly, although there is evidence for priming in neurological populations, the nature and extent of priming effects with these populations appear to be affected by a number of factors, including task demands and etiology.

Finally, Ostergaard and Jernigan (1993) further warn that failure to find statistically significant differences between amnesic patients and normal controls reported in many studies may be the result of limited task sensitivity, rather than truly equivalent performance. They note that for many of the tasks employed, amnesic patients would have to have had negative priming effects in order to have obtained scores significantly different from controls. In other words, these studies lacked power and true differences that might exist between the two groups could therefore not been uncovered.

### ***Implicit Memory Research with Head-Injured Patients.***

Memory problems are among the most common complaints following head injury and poor performance on standardized memory tests is frequently reported for this population. Despite clear evidence for impaired explicit memory performance for many head injured individuals, there is also accumulating research evidence to suggest that head-injured patients' performance on priming tasks is indistinguishable from that of controls (e.g., Ridder & Hiscock, 1995; Vakil, Biederman, Liran, Groswasser, & Aberbuch, 1994), even when these subjects demonstrated severe learning and memory impairments on formal, explicit memory tasks (e.g., Ridder & Hiscock, 1995). Unfortunately, until recently, few studies evaluated implicit memory in the head-injured population separately from other neurological patients and, as a result, the nature and extent of priming effects among the head-injured population has yet to be clearly delineated.

## *Implicit Memory and Malingering*

Despite recent interest in priming and implicit memory in the head-injured population, when this research was begun in 1995, a review of the literature revealed only three studies that employed indirect or implicit memory tasks to assess malingered memory deficits: a study conducted by Wiggins and Brandt (1988), a study conducted by Horton and Smith (1992), and preliminary research with an experimental set of implicit memory and other memory tasks developed to assess malingering (Davis, King, Bajszar, & Squire, 1995). Since that time, Davis and his colleagues have published two additional studies (Davis King, Bloodworth, Spring, & Klebe, 1997a; Davis, King, Klebe, Bajszar, Bloodworth, & Wallick, 1997b) validating the use of implicit memory techniques and there has been continued growth of interest in this topic.

To clarify the rationale for the present study, the available research on malingering and implicit memory tasks will be reviewed.

### *Word-Stem Completion Tasks*

Wiggins and Brandt (1988) employed a word-stem completion task and examined priming effects in normal controls and participants instructed to feign memory deficits. The word-stem completion paradigm has been studied with various populations. The typical procedure involves having participants either rate words or use words in sentences during the priming phase. Following the priming phase, participants are given a series of word-stems, typically the first three letters of the words employed in the priming phase, as well as some unprimed stems. Participants are asked to complete these stems with the first word that comes to mind. Priming is reflected in an increased likelihood of responding with primed items rather than with other words, and may occur in the absence explicitly recalling the previously presented items.

Wiggins and Brandt (1988) did not find a significant difference between the performance of their three groups of simulators (participants instructed to malinger different kinds of memory deficits/etiologies) and the control group. Both simulators (all groups combined) and controls demonstrated priming effects on the word-stem completion task, as did the small group of amnesics tested (n=4). Performance on a word association task was similar. All groups demonstrated a priming effect, producing a greater number of first associations to the stimulus words from a presented list of words than for an unpresented list of words.

Wiggins and Brandt's (1988) failure to find significant differences among their groups may have been due to limitations of their procedure, however. They employed word-stems with multiple possible solutions and they employed a free recall task between presentation of the words and completion of the word-stems that may have altered the priming effects and removed the task from the domain of priming. Nonetheless, their results appear to have contributed to a pause in research in this area for several years.

Horton and Smith (1992) also employed a primed word completion or word-fragment completion task. They found that when participants were motivated to simulate memory impairment, word completion rates were consistently below expected (baseline) rates, whereas under normal (non-malingering) conditions, these subjects demonstrated expected priming effects (Horton & Smith, 1992). These findings suggested that priming effects may be useful in evaluating performance motivation.

Most recently, Davis et al. (1997b) administered a word completion priming test to a group of students instructed to malinger and an equivalent number of controls. They derived a measure of priming, as well as recording latency to produce a word-stem completion. It was expected that participants instructed to malinger would produce lower priming scores and longer response latencies for primed words than would control participants. Uniqueness of the word-stem was manipulated (i.e., stems that could be completed with 10 or more words versus stems that could be completed with only one English word).

As hypothesized, controls demonstrated greater priming scores (completed stems more frequently with primed items) and showed shorter response latencies for primed items than for unprimed ("baseline") items. Participants instructed to malinger did not show the expected response latency difference for items on the multiple word-stem completion possibilities versus the list with unique word stems. A discriminant function analysis using latency scores from the unique stem list and priming scores from the multiple word-stem completion list (variables yielding non-redundant information) yielded correct classification of 48 of 60 (80 percent) of the controls and 44 of 60 (73.3 percent) of the simulated malingerers, yielding a total correct classification rate of 76.7 percent.

The above results, although yet to be replicated and tested on samples including individuals with genuine brain injuries, provide further justification for investigating the utility of implicit memory tasks for the detection of malingering.

### ***Category Classification Task***

In 1995 Davis et al. published a series of implicit memory tasks designed to detect malingering, the Colorado Malingering Test. The results of some of their initial research are published in Davis et al. (1997b). Davis et al. (1997b) employed a computerized category classification/learning test to discriminate between the performance of simulated malingers, control patients, and amnesic patients(n=10). Participants were asked to classify dot patterns as to whether they belonged to the same category as a set of training patterns (e.g., dots creating the outline of the letter "M"). Patterns with no distortion, low distortion, and high distortion of the prototype, as well as random dot patterns were tested after participants simply examined 40 list items and indicated the centre of the pattern. All list items were variations of the same prototypical pattern. Main effects of Group, Type of Pattern (Prototype, High Distortion, Low Distortion, and Random dot patterns) were obtained, as well as a significant interaction between Group and Type of Pattern. Simple effects were observed for Group at the Prototype and Low Distortion conditions and paired comparisons revealed that amnesics and controls did not perform differently on either the Prototype of Low Distortion conditions, while individuals in the malingering condition scored significantly lower than controls and amnesics on the Prototype pattern, and lower than controls on the Low Distortion pattern. In other words, when the pattern was quite clear (prototype and low distortion conditions), the simulated malingerers made more errors than controls. When the pattern was less evident, there were no meaningful group differences with respect to number of errors.

A discriminant function analysis resulted in correct classification of 27 of 44 controls (61 percent), 22 of 43 malingerers (51 percent) and 6 of 10 amnesics (60 percent). When amnesics and controls were grouped together in the classification (amnesics classified as controls considered correctly classified and vice versa), correct classification rates for these groups were raised to 79.6 and 80 percent, respectively, when the prototype pattern score was used as the discriminant variable.

## *Summary of Research Rationale and Design*

Taken together, the findings outlined above suggest that many tasks designed to tap implicit memory are not sensitive to many neurological disorders, even those characterized by severe memory impairment, or to head-injury sequelae. Thus, although the research is far from conclusive, the available evidence suggests that implicit memory tasks are worthy of consideration in dissimulation/malingering research. In short, the implicit memory phenomenon appears to be robust. For this reason, tasks designed to take advantage of this preserved memory function may be useful in discriminating feigned from genuine memory impairment.

The purpose of the following research was three-fold: 1) to investigate the clinical utility of tasks designed to tap implicit memory functions for detecting feigned memory deficits 2) to evaluate the relative utility of pictorial and language-based tasks and 3) to compare the overall sensitivity and specificity of implicit memory tasks for malingering to the sensitivity and specificity of an existing malingering detection task, the revised version of the Hiscock and Hiscock (1989) SVT procedure, the Victoria Symptom Validity Test, (Slick et al., 1994; 1997).

To discriminate among the normal *controls*, normals instructed to *malinger* brain injury deficits, and individuals with *brain injuries*, four memory tasks were employed: 1) a fragmented *Word Identification/Fade-in* task, 2) a fragmented *Picture Identification/Fade-in* task, 3) a Forced-choice *Word Recognition* task; and 4) a Forced-choice *Picture Recognition* task. Each of these tasks involved "primed" (target) and "unprimed" (foil) items.

A group of individuals with genuine brain injuries was included in the present study because the ability to discriminate between individuals with genuine brain injuries and individuals instructed to malinger brain injury deficits (simulated malingerers) is the "litmus test" for techniques designed to detect malingering. Simple analog studies that are designed to discriminate the performance of simulated malingerers from control subjects can result in erroneous conclusions with respect to the sensitivity of different measures for identifying malingerers.

## *Research Design*

### *Priming Phases.*

For the priming phases, participants were asked to indicate whether target words or target pictures presented one at a time on a computer screen, were "pleasant" or "unpleasant" by pressing either the left or right arrow key. The purpose of this rating task was to ensure that participants attended to the target stimuli. Participants were not warned that they would be asked to recall these stimuli later in the study and their actual responses were not collected.

Target items were presented 1, 2, or 4 times during the priming phase, comprising the three levels of *Actual Difficulty*. For the word stimuli, two sets of 30 target words, one containing words with 5 letters and one containing words with 8 or more letters, comprised the two levels of *Perceived Difficulty*. Words were selected from Toglia and Battig (1978). There was no manipulation of perceived difficulty for the picture tasks. Pictures were selected from Snodgrass and Vanderwart (1980).

### ***Word Identification/Fade-in Task.***

Graphics of 15 items from each of the word sets (short words and long words) presented in the priming phase, as well as 15 matched foils, were presented one at a time on the computer screen. Fragments of the words, based on pixels, were faded in from 0 percent to 100 percent pixels (from no word to complete word) over a 3-second interval. The participants were instructed to indicate as soon as they were able to identify the word and then say the word aloud to the experimenter. Five letter words and foils were presented first for each participant. Presentation of the 8-or-more letter words was prefaced by the suggestion that the participant "might find these items a little harder to identify because the words are longer than the items on the previous trial".

Response latency data as well as whether the item was correctly identified were collected for all targets and foils.

***Forced-Choice Word Recognition Task.***

The remaining 15 target words from each of the word sets presented during the priming phase, along with matched foils, were presented on the computer screen two at a time (one target word and one matched foil presented side by side). Participants were asked to indicate, as quickly as possible, which one of the two words they had seen earlier in the study and to guess when uncertain of the correct response. Response latencies were recorded separately for "Hits" (targets correctly identified) and "Misses" (foils incorrectly identified as target items).

Once again, all participants were presented with the 5 letter word set before the 8-or-more letter word set and administration of the second set was prefaced by the suggestion that the second set might be a more difficult because the words are longer than in the previous set.

***Picture Identification/Fade-in Task.***

A Picture Identification/Fade-in task (visual closure task) adapted from the work of Snodgrass and Vanderwart (1980) was employed to assess implicit memory in the visual domain. Fifteen items from the priming phase and 15 unprimed (foil) items were employed. Pictures fragments, based on pixels, were faded in over a 3-second interval. Participants were asked to indicate as soon as they were able to identify the picture by pressing the space bar key and simultaneously naming the picture aloud. Latency to pressing the space bar and whether the item was correctly identified were collected for all target and foil items.

#### *Forced-choice Picture Recognition.*

The fifteen remaining target pictures from the set presented during the priming phase, along with an equal number of matched foils, were presented on the computer screen two at a time (one target picture and one matched foil presented side by side). Participants were asked to indicate, as quickly as possible, which one of the two pictures they had seen during the priming phase, and to provide a response even if uncertain of the correct response. Response latencies were recorded separately for "Hits" (targets correctly identified) and "Misses" (foils incorrectly identified as target items).

### *Comparison Measure: The Victoria Symptom Validity Test*

In order to compare the sensitivity and specificity of the implicit memory tasks described above with an existing measure of dissimulation, participants were also required to complete Slick et al.'s (1994; 1997) modified Hiscock and Hiscock (1989) procedure, the Victoria Symptom Validity Test (VSVT).

### *Main Hypotheses for the Proposed Study*

#### *1. Total Hits.*

A main effect of Group was expected for Total Hits on the Implicit Memory (IM) tasks combined, with participants in both the Brain-Injury and Control groups obtaining higher Total Hit scores than the Malingering group. No difference was expected between the Brain-injury and Control groups with respect to Total Hits.

### *2. Actual Difficulty and Hits.*

Controls and Brain-injury participants were expected to show a modest, but statistically significant, effect of *Actual Difficulty* with subjects making the greatest number of correct identifications for items repeated 4 times (least difficult), and the lowest number of correct responses for items presented only once during the priming phase (most difficult). In other words, repetition (priming) will increase accuracy for both the Identification/Fade-in and Forced-Choice Recognition tasks. The more times an item is repeated during the priming phase, the more likely the participant is to correctly identify the item from fragments as well as in the forced-choice format. Subjects instructed to *malinger* are not expected to show the expected effect of *Actual Difficulty* and are expected to make more errors on average than participants in both the *Control* and *Brain-Injury* groups.

### *3. Perceived Difficulty (Short versus Long Words) and Hits.*

An interaction between Group Membership and *Perceived Difficulty* is expected for the number of Hits. No difference for overall accuracy between the 5- and 8-or-more-letter words sets is expected for either the Control or Brain-injury group, while the *Malingering* group is expected to show greater accuracy for the 5-letter words than for the 8-or-more-letter words for both the Word Identification/Fade-in and Forced-choice Word Recognition tasks.

### ***4. Overall Response Latency.***

Participants in the Brain-injury group are expected to have longer latencies overall than participants in the Control group.

### ***5. Response Latency and Actual Difficulty/ Presentation Level.***

(a) An interaction between Group Membership and *Actual Difficulty*/Presentation Level is expected for the Response Latency measure, with both the Control group and Brain-injury group demonstrating progressively shorter response latencies across the 3 Presentation Levels for Hits. The Malingering group is not expected to show this pattern of performance, as a conscious decision to malinger is expected to result in longer than expected response latencies for Hits in the "easy" conditions (2 and 4 repetitions) for the Malingering group than for either the Control or Brain-injury group.

(b) A main effect of Group Membership is expected for Response Latency for Misses because the conscious decision to make errors is expected to result in longer latencies for the Malingering group than for either the Control or Brain Injury groups.

### *7. Sensitivity and Specificity.*

Correct group classification rates, based on discriminant function analyses, will be higher for discriminant variables derived from the Implicit Memory (IM) tasks than for the variables derived from the Victoria Symptom Validity Test (Slick et al., 1994; 1997).

# METHOD

## Participants

Three groups of individuals participated in the present study: neurologically normal controls (Control group; n=18), neurologically normal individuals instructed to simulate believable brain injury deficits (Malingering group; n=21), and individuals who had sustained a traumatic brain injury (Brain-Injury group; n=15). All participants were paid a nominal fee ($10.00) for their participation.

Neurologically normal participants were community volunteers recruited from a local college (Douglas College, New Westminster, B.C.), which offers both academic and vocational programs, as well as from the general public. All participants were fluent in English. Potential normal participants with a history of loss of consciousness, neurological impairment, and/or psychiatric history were excluded from participation.

Brain-injured participants were solicited from the New Directions Program for head-injured adults (Douglas College, New Westminster, B.C.), a program that provides preparatory skills and educational support for adults with brain injuries who are entering academic or career programs at post-secondary institutions; from the John Simpson Centre, a drop-in centre for adults with brain injuries; as well as from one private psychology practice (the M. Jackson Group) in the

Greater Vancouver area. In order to be included in the Brain-injury group, individuals must have had a history of loss of consciousness, no history of psychiatric disturbance, and no current or anticipated future involvement in litigation. Thirteen of the 15 brain injury participants sustained their injuries in motor vehicle accidents; one was thrown from a horse; and one was beaten.

Severity of head injury is typically estimated by depth of coma, duration of coma, duration of Post-Traumatic Amnesia (PTA; time of first continuous memory after the trauma), or some combination of these variables. Although there is no standard severity classification based on coma duration, one system (reported in Lezak, 1995) suggests coma duration of less than or equal to 20 minutes constitutes a mild injury, longer than 20 minutes but less than or equal to 6 hours is moderate, and greater than 6 hours is severe (p. 755). For the individuals who participated in the present study, self-reported duration of loss of consciousness ranged from 3 minutes to 210 days, with a median of 8 days. According to the classification above, 3 of these individuals suffered mild injuries, 3 suffered moderate injuries, and the remaining 9 sustained severe injuries.

Severity estimates based on duration of PTA are as follows: less than 5 minutes is very mild; 5 to 60 minutes is mild; 1 to 24 hours is moderate, 1 to 7 days is severe; 1 to 4 weeks is very severe; and greater than 4 weeks is extremely severe (Bigler, 1990; cited in Lezak, 1995, p. 173). Only 9 of the 15 Brain Injury Participants were able to provide information about the duration of PTA. For the current sample, durations ranged from 1 hour to 180 days, with a median value of 9.5 days. Based on these severity ratings, 1 of the 9 participants able to provide information sustained a mild injury; 1 sustained a moderate injury; 1 sustained a severe injury; 1 sustained a very severe injury, and the remaining 5 sustained extremely severe injuries.

## Procedure

Neurologically normal individuals were randomly assigned to either the *Control* or *Malingering* group. All participants were tested individually. Prior to test administration, each participant was ensured of his or her anonymity. Prior to testing, the experimenter completed a brief questionnaire requesting demographic data (age, gender, education, and medical information; See Appendix A) by interviewing the participant. Each participant then completed the Shipley Institute of Living Scale (Zachary, 1988), a brief (20-minute) paper-and-pencil measure of general intelligence, and the Revised New Adult Reading Test (NART) (Blair & Spreen, 1989).

The Shipley is a screening instrument used to determine general intellectual level. Correlations between the Shipley Institute of Living Scale total raw score and the Wechsler Adult Intelligence Scale - Revised (WAIS-R) Full Scale IQ score have been reported as moderately high (r=.74 to .85), and correlations between the linear regression derived estimates of WAIS-R IQ based on the Shipley and actual WAIS-R IQ are also reported to be high (r=.85)(Zachary, 1988). Performance on the NART is believed to resist deterioration associated with dementia and neurological impairment. It is therefore used as an estimate of premorbid intellectual functioning. Correlations between Revised NART performance and WAIS-R Verbal IQ, Performance IQ, and Full Scale IQ, were reported to be .83, .40, and .75 for a sample of 66 unimpaired North Americans (Blair & Spreen, 1989). These measures were used, post hoc, to evaluate group equivalence.

Following completion of the measures listed above, participants were given instructions for the remainder of the testing. Instructions were given to participants in an opaque envelope to ensure that the experimenter remained unaware of the participant's group membership. Participants in the *Malingering* group received the following instructions, adapted from Slick et al., 1994:

"**Please do <u>not</u> reveal the following information to the examiner.** Imagine that you were involved in an automobile accident about six months ago. You are currently involved in a court case. Damages will be awarded on the basis of the following tests you are about to complete. Your job is to perform as if you have brain damage. It is important that you do **not** make it obvious that your are faking damage. Your results must be **believable;** do **not** make your efforts obvious to the examiner."

Participants in the *Control* and *Brain-injury* groups were given instructions that stated:

"**Please do <u>not</u> reveal the content of these instructions to the examiner**. On the following tasks you are to try your best. Your results will be used to create norms for these newly developed tests."

### *Experimental Tasks*

All tasks were presented via IBM-compatible computer, using locally developed software.

#### *Priming Phase*

##### *Word Stimuli.*

In the priming phase, words were presented one at a time on a computer screen for 3 seconds each. Participants were asked to indicate whether the word was "pleasant" or "unpleasant" by pressing one of 2 computer keys (the left or right arrow keys). Participants were instructed that "there is no right or wrong answer" and that their "first impression is of interest to the researcher". The purpose of this "rating" task was to ensure that the participant attended to each stimulus. This technique was employed by Warrington (1984) for forced-choice recognition tasks, and a similar procedure was used by Davis et al. (1997b).

Whether or not the participant responded within 3 seconds, the presentation was terminated and the next stimulus was presented. Two separate word lists, one of words containing 5 letters and the other of words containing 8 or more letters, were included, comprising the two levels of *Perceived Difficulty/Word Length.*

Three ***Actual Difficulty*** levels were included. *Actual Difficulty* was operationally defined as the number of times an item was presented during the priming phase (1, 2, or 4 times). For each level of *Perceived Difficulty/Presentation Level,* 10 words (randomly selected by the computer from a total set of 60 words) were included, making a total of 70 presentations at each level and 140 presentations in all. Five-letter words were presented first for each participant. Repeated presentation of target items was done using a modified random presentation procedure in which an individual item could not appear on two consecutive trials.

***Picture Stimuli.***

During the picture priming phase, the same procedure was followed as for the word priming described above. The computer randomly selected a set of 30 pictures from a total set of 60 items. Ten of these pictures were included at each Actual Difficulty level (1, 2, and 4 repetitions) for a total of 70 presentations. The participants were instructed to indicate whether the picture was "pleasant" or "unpleasant" by pressing either the left or right arrow key. Once again, participants were instructed that "there is no right or wrong answer" and that their "first impression is of interest to the researcher". A modified random presentation procedure was employed with the stipulation that a target item could not appear on two consecutive trials.

### ***Word Identification/Fade-in Task***

During the *Word Identification/Fade-in* task, 15 randomly selected primed words from the 5-letter word set and 15 randomly selected primed items from the 8-or-more letter set, as well as an equivalent number of matched foils, were employed. Words, in fragments based on pixels (graphic points on the computer screen), were presented in the center of the screen. The words were faded in at a constant rate, from 0 percent of the word graphic to 100 percent of the word graphic over a 3-second period. The complete word then remained on the screen for an additional 3 seconds, if the participant had not yet responded. Participants were asked to indicate, as soon as they were able to identify the word by pressing the space bar on the keyboard. Once the space bar was depressed, the word graphic disappeared and the participant was then to say the word aloud. The examiner indicated, by pressing either the left or right arrow key, whether the participant's response was correct or incorrect.

All 15 primed 5-letter words and their matched foils were presented first, in random order.

Following completion of the 5-letter items, participants were given the following instructions by the examiner: "You may find the next items more difficult because the words are longer. Once again, respond as quickly as possible by pressing the space bar when you know what the word is". This step was designed to manipulate *Perceived Difficulty/Word Length* was not expected to alter the actual difficulty of the task. The 15 8-or-more-letter words were then presented in random order and the participant was required to respond as for the 5-letter word procedure outline above.

***Forced-choice Word Recognition***

During the *Word Recognition* task, a primed, target word and a matched foil (equated for word length) were presented side by side (either side of the centre of the monitor screen) and separated by approximately 5 centimetres. Target words were the remaining 15 primed items, for each word set, that were not employed in the Word Identification/Fade-in task and foils were the remaining 15 words that had not yet been presented from the original set of 60 words. Participants were asked to indicate, as quickly as possible, which one of the two items they had seen previously by striking one of two computer keys (the left arrow for the item presented to the left of centre or the right arrow for the item presented to the right of centre). Right and left presentation (foil and correct response) were counter-balanced. All 15 5-letter words and their matched foils were presented first, in random order.

Following completion of the 5-letter items, participants were given the following instructions by the examiner: "You may find the next items more difficult because the words are longer. Once again, respond as quickly as possible and always give a response, even when you are not certain". Again, this step was designed to manipulate ***Perceived Difficulty***. The 15 8-or-more-letter words and their matched foils were then presented in random order as per the protocol for the 5-letter items.

### ***Picture Identification/Fade-in Task***

During the *Picture Identification/Fade-in* task, 15 randomly selected primed pictures from the 30-item set were employed, as well as 15 matched foils (unprimed items). Pictures, in fragments based on pixels (graphic points on the computer screen), were presented in the center of the screen. The pictures were faded in at a constant rate, from 0 percent of the picture graphic to 100 percent of the picture graphic over a 3-second period. The complete picture then remained on the screen for an additional 3 seconds, if the participant had not yet responded. Participants were asked to indicate as soon as they were able to identify the picture by pressing the space bar on the keyboard. Once the space bar was depressed, the picture graphic disappeared and the participant was asked to identify the picture by saying its name aloud. The examiner then indicated, by pressing either the left or right arrow key, whether the participant's response was correct or incorrect.

### ***Forced-choice Picture Recognition***

During the *Picture Recognition* task, a primed, target picture and a matched foil were presented side by side (either side of the centre of the monitor screen) and separated by approximately 5 centimetres. Target pictures were the remaining 15 primed items that were not employed in the *Picture Identification/Fade-in* task. Participants were asked to indicate, as quickly as possible, which of the two items they had seen earlier in the study by striking one of two computer keys (the left arrow for the item presented to the left of centre or the right arrow for the item presented to the right of centre). Right and left presentation (foil and correct response) were counter-balanced. Presentation of target items was randomized.

### ***Victoria Symptom Validity Test (VSVT)***

For the purpose of comparison, the Slick et al.'s (1994; 1997) revision of the Hiscock and Hiscock forced-choice procedure, the Victoria Symptom Validity Test (VSVT), was employed via computer as per the published protocol. This is a computer administered, forced-choice number recognition task. Participants are instructed to look at a 5-digit number for 5 seconds and then try to remember the number over a 5, 10, or 15 second delay. Sixteen items are presented at each delay level (8 Hard items, for which the target and foil share common digits, and 8 easy items, for which there are no common digits). Following the delay subjects indicate, as quickly as possible, which of two items (target or foil) they were presented with immediately before the delay. Hits and Misses were recorded, as well as Response Latency.

## *Materials*

### *Word Stimuli*

Words were selected from Toglia and Battig's (1978) word lists. Toglia and Battig's compendium is derived from college-students ratings of a large number and variety of individual words for seven basic semantic characteristics (dimensions): [concreteness (CON); imagery (IMG); categorizability (CAT); meaningfulness (MNG); familiarity (FAM); number of attributes (NOA); and pleasantness (PLS)] on 7-point scales for which 1 was the lowest score and 7 was the highest score. Words were clustered using a BC TRY cluster analysis (Tyron & Bailey, 1970, cited in Toglia and Battig, 1978). Eight word clusters resulted. For the purpose of the present study, words were selected from Clusters 6, 7, and 8. Cluster 6 is described as words that are somewhat above average in all dimensions, ranking third from the top on each of the seven dimensions. Cluster 7 is described as words that are second from the top in CON, IMG, and CAT, but are relatively low in PLS and slightly below average in NOA. Words in cluster 7 are average or slightly above in MNG and FAM and can also be viewed as slightly lower on all dimensions than words in Cluster 8. Cluster 8 is described as words that tend to have the highest ratings on all of the seven dimensions, except PLS.

In creating the word list for the present study, only those words with unique stems (unique first three letter strings) formed the initial pool. This resulted in a subset of 258 and 160 items for the five-letter and 8 or more letter word sets, respectively. Next, words with ratings furthest from the reported means for IMG, MNG, and FAM were eliminated from the item pool for each word set until a subset of 60 items remained for both the 5-letter word set.

Imagery (IMG) (the capacity to arouse mental images), MNG (capacity to arouse other words as associates), and FAM (how commonly or frequently the word has been experienced) dimensions were selected for comparison because these characteristics appear, at least on the surface, to be related to the likelihood a word would be recalled or remembered. Complete word lists with IMG, MNG, and FAM ratings are presented in Appendix B.

### *Picture Stimuli*

Picture stimuli were selected from the work of Snodgrass and Vanderwart (1980). Only those items with very high agreement (98 percent or above) for *Picture Name* were included in the initial subset. This resulted in a subset of 55 items that could be retrieved from computer graphic files. Five additional items with high Picture Name agreement were selected to complete the set. These items had a mean picture name agreement of 95 percent. See Appendix C for an example of these pictures. See Appendix D for a complete list of the pictures employed with their imagery (IMG), familiarity (FAM), and complexity (COM) ratings.

### *Design*

Half of the participants within each group received the picture priming first and the other half received the word priming tasks first. These priming phases were presented in succession. Participants who received the picture priming phase first received the Picture Identification/Fade-in task followed by the Word Identification/Fade-in task and then the Forced-choice Picture Recognition task followed by the Forced-choice Word Recognition task. Participants who received the picture priming phase first received Word Identification/Fade-in prior to Picture Identification/Fade-in followed by Forced-choice Word Recognition prior to Forced-choice Picture Recognition.

Following completion of the Implicit Memory (IM) tasks, participants completed the VSVT as per protocol. No additional instructions were given.

Following completion of all the experimental tasks, participants completed a post-experimental questionnaire, adapted from Bernard (1990), to evaluate participants' understanding of task instructions and perception of success in following these instructions, i.e., to evaluate the adequacy of manipulation.

Bernard (1990) asked participants to respond to both open-ended and 5-point Likert response items assessing: 1) the subject's understanding of the instructions; 2) how hard the subject tried to follow the instructions; 3) the subject's perception of how successful he or she was in following the instructions; 4) how successful the subject felt he or she was in producing believable deficits; and 5) the subject's beliefs about the true purpose of the study. Bernard (1990) also had each subject paraphrase the instructions he or she had been given. A similar questionnaire was employed in the present study (see Appendix E).

Finally, all participants were debriefed prior to being released and instructed not to discuss their participation with other potential participants.

# RESULTS

## Demographic and Background Variables

The means and standard deviations for age (AGE), education (EDUC), and estimated intelligence scores (Revised New Adult Reading Test Verbal Intelligence Quotient Estimate, NARTVIQ; Revised New Adult Reading Test Performance Intelligence Quotient Estimate, NARTPIQ; Revised New Adult Reading Test Full Scale Intelligence Quotient Estimate, NARTFSIQ; and the Shipley Institute of Living Scale Full Scale Intelligence Quotient Estimate, SHIPFSIQ) by Group [Brain Injury (BI), Control (C), and Malingering (M)] are provided in Table 1.

Separate one-way ANOVAs with groups as the between-subjects variable were performed for each of these variables. Tests of Homogeneity of Variances, Levene Statistic, ranged from .147 to .425. Significance levels on 2 and 51 degrees of freedom ranged from .639 to .863 (See Appendix F, Table 10), indicating no main effect of group. Hence, for the purposes of further analyses, the groups are considered equivalent with respect to these variables.

*Table 1.*
*Means and Standard Deviations for Background Variables by Group.*

| GROUP | AGE | EDUC. | NARTVIQ | NARTPIQ | NARTFSIQ | SHIPFSIQ |
|---|---|---|---|---|---|---|
| BI (n=15) | | | | | | |
| Mean | 37.5 | 12.0 | 101.5 | 106.5 | 104.0 | 98.9 |
| S.D. | 7.6 | 1.8 | 11.5 | 5.5 | 10.0 | 10.3 |
| C (n=18) | | | | | | |
| Mean | 35.9 | 13.1 | 104.4 | 107.9 | 106.6 | 104.7 |
| S.D. | 9.5 | 1.6 | 10.4 | 4.8 | 9.0 | 7.6 |
| M (n=21) | | | | | | |
| Mean | 31.4 | 12.7 | 99.9 | 105.8 | 102.6 | 99.9 |
| S.D. | 8.3 | 2.2 | 11.4 | 5.3 | 9.9 | 10.2 |
| Total (N=54) | | | | | | |
| Mean | 34.6 | 12.7 | 101.8 | 106.7 | 104.3 | 101.2 |
| S.D. | 8.8 | 1.9 | 11.1 | 5.2 | 9.6 | 9.6 |

## ***Characteristics of the Brain Injury Sample***

Summary statistics for Age, Education, and obtained Intelligence estimates are reported in Table 1, above. In addition, participants in the brain injury group provided information about their time since injury, duration of loss of consciousness, and first memory after regaining consciousness (reported in the Participants section, above). Many participants were unable to provide more than rough estimates of these values and no corroborating medical information was obtained because contact with these individuals was made through non-medical agencies. Time since injury ranged from 18 months to 21 years, with a median of 7 years.

Brain Injury Participants were also asked to indicate any cognitive or physical difficulties they were experiencing at the time of their participation. The most common self-reported difficulty was poor memory; thirteen of 15 participants reported memory difficulties. (See Table 11, Appendix F for a summary of self-reported difficulties).

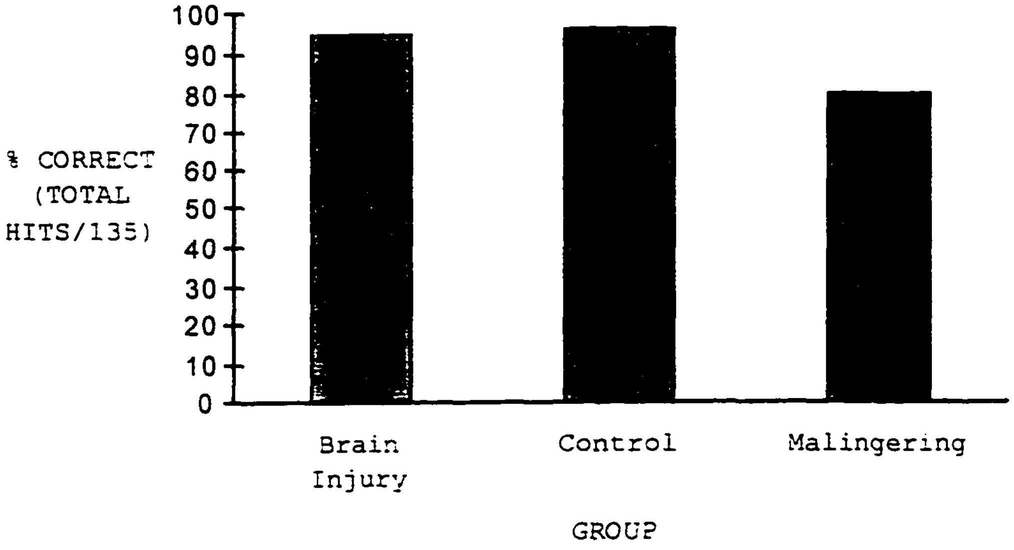
## Main Hypotheses

### *Hypothesis 1: Total Hits*

Participants in the Control (C) and Brain-Injury (BI) groups were expected to respond correctly more frequently (higher overall Hit rate) on all Implicit Memory (IM) tasks combined than participants in the Malingering (M) group. To evaluate this, total number of Hits (correct responses) for all IM tasks combined (Word Identification/Fade-in, Forced-Choice Word Recognition, Picture Identification/Fade-in, and Forced-Choice Picture Recognition) were tallied. Of a possible score of 135, the mean hits for the Brain Injury group was 127.87, s.d. 6.56; the mean Hits for the Control group was 129.72, s.d. 3.14; and the mean Hits for the Malingering group was 107.10, s.d. 17.20. A Multivariate Analysis of Variance (MANOVA) with Group Membership (3 levels) as the between-subjects variable and Presentation Level (3 levels; 1, 2, and 4 presentations) and Stimulus Type (2 levels; Words, Pictures) as the within-subjects variable revealed a statistically significant difference between the groups [$F(2, 51)=22.564$, $p<.001$] with respect to total number of Hits (See Figure 1).

Paired contrasts, not assuming equal variances, revealed no significant difference between the Brain Injury and Controls groups [$t(19.3)=-1.004$, $p=.328$], while both the Brain Injury and Control groups made a significantly greater number of Hits, on average, than participants in the Malingering group [Brain Injury vs. Malingering, $t(27.4)=5.04$, $\underline{p}<.001$; Control vs. Malingering, $t(21.55)=5.914$, $\underline{p}<.001$; Tukey HSD].

*Figure 1.*
*Total Number of Hits by Group for All Implicit Memory (IM) Tasks Combined.*



## ***Hypothesis 2: Actual Difficulty/Presentation Level and Hits***

It was hypothesized that participants in the Control and Brain Injury groups, and not participants in the Malingering group, would show a modest but statistically significant, effect of *Actual Difficulty/Presentation Level.* In other words participants in the Control and Brain Injury groups would have the greatest number of Hits for items repeated 4 times during the priming phase (least difficult) and the lowest number of correct responses for items presented only once during the priming phase (most difficult).

To determine if repetition of items during the priming phases increased the likelihood that the item would be correctly selected, i.e., increased the likelihood of a Hit, Hits were subjected to a Multivariate Analysis of Variance with Group Membership (3 levels) as the between-subjects variable and Presentation level (3 levels) and Stimulus Type (2 levels) as the within subjects variables. Results of the analysis reveal no main effect of Presentation level [$F(2,50)=1.442.p=.246$], but a significant Presentation Level by Group Membership interaction [$F(4,102)=3.254$, $p=.015$] was obtained (See Figure 2). The homogeneity of covariance across repeated measure requirement was met (Huyndt-Feldt Epsilon $\geq .90$).

Examination of the Group Membership by Presentation Level interaction revealed that participants in both the Brain Injury and Control groups showed a very slight improvement in Hit rates across presentation levels with Presentation 4>2>1. Participants in the Malingering group did not show the same pattern. In fact, their best performance was for Presentation Level 1.

Paired contrasts at each Presentation Level, not assuming equal variances, revealed no reliable difference between group means for participants in the Brain Injury and Control groups at any presentation level, significant differences between the Control group and the Malingering group at each presentation level, as well as significant differences between the Brain Injury and Malingering groups at each Presentation Level (See Table 2).

*Figure 2.*

*Percent Hits by Group by Presentation Level for All Implicit Memory (IM) Tasks Combined.*

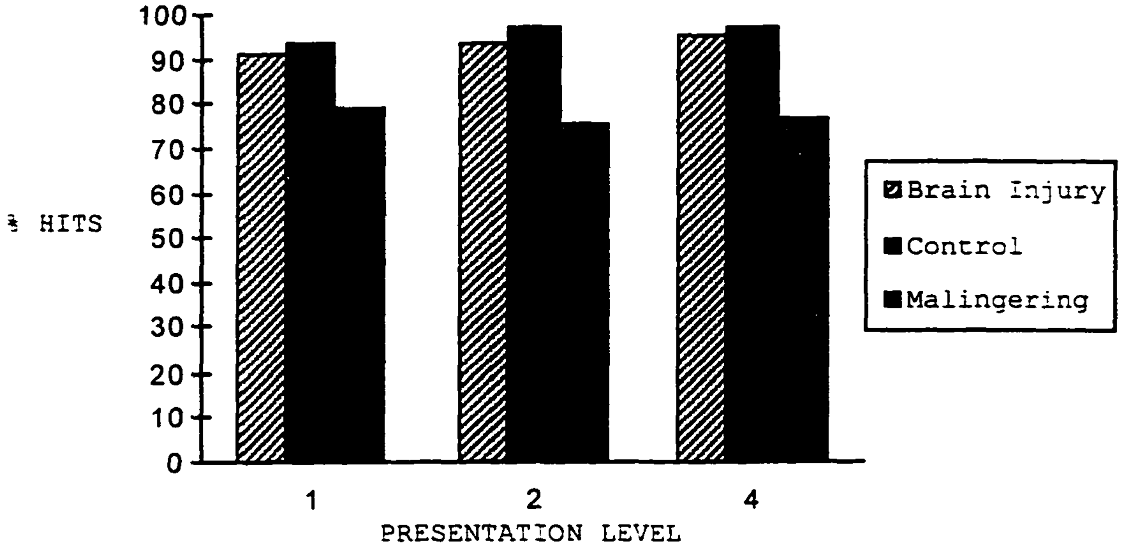


*Table 2.*

*Paired Contrasts for Hits at Each of 3 Presentation Levels for All IM Tasks Combined.*

| Presentation Level | Groups | *t* | *df* | Significance (2-tailed) |
|---|---|---|---|---|
| 1 | BI v. C | 1.14 | 27.4 | .264 |
| | BI v. M | 3.7 | 33.5 | .001* |
| | C v. M | 4.9 | 31.0 | <.001* |
| 2 | BI v. C | 1.6 | 19.6 | .126 |
| | BI v. M | 4.5 | 31.3 | <.001* |
| | C v. M | 6.1 | 22.9 | <.001* |
| 4 | BI v. C | 1.3 | 22.4 | .191 |
| | BI v. M | 4.8 | 26.4 | <.001* |
| | C v. M | 5.7 | 22.2 | <.001* |

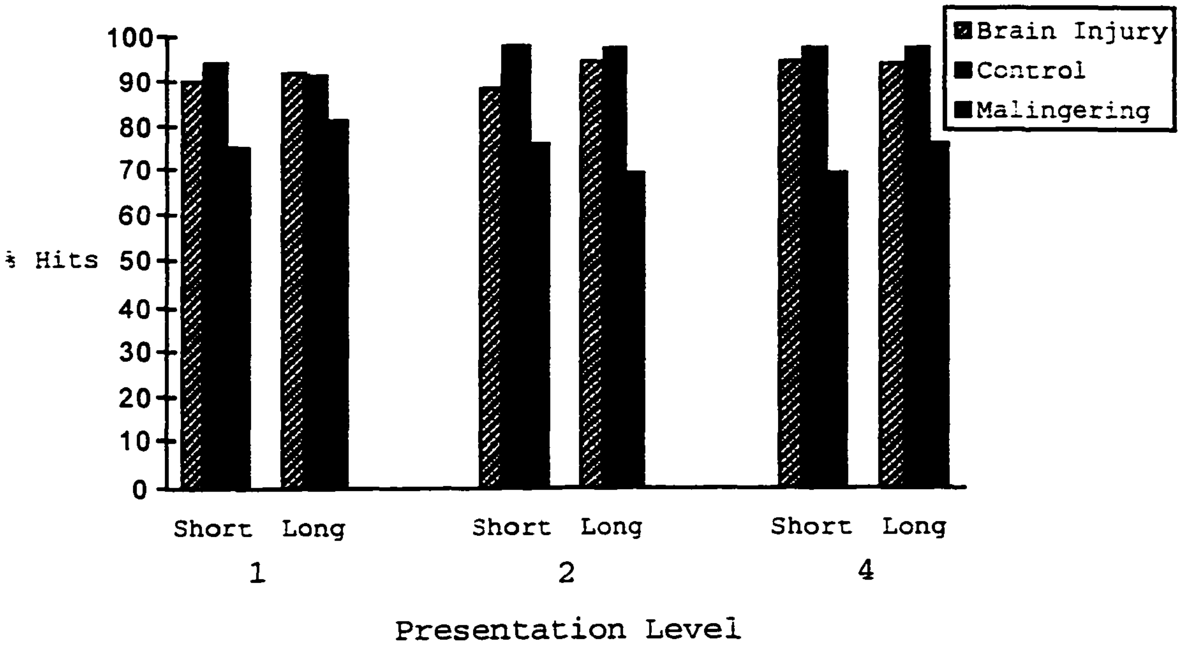
(* significantly different group means, Tukey HSD)

### *Hypothesis 3: Perceived Difficulty/Word Length and Hits*

A Group Membership by Perceived Difficulty interaction (Short vs. Long words) was expected for the two Implicit Memory (IM) word tasks combined, (Forced-choice Word Recognition and Word Identification/Fade-in), with participants in the Control and Brain Injury groups demonstrating no difference in overall Hit rates as a function of Perceived Difficulty/Word Length and participants in the Malingering group showing greater accuracy for the 5-letter words than for the 8-or-more letter words.

A mixed model MANOVA with three within subject factors, Task (2 levels; Forced-choice, Identification/Fade-in), Word Length (2 levels; Short and Long) and Presentation Level (3 levels; 1, 2, and 4 presentations), and one between subjects factor, Group Membership (3 levels), was conducted. The results are depicted in Figure 3. Results indicated no main effect of Word Length [$F(1,51)=.845, p=.362$] or Word Length by Group Membership interaction [$F(2,51)=1.151, p=.324$]. All other 2-, 3-, and 4-way interactions involving Perceived Difficulty/Word Length also failed to reach statistical significance, although the Presentation Level by Word Length by Group Interaction approached, but failed to reach statistical significance [$F(4,102)=2.653, p=.037$, Bonferroni correction factor, $p<.008$ for statistical significance].

*Figure 3.*
*Total Number of Hits by Group for Short Words and Long Words by Presentation Level, All IM Tasks Combined.*

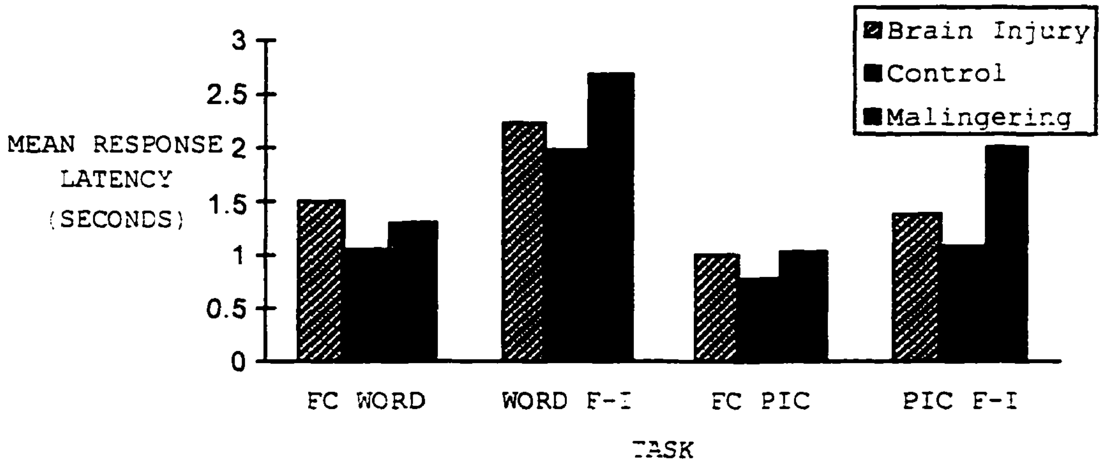


Because there was no significant main effect for Word Length for the Forced-Choice Word Recognition Task and the Word Fade-in task combined, short and long items were combined in subsequent analyses.

### ***Hypothesis 4: Overall Response Latency***

Participants in the both the Brain Injury and Malingering groups were expected to have longer Response Latencies overall than participants in the Control group. No specific expectation was put forward with respect to a difference between the Brain Injury and Malingering groups. The mean Response Latency for each Task by Group Membership, Hits only, is depicted in Figure 4. A Multivariate Analysis of Variance with Task (4 levels) and Presentation Level (3 levels) as the within-subject factors and Group Membership as the between-subjects factor was conducted. Hits/Misses could not be employed as a within-subjects variable as many subjects would have had no misses (missing data) at several presentation levels. Results revealed a statistically significant main effect of Group Membership [*F*(2,51)=18.48,*p*=.002], with participants in the Control group responding most quickly (mean 1.164s, s.d.= .677), participants in the Malingering group responding most slowly (mean 1.728s, s.d.=.677) and participants in the Brain Injury group intermediate (mean 1.462s, s.d.=.679).

*Figure 4.*
*Mean Response Latency for Each Task by Group (Hits Only).*



### ***Hypothesis 5: Response Latency and Actual Difficulty/Presentation Level***

An interaction between Group Membership and Actual Difficulty Level/Presentation Level was expected. As reported above, a mixed model Multivariate Analysis of Variance with Task (4 levels) and Presentation Level (3 levels) and as within-subjects factors and Group Membership (3 levels) as the between-subjects factor was conducted. A main effect of Presentation Level was observed [$F(2,50)=12.04, p<.001$], indicating that all participants, regardless of Group Membership responded most quickly to items presented 4 times (mean 1.40s, s.d.=.600). least quickly to items presented only once (mean 1.51s, s.d.=.587). The response latency for items presented twice was intermediate (mean 1.45s, s.d.=.587). The Presentation Level by Group Membership interaction was not statistically significant [$F(4,102)=1.137, p=.343$), nor was the Task by Presentation Level by Group Interaction [$F(12,94)=.606, p=.832$).

The Huynh-Feldt criterion for homogeneity of covariance across repeated measures requirement was met (Huynh-Feldt Epsilon>.85).

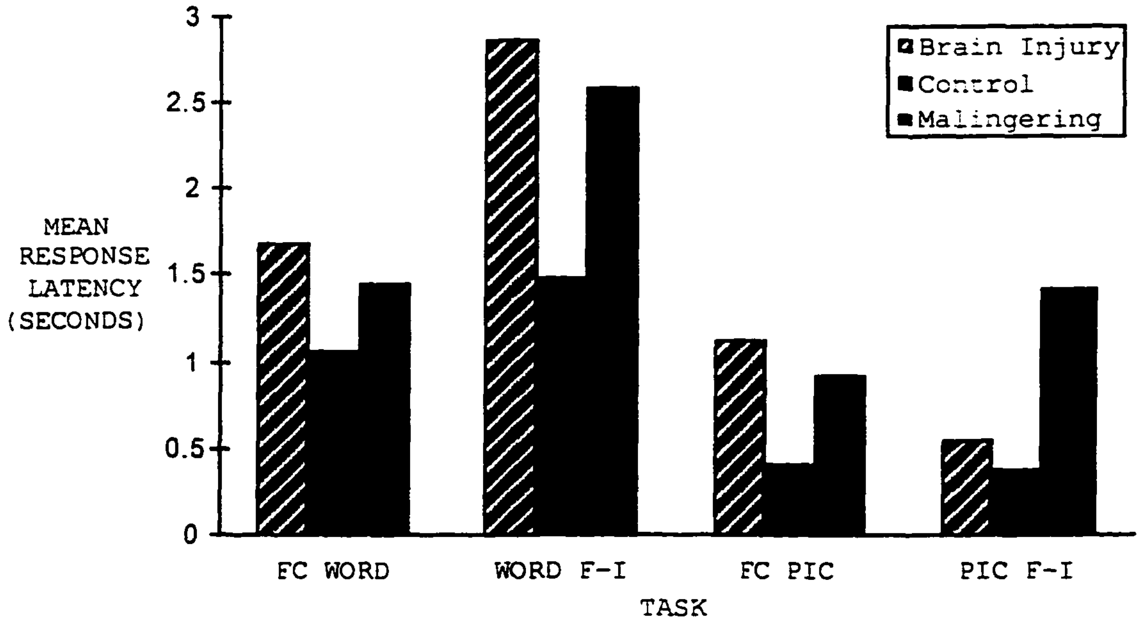
### *Hypothesis 6: Mean Response Latency for Misses on the Implicit Memory Tasks*

Mean Response Latency for each task b Group Membership, for Misses (incorrect responses) only, is depicted in Figure 5. A Multivariate Analysis of Variance with Task (4 levels; Forced-Choice Word Recognition, Word Fade-in, Forced-choice Picture Recognition, and Picture Fade-in) as the within-subject factor and Group Membership as the between-subjects factor revealed a statistically significant main effect of Task [F(3,49)=12.427, *p*<.001; Task 6<5<2<3], no Task by Group Membership interaction [F(6,100)=1.530, *p*=.176], and a significant main effect of Group membership [F(2,51)=9.855, *p*<.001; Control<Brain Injury<Malingering]. Presentation Level was not included as a within-subjects variable as many participants had no incorrect responses (missing data) at several presentation levels.

The homogeneity of the covariance matrix across repeated measures requirement was not met (Huyndt-Feldt Epsilon=.664) and Pillai's trace was employed.

*Figure 5.*

*Mean Response Latency for Each IM Task by Group Membership (Misses Only).*



### *Hypothesis 7: Sensitivity and Specificity*

A sensitive test is one with a low false negative error rate. In other words, a test sensitive to malingering would be able to identify malingerers. Specificity refers to a low false positive error rate or true negative rate i.e., the ability to discriminate between malingerers and non-malingerers (controls and individuals with genuine brain injury combined) and not to incorrectly identify individuals as malingerers. To investigate the relative sensitivity of the Implicit Memory tasks and the Victoria Symptom Validity Test (Slick et al., 1994; 1997), a number of discriminant function analyses were conducted.

#### *Implicit Memory Tasks*

A discriminant function analysis was conducted on Total Hits for the Implicit Memory (IM) tasks. Classification results are presented in Table 3. For the purposes of the overall classification rates, Brain Injury Participants classified as Controls are considered to be correctly classified, i.e., they are not misidentified as Malingerers and the a priori expectation was that there would be no differences between participants in the Control and Brain Injury groups with respect to Total Hits.

Seventy-one percent (15/21) of the Malingerers were correctly classified, while 28.6 percent (6/21) were classified as Controls. None of the Malingerers were incorrectly classified as Brain Injury participants. Eighty-seven percent (13/15) of the Brain Injury participants were classified as Controls, while 13.3 percent (2/15) were incorrectly classified as Malingerers using this variable. All of the Controls were correctly classified (18/18). Total correct classification was 46/54 (85.2 percent).

*Table 3.*

*Participant Group Membership (Rows) by Discriminant Classification (Columns) for Total Hits Implicit Memory Tasks Combined.*

| Actual Group Membership | N | Predicted Group Membership | |
|---|---|---|---|
| | | Control | Malingerer |
| Brain Injury | 15 | 13(87) | 2(13) |
| Control | 18 | 18(100) | 0(0) |
| Malingerer | 21 | 6(29) | 15(71) |

Note. Percentage by row in parentheses.

### ***Victoria Symptom Validity Test***

A discriminant function analysis was conducted using Total Hits on Hard items (5, 10, and 15 second delays combined) for the VSVT. Results are presented in Table 4. Once again, Brain Injury Participants classified as Controls were considered to be correctly classified. As indicated in Table 3, 71.4 percent of Malingering group (15/21) were correctly classified and 28.6 percent (6/21) were classified as Controls. For the Brain Injury Group, 86.7 percent were classified as controls (13/15) and 13.3 percent (2/15) were classified as Malingering. Within the Control group, all participants were correctly classified. Total correct classification was 46/54 (85.2 percent), a performance identical to the performance for Total Hits on the IM tasks.

*Table 4.*

*Participant Group Membership (Rows) by Discriminant Function Classification (Columns) for Hits on VSVT Hard Items.*

| Actual Group Membership | N | Predicted Group Membership | |
|---|---|---|---|
| | | Control | Malingerer |
| Brain Injury | 15 | 13(87) | 2(13) |
| Control | 18 | 18(100) | 0(0) |
| Malingerer | 21 | 6(29) | 15(71) |

*Note.* Percentage by row in parentheses.

## Additional Analyses

### *Sensitivity of Implicit Memory and Victoria Symptom Validity Test Combined*

A discriminant function analysis on the Total Hits for the IM tasks and Total Hits (Hard items only) of the VSVT was conducted to investigate combined sensitivity and specificity. Participants in the Brain Injury group classified as Controls were considered to be correctly classified and vice versa. Results are presented in Table 5. Total correct classification rate was 48/54 (88.9 percent). One more Brain Injury and one more Malingering participant were correctly classified than when employing either task alone.

*Table 5.*

*Participant Group Membership (Rows) by Discriminant Function Classification (Columns) for Hits on VSVT Hard Items and Total Hits on the Implicit Memory Tasks Combined.*

| Actual Group Membership | N | Predicted Group Membership | |
|---|---|---|---|
| | | Control | Malingerer |
| Brain Injury | 15 | 14(93) | 1(7) |
| Control | 18 | 18(100) | 0(0) |
| Malingerer | 21 | 5(24) | 16(76) |

*Note.* Percentage by row in parentheses.

### ***Sensitivity of the VSVT Hard Items at 15-second Delay***

Although examination of scores revealed that hits on Hard items at the 15 second delay was not as sensitive to between group differences as hits on Hard items at the 10 second delay, an analysis was conducted on the 15 second delay because previous research (Slick et al., 1994) found this variable to be the best discriminator between Controls and individuals instructed to malinger. Eighty percent (12/15) of the BI participants were classified as Controls while 20 percent (3/15) were classified as Malingerers. For the Malingerer group, 71.4 percent (15/21) were correctly classified and 28.6 percent (6/21) were classified as Controls. Of the Controls, 16.7 percent (3/18) were incorrectly classified as Malingering and the remaining 83.5 percent (15/18) were correctly classified.

## *Performance of Forced-choice versus Identification/Fade-in Tasks*

Forced-choice tasks fall within the explicit memory domain. However, for the IM tasks, there was also an implicit memory component to these tasks (i.e., prior exposure to target items may have resulted in correct guessing and/or shorter response latencies). Nonetheless, given the explicit memory component, both individuals with genuine memory impairment and individuals instructed to malinger might be expected to perform more poorly on the forced-choice tasks than on identification/fade-in tasks.

Scores on the Identification/Fade-in tasks (Word and Picture tasks combined) and Forced-choice tasks (Word and Picture tasks combined) were compared. A significant main effect of Task was observed [$F(1,51)=40.5$, $p<.001$] with participants, independent of Group Membership, obtaining higher performance on Fade-in than on Forced-choice tasks. There was also a significant Group Membership by Task interaction [$F(2,51)=9.22$, $p<.001$] with participants in the Malingering group showing a large discrepancy between performance on the two groups of tasks (mean 13.27 correct versus 9.77 correct, respectively) and Brain Injury and Control participants showing only slight differences between performances on the two groups of tasks.

Exact binomial probabilities for the Forced-choice recognition tasks indicated that 4 correct out of 15 has a probability of $p=.04$. Therefore, a score of 4 or less is considered significantly worse than chance. None of the participants scored in this range.

### ***Victoria Symptom Validity Test: Response Latencies***

In order to evaluate the utility of VSVT response times as a measure of simulated malingering, mean Response Latencies were subjected to a Multivariate Analysis of Variance. Mean Response latencies were recorded for Easy and Hard test items separately. Individual response latencies were not available for separate analysis due to limitations of the print-out of this commercially available program. One participant in the Brain Injury group was excluded from this analysis because he took a break during the assessment session and response latency for an individual response could not be excluded from analyses due to limitations of the printout of this program. Sample size for the BI group for this and the following analysis was therefore n=14.

Table 6 includes the mean Response Latency, by Group, for the Easy and Hard items, separately. A one between factor, one within factor MANOVA with Item Difficulty (Easy, Hard) as the within-subjects factor and Group Membership (Control, Brain Injury, Malingering) as the between-subjects factor revealed a main effect of Item Difficulty [$F(1,50)=168.7$, $p<.001$] and a main effect of Group [$F(2,50)=8.183$, $p=.001$). The Item Difficulty by Group Membership interaction was not statistically significant [$F(2,50)=1.903$, $p=.160$).

As indicated in Table 6, all participants, independent of Group Membership, tended to respond more slowly to difficult items than to easy items, leading to a significant main effect of Item Difficulty. In addition, participants in the Malingering group responded more slowly than participants in either the Brain Injury or Control groups when the data were collapsed across Item Difficulty (main effect of Group Membership). The Control group demonstrated the shortest overall latency (*M*=1.545, s.d.=.459), while the Brain Injury group's mean latency score (*M*=2.122, s.d. .540) fell between the Malingering (*M*=2.499, s.d.=1.030) and Control groups' means.

*Table 6.*
*VSVT Response Latencies for Easy and Hard Separately and Combined Items by Group.*

| Item | Group | Mean | Standard Deviation |
|---|---|---|---|
| Easy | Brain Injury | 1.687 | .429 |
| | Control | 1.228 | .335 |
| | Malingerer | 2.055 | .871 |
| Hard | Brain Injury | 2.557 | .651 |
| | Control | 1.861 | .583 |
| | Malingerer | 2.943 | 1.189 |
| Easy & Hard Combined | Brain Injury | 2.122 | .540 |
| | Control | 1.545 | .459 |
| | Malingerer | 2.499 | 1.030 |

### *Victoria Symptom Validity Test: Variability of Response Latency*

To investigate the utility of variability in response Latencies as a potential indicator of malingering, the mean variance of Response Latencies were subjected to a MANOVA. As indicated above, one participant in the Brain Injury group was excluded from analysis because he took a break during the assessment session and individual response latencies for a participant's individual responses could not be excluded from analyses due to limitations of the printout of this program. Sample size for the Brain Injury group was therefore n=14.

Table 7 includes the Mean Variance of the Response Latencies, by Group, for the Easy and Hard items separately. A one between factor, one within factor MANOVA with Item Difficulty as the within-subjects factor and Group Membership as the between-subjects factor revealed a main effect of Item Difficulty [$F(1,50)=21.461$, $p<.001$), and a main effect of Group Membership [$F(2,50)=4.263$, $p=.020$]. The Item Difficulty by Group membership interaction was not statistically significant [$F(2,50)=1.023$, $p=.367$].

*Table 7.*

*Means and Standard Deviations for Variance of VSVT Response Latencies for Easy and Hard Items Separately by Group.*

| Item | Group | Mean | Standard Deviation |
|---|---|---|---|
| Easy | Brain Injury | .558 | .485 |
| | Control | .209 | .302 |
| | Malingerer | .884 | .753 |
| Hard | Brain Injury | .956 | .434 |
| | Control | .508 | .304 |
| | Malingerer | 1.893 | 1.080 |

As indicated in Table 7, all participants, independent of Group Membership, tended to respond more variably with respect to Response Latency to Difficult items ($M$=1.119) than to Easy items (*M*=0.550), leading the significant main effect of Item Difficulty for the Variance of Response Latency. In addition, participants in the Malingering group responded more variably than participants in either the Brain Injury or Control groups, when the data were collapsed across Item Difficulty. The Control group demonstrated the least variability overall (*M*=.359), while the Brain Injury group's mean score (*M*=.757) fell between the Malingering (*M*=1.389) and Control groups' (*M*=.359), suggesting that that this variable may have some utility in discriminating between groups. However, F-test pairwise comparisons revealed no statistically significant differences between groups, likely due to large within group variability, particularly for the Brain Injury and Malingering groups. However, the Brain Injury versus Control group comparison approached statistical significance [$F(1,31)=4.779, p=.037$].

### ***Implicit Memory Tasks: Variability of Response Latency***

The mean variance of Response Latencies, Hits only, were subjected to analysis of variance. The main effect of group failed to reach statistical significance [$F(2,53)=1.856$, $p=.167$]. As a result, F-test pairwise comparisons were not conducted.

## ***Effort and Success***

Following completion of all tasks, participants were asked to rate their Effort in terms of following the instructions, on a 5-point scale from Tried not at all (1) to Tried Very Hard (5). They also rated their perceived success in following the instructions provided on a similar 5-point Likert scale from (1) Completely unsuccessful to (5) Very Successful.

A comparison across Effort and Success ratings was conducted for participants correctly classified and participants incorrectly classified, based on the Total Hits for the Implicit Memory (IM) tasks combined. For the purposes of this comparison, Brain Injury participants classified as Controls were considered to be correctly classified. No Controls were incorrectly classified, so only the Brain Injury participants and Malingering group participants were examined.

Table 8 presents the number of participants in each of the Effort and Success categories for participants correctly classified and participants incorrectly classified. For the Malingerer group, 13 of 15 correctly classified participants (86.7 percent) rated themselves as trying Hard or Very Hard (4 or 5), while only 50 percent (3 of 6) of the incorrectly classified participants rated themselves as 4 on the Effort scale. None of these participants gave him- or herself a 5 rating. A similar pattern was seen for the Success variable. Ten of 15 (66.7 percent) of the correctly classified Malingerers rated themselves as Successful or Very Successful in following the instructions, while only 2/6 (33.3 percent) of the incorrectly classified Malingerers gave themselves a rating of 4 (Successful). None rated him- or herself as Very Successful (5).

Some of the frequencies for the Brain Injury group were very small. Nonetheless, 8 of 13 (61.5 percent) of the correctly classified participants rated themselves as Trying Hard (4) or Trying Very Hard (5). On the Success Variable 11 of 13 (84.6 percent) of the correctly classified participants rated themselves as Successful (4) or Very Successful (5). Of the 2 Brain Injury participants incorrectly classified as Malingerers, neither rated him or herself as Trying Hard (4) or Trying Very Hard (5), while one rated himself as Successful (5) and the other rated himself as Very Successful (5).

Chi-square analyses for cell frequencies were not conducted for either the Effort or the Success variables because even when data were collapsed across cells (i.e., combining responses 1, 2, and 3 to indicate Low Effort and Low Success and combining 4 and 5 to indicate High Effort and High Success) half of the expected cell frequencies for both analyses fell below 5.

*Table 8.*
*Frequencies for Effort and Success Ratings for Malingering and Brain Injured Participants Correctly and Incorrectly Classified.*

| | Malingering | | Brain Injury | |
|---|---|---|---|---|
| Self Ratings | Correct | Incorrect | Correct | Incorrect |
| Effort | | | | |
| 1 | 1 | 0 | 1 | 0 |
| 2 | 0 | 2 | 1 | 1 |
| 3 | 1 | 1 | 3 | 1 |
| 4 | 9 | 3 | 6 | 0 |
| 5 | 4 | 0 | 2 | 0 |
| Success | | | | |
| 1 | 0 | 0 | 1 | 0 |
| 2 | 0 | 2 | 0 | 0 |
| 3 | 5 | 2 | 1 | 0 |
| 4 | 8 | 2 | 9 | 1 |
| 5 | 2 | 0 | 2 | 1 |

### *Cutoff Scores for the Implicit Memory Tasks*

To evaluate the usefulness of simple cut-off scores, criteria were set at one and two standard deviations below the mean of the Controls' performance for Total Hits on the Implicit Memory (IM) Tasks Combined, i.e., at 126.6 (liberal) and 123.4 (conservative) out of a possible 135. Three of the Brain Injury Participants scored below the more liberal cut off and 2 scored below the more conservative cut-off score.

Hence, with respect to the Brain Injury group 20 percent and 13 percent of participants, respectively would be misclassified as Malingering according to the cut-off. For the more conservative cut-off, 4 of the 21 Malingering participants would be incorrectly identified as controls, while for the more liberal cut-off score, 6 (29 percent) of the Malingerers would be classified as Controls. Finally, 1 control would be misclassified for the conservative cut-off and 2 controls for the liberal cut-off. Total correct classification rates would be 45/54 (83.3 percent) for both the liberal and conservative cut-off, although false positive and false negative error rates would differ for the two cut-off scores.

For the VSVT hits on Hard items combined a similar procedure resulted in cut-off scores of 20 and 18.2 (out of 24; Hard items only). Using the liberal cut-off, 4 of 15 (26.7 percent) of the Brain Injured Participants would be incorrectly classified. For the conservative estimate, only 2 of the 15 (13.3 percent) of the Brain Injury Participants would be misclassified as Malingerers. The liberal estimate would also result in the misclassification of 3 of 18 (16.7 percent) Controls as Malingering. The conservative cut-off would have resulted in no misclassification of Controls. Finally, the liberal estimate would result in misclassification of 6 of 21 (29 percent) of Malingerers as Controls, while the more conservation cut-off would result in incorrect classification of 7 of 21 (33.3 percent) of

Malingerers. Hence the total correct classification rate would be 41/54 (75.9) for the liberal cut-off and 45-54 (83 percent) for the conservative cut-off score.

The cut-off score procedure proposed by Slick et al. (1996) could not be applied to the IM tasks because exact probabilities could not be calculated for the word and picture fade-in tasks, as they are not alternate forced-choice tasks. However, a cumulative frequency table, Table 9, is provided for Total Hits IM tasks combined and Hard Items only by Group to allow other researchers to determine their own cut-off scores and related sensitivity and specificity values.

*Table 9.*

*Cumulative Percent for Total Hits (maximum 135) IM Tasks Combined and Hits for VSVT Hard Items (maximum 24) by Group.*

| | Group | | |
|---|---|---|---|
| Percentile Rank | Control | Malingering | Brain Injury |
| Total Hits IM Tasks | | | |
| 99 | 134 | 132 | 134 |
| 95 | 134 | 131 | 134 |
| 90 | 133 | 128 | 133 |
| 75 | 132 | 124 | 132 |
| 50 | 130 | 106 | 130 |
| 25 | 128 | 91 | 127 |
| 10 | 125 | 89 | 118 |
| 5 | 121 | 87 | 109 |
| 1 | 121 | 69 | 109 |
| Hits VSVT Hard Items | | | |
| 99 | 24 | 24 | 24 |
| 95 | 24 | 24 | 24 |
| 90 | 24 | 22 | 24 |
| 75 | 24 | 20 | 23 |
| 50 | 22 | 17 | 22 |
| 25 | 21 | 9 | 19 |
| 10 | 19 | 7 | 17 |
| 5 | 19 | 6 | 17 |
| 1 | 19 | 4 | 17 |

Finally, with respect to cut-off scores based on binomial probabilities for VSVT Hard Items (Slick et al., 1997, p. 29) for the present research only 4 of the 21 individuals in the malingering group produced scores in the invalid range (7 or less), 4 produced scores in the questionable range (8 to 15), and 13 produced scores in the valid range (16 to 24), resulting in only 38 percent sensitivity, a much higher false negative error rate than reported by Slick et al. (1996). The poor sensitivity for the present data using the 3-category classification system suggests that the present sample and the sample employed by Slick et al. (1996) may not be directly comparable and that simple cut-off scores based on binomial probabilities may be inadequate for detecting the majority of malingerers.

### *Item Analysis for the Implicit Memory Tasks*

The total number of times each of the word and picture items was presented (Presentation levels combined) and the total proportion of times each item was correctly responded to is reported in Appendix G.

For the Word stimuli, The total proportions correct ranged from .71 to 1.00. The overall proportion correct (all words combined) was .88. The number of times any given word was presented and tested ranged from 32 to 49.

For the Picture stimuli, the total proportion correct ranged from .79 to 1.00 and the overall proportion correct (all pictures combined) was .92. The number of times any given picture was presented and tested ranged from 32 to 47.

### *Split-Half/Odd-Even Reliability*

To evaluate the extent to which task scores reflect true score rather than measurement error, participants' task performances were separated into two forms of equal length (45 items each for the word tasks combined; Forced-choice Word Recognition and Word Identification/Fade-in tasks). Since items were selected at random for presentation from a limited pool of items, forms were created by taking the first, third, fifth item, and so on, for each presentation level to create the first list. Alternate items (second, fourth, sixth, etc.) were used to create the second list. Total number Hits was tallied for each list. For the word tasks combined the mean number of correct response for list 1 (maximum 45) was 39.6, s.d.= 5.5. For the List 2, the mean number of correct responses was 39.4, s.d.=5.9. The correlation between forms was r=0.91, Equal-length Spearman-Brown reliability coefficient was 0.95.

A similar procedure was followed to create two lists for the Forced-choice Picture Recognition and Picture Identification/Fade-In tasks combined; however, the first list consisted of 23 items, while the second consisted of 22 items. The mean total number correct for the first list was 21.2, s.d.=2.6, while the mean total number correct for the second list was 20.2, s.d.=2.4. The correlation between form was r=0.86, unequal-length Spearman-Brown coefficient was

0.92. Scatterplots for word and picture analyses are presented in Appendix H.

# DISCUSSION

One of the difficult decisions a neuropsychologist must make, particularly in the medical-legal setting, is to determine whether a client's demonstrated deficits are the result of brain trauma or other factors, such as mood disturbance, poor motivation, or pre-existing difficulties. When individuals have experienced long periods of unconsciousness and, as the result, present with profound cognitive and motor impairments, the answer is clear. However, when an individual has sustained a head injury followed by no loss of consciousness, a short period of confusion, or a very brief loss of consciousness, deficits vary widely. Sequelae may be transient, none existent, subtle, or marked in some domains. The task of determining which individuals are experiencing genuine cognitive difficulties and which are feigning deficits to receive attention, compensation, or both, becomes much more challenging for the neuropsychologist.

A number of experimental tasks have been developed to discriminate individuals instructed to feign memory deficits from both clinical patients with demonstrated memory and other cognitive impairments and normal controls, as well as suspected malingerers. Two of the most widely employed techniques are the Portland Digit Recognition Test (Binder, 1990) and Hiscock and Hiscock's (1989) Digit-Memory Test. The latter task was revised by Slick et al. (1994; 1997) and is now available commercially as the Victoria Symptom Validity Test (VSVT).

Preliminary research supports the utility of the VSVT for discriminating individuals instructed to malinger memory deficits from both normal subjects and clinical patients (Slick et al., 1994; 1996). Slick et al. (1994) reported correct classification rates, based on discriminant function analyses, of 77 percent for a sample consisting of 22 controls, 20 participants instructed to feign memory deficits, and 10 participants with documented traumatic brain injuries (TBI). Only 1 of the 10 TBI participants was incorrectly classified as malingering; none of the controls was incorrectly classified; and 4 of 20 malingerers were incorrectly classified as traumatically brain-injured. Slick et al. (1996) reported improved sensitivity (19 percent; 8/43 false negative error rate) for a revised, three tier (Valid, Questionable, and Invalid/Malingering) decision rule that has the added advantage of not being dependent on sample characteristics, one of the main criticisms of discriminant function analyses.

The VSVT is a vast improvement over previous measures employed to identify malingerers. It is time and cost efficient and clearly has considerable clinical utility. The false positive rate (incorrectly identifying TBI individuals as intentional malingerers) is low, but the false negative error rate (incorrectly classifying malingerers as TBI patients) is high enough to cause some concern. Although clinicians may be less concerned with false negative error rates than with false positive error rates, insurers are certainly concerned with the latter. A task or series of tasks with lower false negative rates would, hence, be a very desirable clinical tool. One promising forced-choice task, the Test of Memory Malingering (TOMM; Tombaugh, 1997) has recently been developed and preliminary results, along the with results of other refined Symptom Validity Testing procedures, suggest that additional research with this technique is warranted.

The main purpose of the present research was two-fold: 1) to provide preliminary support for the utility of a series of newly developed Implicit Memory (IM) tasks (a Forced-Choice Word Recognition Task, A Word Fade-in Task, a Forced-Choice Picture Recognition Task, and a Picture Fade-in Task) for discriminating individuals feigning brain-injury from controls and individuals with a history of traumatic brain injury and 2) to compare the sensitivity and specificity of these newly developed tasks to the VSVT (Slick et al., 1994; 1997).

The results of the present research clearly suggest that further investigation of these newly developed implicit memory tasks is warranted. Discriminant function analysis with total number of hits combined, correctly classified 85 percent of the 54 participants in this study, an identical performance to the Hard items combined from the VSVT, a comprehensively researched, commercially-available procedure.

With respect to the IM tasks, the overall utility of the IM tasks for discriminating individuals instructed to malinger from individuals with genuine brain injuries and controls was supported by the findings. Total hit scores correctly classified 85 percent (46 out of 54) of the total sample, a result comparable to the best discriminating variable from the VSVT. A combination of the two tasks resulted in correct classification of 48/54 (89 percent) of participants.

Despite promising initial results, a number of the specific hypotheses put forward were not supported and point to limitations of the present IM tasks, as well as directions for future refinements of these tasks. These limitations will be addressed, in turn, below.

The present IM tasks take approximately 24 minutes to administer, approximately 9 minutes longer than the VSVT. One of the main hypotheses of the present research was that number of presentations for individual items (Actual Difficulty/Presentation Level) would be positively associated with number of Hits and negatively associated with Response Latency, at least for the Brain Injury and Control participants. In other words, it was expected that repetition of items (priming) would result in increased accuracy and reaction time, for Hits only, on each of the IM tasks. Results did not entirely support these hypotheses. No priming effects were observed with respect to accuracy (total Hits). Response latency was affected by repetition of items during the priming phases, however.

Examination of the results with respect to Hits suggests that the failure to obtain significant priming effects may have been the result of ceiling effects. In other words, the majority of participants in the Control and Brain Injury groups achieved perfect or near perfect scores for items at each of the presentation levels, as well as for foil items not previously presented. Repetition could therefore not significantly improve response accuracy as accuracy rates were near perfect (ceiling) for even the most "difficult" items, the foils. This finding suggests two possible courses of action for improving the IM tests: 1) eliminating or reducing number of item repetitions and 2) increasing item difficulty. It should be noted, however, that some researchers, e.g., Jacoby & Dallas (1981), have failed to find significant improvement in implicit memory measures (perceptual recognition) with multiple (2) repetition of items in the study phase compared to a single prior exposure. This finding suggests that a ceiling effect is not the only explanation for the failure to find a significant main effect of Presentation Level for Hits in the present study.

Eliminating 1 or 2 of the repetition levels (items presented four times and items presented two times during the "priming" phases) would substantially reduce the overall administration time, likely without reducing the sensitivity of the test, as the same number of test items and foils could still be presented (the same total score potential). Increasing item difficulty would be a more daunting task with unknown results, benefits, and costs. Two suggestions for increasing item difficulty would be including easy and hard foils for forced-choice items e.g., for words this might entail employing similarly spelled items for difficult target-foil pairs and items containing no common letters in the word-stem (first 3 letters) for easy target-foil pairs. For the Forced-choice Picture Recognition tasks, increasing item difficulty would be a more challenging task and might require replacing the simple picture stimuli employed in the current IM tasks with geometric designs or pictures with slightly different details in the target-foil pairs (e.g., a ball with stars on it versus a ball with circle decorations). For the Identification/Fade-in tasks, difficulty could be increased by eliminating fade-in to 100 percent of the item. Presentation up to only 50 percent of the previously presented items and foils, rather than fading in to the complete stimulus, may increase item difficulty enough to reveal priming effects with respect to Total Hits. Alternately, as suggested for the Forced-choice tasks, targets and foils with similar details or characteristics could be employed. Considerable future research would be needed to investigate the effectiveness of these and similar manipulations. Whether such manipulations would lead to more sensitive measures of malingering is unclear.

With respect to the effect of Presentation Level/Actual Difficulty on Response Latencies, there was some support for the hypothesis that repeated prior exposure would be associated with decreased Response Latencies. For the Forced-Choice tasks (Word and Picture) combined, all participants, independent of Group Membership, tended to respond most quickly to items presented 4 times during the priming phases and most slowly to items presented once. For the Identification/Fade-in tasks (Word and Picture) combined, there was also a main effect of Presentation Level. These findings indicate that even though the tasks were very simple, priming effects could be observed. It must be noted, however, that although a priming effect was observed with respect to Response Latency for the IM tasks, Response Latency variables were not very useful for discriminating among groups. This finding was unexpected given that Davis et al. (1995) reported Response Latency measures to be the most powerful discriminating variables for their implicit memory tasks. The discrepancy between the present findings and those of Davis et al. (1995) can likely be explained by the fact that these researchers did not include a genuine Brain Injury sample. Their sample consisted of university students instructed to malinger and university student controls. The present results suggest a great deal of overlap between Response Latencies for Brain Injury participants and participants instructed to malinger. As a result, Response Latency measures may discriminate well between Controls and simulated malingerers or Controls and individuals with genuine neurological impairment, but may result in unacceptably high misclassification rates in clinical practice.

The hypothesis that participants instructed to malinger would show longer Response Latencies for Misses (incorrect items) than for Hits (correct items), because the conscious decision to provide an incorrect response would increase decision making time, was also not supported by the data, once again, perhaps because of ceiling effects (few Misses across groups) and considerable variability in the Response Latency within groups.

Another hypothesis that was not supported by the data obtained was expectation of an interaction between Perceived Difficulty (Word Length) and Group membership for the Forced-choice Word Recognition and Word Fade-in tasks. None of the groups demonstrated any reliable difference in Hit rates for Short (5-letter) and Long (8-or more letter) words. This suggests that the manipulation of Perceived Difficulty was ineffective. Malingerers did not show significant lower hit rates for Long words than for Short words. As a result, future versions of the IM could eliminate this variable or replace it with a more effective manipulation of Perceived difficulty, perhaps including 2 or more delay intervals, as this has been found to be useful in the past (e.g., Slick et al., 1994).

Apart from the sensitivity and specificity of the new IM tasks with respect to discriminating Controls and Brain-injured individuals from naive malingerers, the most impressive finding for the present series of tasks, was the consistency with respect to Group Membership main effects across tasks. Hit rates for all tasks revealed similar patterns of results with respect to Group Membership. Namely, Controls and Brain-Injured Participants were not significantly different with respect to total Hits for any of the 4 tasks, while both groups obtained significantly higher Hit rates than the Malingering group on each of the tasks. This suggests that these tasks are insensitive to genuine impairment, one of the key characteristics required for a sensitive malingering task.

Overall, although some of the specific hypotheses were not supported, the findings are interesting and suggest further revision and investigation of IM tasks is warranted for several reasons. Firstly, findings indicate that tasks other than the simple 2-alternate forced choice tasks can discriminate between Malingerers and non-Malingerers. The Identification/Fade-in tasks showed exactly the same pattern of results as did the more traditional 2-alternate Forced-Choice tasks. Findings are also interesting in that they support previous research findings that indicate that even persons with moderate traumatic brain-injuries can perform equivalently to Controls on some recognition tasks. Finally, the results suggest that Picture and Word tasks can produce similar results with respect to discrimination between Malingerers and non-Malingerers (Controls and Brain-Injured Participants). Comparable results for the two types of stimuli are particularly important given that many individuals involved in accidents in which head injuries are sustained are under-educated. Forced-choice Picture Recognition and Identification/Picture-Fade in tasks may be very useful for working with such special populations. The utility of picture stimuli in discriminating feigned from genuine impairment is strongly supported by the work of Tombaugh (1997).

With respect to the results of the VSVT, although its sensitivity was once again confirmed, discriminant function analysis revealed that the utility of specific discriminating variables may vary from sample to sample. Slick et al. (1994) reported that the total number of Hard items correct at the 15-second interval was the best discriminating variable, resulting in correct classification of 83 percent of their sample of 52 participants. In the present study, the total number of difficult items correct at the 10-second delay interval was the best discriminator among the groups. If clinically useful cut-off scores are to be developed, they must be based on reliable discriminating variables. The results of the present research combined with the results of Slick et al. (1994), suggest point cut-off scores should be based on a combination of scores on difficult items combined or difficult items at long delay (10- and 15- seconds combined), as these would be more sensitive and reliable measures than cut-off scores based on performance at a single delay interval. Alternatively, criteria that are completely independent of sample, such as the new three tier system proposed by Slick et al. (1996), would also be appropriate. More investigation clearly is warranted with respect to which VSVT variables most reliably discriminate among groups and what, if any, sample characteristics might contribute to the instability of discriminating variables. The same concerns hold true for the IM tasks as well.

As a final point, it should be mentioned the general population appears to be naive with respect to how a genuine brain injury would affect functioning on cognitive tasks. The present results suggest that the general conception of head injured persons of slow, confused individuals. As a result of this misconception or gross exaggeration, naive simulators respond slowly and make many more errors than is typically the case for genuinely brain injured individuals. These findings suggest that tasks designed to detect conscious malingerers should focus on developing sensitive measures of accuracy and response latency. Since accuracy and response latency are both affected by previous exposure to information, priming or implicit memory will continue to be a worthy area of investigation for the development of clinical tools for the assessment of malingering.

Further revision of the IM tasks may lead to a very useful clinical tool that when used in conjunction with other tasks designed to detect malingering may result in very low or negligible false positive error rates (incorrectly identifying Brain Injured Individuals as Malingerers) and low false negative error rates (incorrectly identifying Malingerers as Brain Injured). The more reliable tests that can be produced that discriminate between genuine and feigned impairment, the more confident a neuropsychologist can be in concluding that an individual is feigning impairment.

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# APPENDIX A:

# DEMOGRAPHIC QUESTIONNAIRE

Identification code: _ _ _ _ _

Date of Assessment: ____/____/____ D / M / Y

Gender: M F

Age: ___ years ___ months

Years of Education: __ __

Psychiatric History (circle one) Y N

History of Loss of Consciousness (LOC) (circle one) Y N

If Yes,
Date of LOC____ ____________________
Cause of LOC ____________________
Duration of LOC____ ____________________
Date of First memory after LOC ____________________

Any difficulties as the result of LOC? If so, have list participant's self-reported difficulties

1. ________________________________________
2. ________________________________________
3. ________________________________________
4. ________________________________________
5. ________________________________________
6. ________________________________________

## APPENDIX B:

## IMAGERY, MEANING, AND FAMILIARITY RATINGS FOR 5-LETTER WORDS

| WORD | IMG | MNG | FAM |
|---|---|---|---|
| AISLE | 5.22 | 4.00 | 5.77 |
| APPLE | 6.43 | 4.51 | 6.51 |
| BADGE | 5.13 | 4.16 | 5.47 |
| BELLY | 5.70 | 4.40 | 5.60 |
| BLADE | 5.70 | 4.23 | 5.87 |
| BLINK | 6.21 | 4.12 | 6.50 |
| BLUSH | 5.59 | 4.82 | 6.08 |
| BREAD | 6.38 | 4.84 | 6.52 |
| BRICK | 5.69 | 3.98 | 6.13 |
| BROIL | 5.09 | 4.07 | 5.76 |
| BRUSH | 5.50 | 4.52 | 6.22 |
| CABIN | 5.47 | 4.88 | 6.15 |
| CHIEF | 5.03 | 4.55 | 5.82 |
| CHOIR | 5.61 | 4.18 | 6.00 |
| CLOAK | 5.12 | 4.10 | 5.23 |
| CRANE | 6.38 | 4.02 | 5.81 |
| COACH | 5.20 | 4.10 | 5.86 |
| DAISY | 5.67 | 4.31 | 5.93 |
| DITCH | 5.41 | 4.16 | 6.08 |
| EASEL | 5.26 | 4.05 | 5.06 |
| FABLE | 4.71 | 4.43 | 5.51 |
| FLASH | 5.37 | 4.69 | 5.88 |
| FLUTE | 5.75 | 4.36 | 5.70 |
| FRAME | 6.00 | 4.01 | 6.23 |
| FROWN | 5.83 | 4.55 | 5.76 |
| FUZZY | 5.13 | 4.38 | 5.56 |
| GHOST | 5.72 | 4.36 | 6.17 |
| GLIDE | 5.89 | 4.90 | 6.46 |
| GLOBE | 5.70 | 4.52 | 5.75 |
| GREEN | 5.81 | 5.02 | 6.19 |

| WORD | IMG | MNG | FAM |
|---|---|---|---|
| LEVER | 5.09 | 4.11 | 5.92 |
| MAPLE | 5.05 | 4.13 | 5.92 |
| MARRY | 5.17 | 4.61 | 6.31 |
| MEDAL | 5.23 | 4.20 | 5.68 |
| OPIUM | 5.02 | 4.13 | 5.60 |
| NOBLE | 5.24 | 4.85 | 5.73 |
| PRIZE | 5.11 | 4.41 | 5.82 |
| PURSE | 5.61 | 4.33 | 6.07 |
| QUEEN | 5.94 | 4.56 | 5.74 |
| RACES | 5.40 | 4.56 | 5.97 |
| RELIC | 5.20 | 4.03 | 5.44 |
| RIFLE | 5.61 | 4.53 | 5.98 |
| ROBIN | 5.96 | 4.31 | 5.84 |
| SATIN | 6.02 | 4.38 | 5.71 |
| SKIRT | 5.53 | 4.45 | 5.71 |
| SLUSH | 5.32 | 4.15 | 5.40 |
| SMACK | 5.95 | 4.81 | 5.85 |
| SPADE | 5.72 | 4.36 | 5.87 |
| SPICE | 5.86 | 4.52 | 5.92 |
| STAND | 5.04 | 4.17 | 5.92 |
| SWEEP | 5.06 | 4.15 | 5.83 |
| THIEF | 5.22 | 4.80 | 6.05 |
| TIGER | 6.00 | 4.33 | 5.87 |
| TOAST | 5.62 | 4.02 | 6.12 |
| TREAT | 5.27 | 4.33 | 6.10 |
| TRIBE | 5.09 | 4.12 | 5.77 |
| TROOP | 5.20 | 4.62 | 5.84 |
| VITAL | 6.07 | 4.85 | 6.47 |
| WALTZ | 4.94 | 4.33 | 5.27 |
| WHEAT | 5.78 | 4.47 | 6.04 |

## APPENDIX B (CONTINUED):

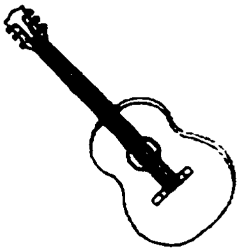
## IMAGERY, MEANING, AND FAMILIARITY RATINGS FOR 8-LETTER WORDS

| WORD | IMG | MNG | FAM |
|---|---|---|---|
| ALLIGATOR | 6.06 | 4.25 | 5.71 |
| ASPARAGUS | 5.84 | 4.42 | 6.08 |
| BASEBALL | 5.98 | 4.46 | 6.26 |
| BEAUTIFUL | 4.85 | 4.22 | 6.09 |
| BRACELET | 6.00 | 4.61 | 6.21 |
| BUNGALOW | 4.95 | 4.25 | 5.07 |
| BUTTERFLY | 6.18 | 4.24 | 5.95 |
| CALENDAR | 5.54 | 4.36 | 6.03 |
| CARNATION | 6.05 | 4.66 | 5.64 |
| CATHEDRAL | 5.93 | 4.48 | 5.14 |
| CHAMPAGNE | 5.55 | 4.45 | 5.58 |
| CIRCULAR | 5.37 | 4.51 | 5.61 |
| CLARINET | 5.87 | 4.28 | 5.42 |
| CONSTITUTION | 5.09 | 4.33 | 5.67 |
| CRUCIFIX | 5.55 | 4.31 | 5.16 |
| DECORATE | 5.02 | 4.00 | 5.63 |
| DEVELOPMENT | 4.52 | 4.45 | 5.60 |
| ELEPHANT | 5.74 | 4.40 | 5.73 |
| ESCALATOR | 5.37 | 4.33 | 5.51 |
| FRATERNITY | 5.02 | 4.07 | 5.84 |
| FRECKLES | 5.63 | 3.95 | 5.83 |
| FRIVOLOUS | 5.15 | 3.93 | 5.31 |
| GARDENIA | 5.58 | 4.19 | 5.46 |
| HONEYMOON | 5.57 | 5.37 | 6.15 |
| HORIZONTAL | 5.15 | 4.03 | 6.02 |
| HOSPITAL | 5.91 | 5.03 | 6.21 |
| INFIRMARY | 5.49 | 3.52 | 5.28 |
| INSTITUTE | 4.98 | 4.45 | 5.91 |
| JUNCTION | 4.96 | 4.19 | 5.63 |
| KANGAROO | 4.88 | 4.72 | 5.87 |

| WORD | IMG | MNG | FAM |
|---|---|---|---|
| LEMONADE | 5.92 | 4.58 | 5.92 |
| LIEUTENANT | 5.46 | 4.63 | 5.53 |
| LIMOUSINE | 5.89 | 5.05 | 5.79 |
| MAGAZINE | 5.65 | 4.93 | 6.15 |
| MATTRESS | 5.95 | 4.50 | 5.98 |
| MINISTER | 5.91 | 4.87 | 5.63 |
| MONASTERY | 5.44 | 4.16 | 5.35 |
| MORPHINE | 5.44 | 4.33 | 5.20 |
| MOUTHPIECE | 5.43 | 4.00 | 5.69 |
| NECKLACE | 6.00 | 4.57 | 6.10 |
| NIGHTGOWN | 5.58 | 4.52 | 5.80 |
| ORCHESTRA | 5.97 | 4.77 | 5.97 |
| PATIENTS | 5.07 | 4.22 | 6.00 |
| PAVEMENT | 5.31 | 4.47 | 6.05 |
| PENICILLIN | 4.95 | 4.55 | 5.68 |
| PERPENDICULAR | 5.72 | 3.78 | 6.02 |
| RAINCOATS | 5.94 | 4.16 | 5.69 |
| RECEIVER | 4.98 | 4.68 | 6.15 |
| REFRIGERATOR | 5.89 | 5.34 | 6.72 |
| REHABILITATE | 4.55 | 4.89 | 6.01 |
| SCAVENGER | 4.95 | 4.23 | 5.48 |
| SECRETARY | 5.53 | 4.11 | 6.05 |
| SIDEWALK | 5.25 | 4.25 | 6.60 |
| SUBMARINE | 5.88 | 4.03 | 5.69 |
| SYNAGOGUE | 4.92 | 4.30 | 5.05 |
| TORTOISE | 5.44 | 4.03 | 5.46 |
| THERMOMETER | 5.83 | 4.43 | 5.80 |
| TROMBONE | 5.73 | 4.17 | 5.55 |
| UMBRELLA | 5.49 | 4.00 | 5.90 |
| XYLOPHONE | 6.07 | 5.15 | 5.09 |

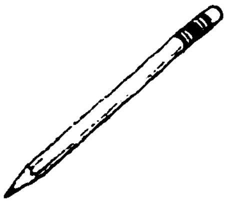
# APPENDIX C:

## SAMPLE OF PICTURE STIMULI FROM SNODGRASS & VANDERWART (1980)



Guitar

Cat



Pencil

Snowman

# APPENDIX D:

## NAME, IMAGERY, FAMILIARITY, AND CONCRETENESS RATINGS FOR PICTURE STIMULI

| PICTURES | NAME | IMG | FAM | CON |
|---|---|---|---|---|
| SNOWMAN | 100 | 4.00 | 3.15 | 2.52 |
| PUMPKIN | 98 | 4.18 | 3.08 | 2.60 |
| SCREWDRIVER | 98 | 4.30 | 3.42 | 2.35 |
| HAMMER | 100 | 4.10 | 3.48 | 2.60 |
| STOOL | 98 | 4.12 | 3.08 | 2.32 |
| KITE | 100 | 4.10 | 2.48 | 2.85 |
| MUSHROOM | 98 | 3.78 | 2.88 | 3.12 |
| DRUM | 98 | 3.71 | 2.60 | 2.88 |
| CANDLE | 100 | 3.85 | 3.08 | 2.48 |
| HAT | 98 | 3.65 | 3.18 | 2.35 |
| WHISTLE | 100 | 4.55 | 2.45 | 2.55 |
| CHAIN | 98 | 4.46 | 2.82 | 2.55 |
| SAW | 98 | 4.55 | 2.92 | 2.25 |
| CIGARETTE | 98 | 4.65 | 3.65 | 2.25 |
| LEMON | 100 | 4.35 | 3.25 | 1.85 |
| GLOVE | 98 | 3.65 | 3.38 | 3.02 |
| UMBRELLA | 100 | 3.92 | 3.95 | 3.00 |
| RABBIT | 100 | 4.20 | 2.95 | 3.28 |
| SLED | 98 | 4.49 | 2.80 | 3.05 |
| SOCK | 100 | 3.72 | 4.52 | 1.62 |
| PENCIL | 100 | 4.40 | 4.42 | 2.32 |
| LADDER | 98 | 3.75 | 3.35 | 2.32 |
| GLASS | 98 | 4.40 | 4.78 | 1.82 |
| FROG | 100 | 3.60 | 2.48 | 3.62 |
| GUITAR | 98 | 4.20 | 3.58 | 4.00 |
| HORSE | 100 | 4.20 | 3.55 | 3.82 |
| CLOCK | 98 | 2.20 | 4.38 | 2.68 |
| DRESS | 100 | 2.30 | 3.62 | 2.65 |
| DOOR | 98 | 3.80 | 4.68 | 3.22 |

| PICTURES | NAME | IMG | FAM | CON |
|---|---|---|---|---|
| TREE | 100 | 3.52 | 4.68 | 3.70 |
| SANDWICH | 100 | 3.55 | 4.45 | 3.42 |
| OWL | 100 | 4.10 | 2.22 | 4.22 |
| PIPE | 98 | 4.26 | 2.90 | 1.88 |
| BALLOON | 100 | 4.33 | 2.58 | 1.55 |
| SCISSORS | 98 | 4.40 | 3.98 | 2.15 |
| SPOON | 98 | 4.10 | 4.50 | 2.02 |
| RULER | 98 | 3.98 | 3.58 | 1.85 |
| APPLE | 98 | 4.05 | 3.98 | 1.82 |
| BELT | 98 | 4.05 | 4.12 | 2.00 |
| TOASTER | 100 | 3.92 | 4.08 | 2.78 |
| CAT | 100 | 3.78 | 4.22 | 3.25 |
| CHAIR | 100 | 3.22 | 4.58 | 2.05 |
| BROOM | 100 | 4.35 | 3.42 | 2.42 |
| SHIRT | 100 | 3.86 | 4.56 | 3.08 |
| TOOTHBRUSH | 98 | 4.40 | 4.62 | 2.42 |
| VEST | 98 | 3.70 | 3.48 | 2.60 |
| ASHTRAY | 100 | 3.20 | 3.56 | 2.25 |
| FISH | 100 | 3.58 | 3.28 | 3.75 |
| BUTTERFLY | 100 | 3.92 | 2.92 | 4.25 |
| BELL | 100 | 2.92 | 2.20 | 2.62 |
| NAIL | 98 | 4.73 | 3.28 | 1.80 |
| BED | 100 | 3.65 | 4.72 | 2.85 |
| BOOK | 100 | 4.33 | 4.75 | 2.10 |
| ARROW | 98 | 2.27 | 3.38 | 1.05 |
| BANANA | 100 | 4.42 | 3.65 | 1.32 |
| BALL | 93 | 2.84 | 3.20 | 2.28 |
| HELICOPTER | 95 | 3.42 | 2.55 | 3.80 |
| DUCK | 95 | 3.85 | 2.75 | 3.32 |
| ONION | 95 | 3.90 | 3.32 | 2.85 |
| TURTLE | 95 | 4.12 | 2.40 | 3.62 |

## APPENDIX E:

## POST-EXPERIMENTAL PERFORMANCE QUESTIONNAIRE

1) Were you able to understand the instructions given to you?

**(circle only 1 response)**

**no** **Yes**

<u>If No,</u> what did you not understand?____________________

____________________________________________________________

2) Which level best describes your effort in following the instructions given to you (In other words, how hard did you try?)

___ Not at all.

___ Not much effort.

___ Moderate effort.

___ Tried hard.

___ Tried very hard.

3) **Which example below best describes how successful you think you were in following the instructions?**

___ Completely unsuccessful.

___ Note very successful.

___ Unsure.

___ Moderately successful.

___ Very successful.

4) Briefly state what you think was the purpose of this study.

# APPENDIX F:

# TESTS OF HOMOGENEITY OF VARIANCES FOR BACKGROUND VARIABLES

*Table 10.*

*Tests of Homogeneity of Variances for Background Variables.*

| Variable | Levene Statistic | df1 | df2 | Sig. |
|---|---|---|---|---|
| AGE | .274 | 2 | 51 | .762 |
| EDUC | .413 | 2 | 51 | .664 |
| NARTVIQ | .147 | 2 | 51 | .863 |
| NARTPIQ | .207 | 2 | 51 | .814 |
| NARTFSIQ | .151 | 2 | 51 | .861 |
| SHIPFSIQ | .452 | 2 | 51 | .639 |

*Table 11.*

*Summary of Self-Reported Difficulties by Brain Injury Participants.*

| Difficulty | No. Participants Reporting | % of Participants Reporting |
|---|---|---|
| None | 1 | 6.7 |
| Memory | 12 | 80.0 |
| Attention and Concentration | 4 | 27.0 |
| Fatigue | 3 | 20.0 |
| Balance | 1 | 6.7 |
| Irritability | 3 | 20.0 |
| Time Management | 1 | 6.7 |
| Loses Things | 2 | 13.3 |
| Other | 11 | 73.3 |

## APPENDIX G:

## SUMMARY OF ITEM ANALYSIS FOR WORDS

| WORD | TIMES PRESENTED | TOTAL PROPORTION CORRECT |
|---|---|---|
| AISLE | 46 | .87 |
| APPLE | 45 | .91 |
| BADGE | 43 | .86 |
| BELLY | 43 | .95 |
| BLADE | 39 | .85 |
| BLINK | 38 | .82 |
| BLUSH | 49 | .82 |
| BREAD | 41 | .85 |
| BRICK | 37 | .92 |
| BROIL | 34 | .82 |
| BRUSH | 41 | .90 |
| CABIN | 41 | .88 |
| CHIEF | 42 | .88 |
| CHOIR | 37 | .81 |
| CLOAK | 44 | .86 |
| CRANE | 38 | .89 |
| COACH | 37 | .84 |
| DAISY | 40 | .83 |
| DITCH | 43 | .95 |
| EASEL | 37 | .78 |
| FABLE | 37 | .81 |
| FLASH | 39 | .87 |
| FLUTE | 35 | .91 |
| FRAME | 37 | .86 |
| FROWN | 35 | .86 |
| FUZZY | 38 | .89 |
| GHOST | 41 | .95 |
| GLIDE | 45 | .82 |
| GLOBE | 39 | .88 |
| GREEN | 42 | .90 |

| WORD | TIMES PRESENTED | TOTAL PROPORTION CORRECT |
|---|---|---|
| LEVER | 47 | .79 |
| MAPLE | 45 | .87 |
| MARRY | 43 | .95 |
| MEDAL | 34 | .85 |
| OPIUM | 39 | .87 |
| NOBLE | 39 | .87 |
| PRIZE | 41 | .95 |
| PURSE | 42 | .90 |
| QUEEN | 40 | .95 |
| RACES | 41 | .80 |
| RELIC | 41 | .88 |
| RIFLE | 36 | .89 |
| ROBIN | 38 | .89 |
| SATIN | 40 | .80 |
| SKIRT | 42 | .83 |
| SLUSH | 40 | .85 |
| SMACK | 43 | .88 |
| SPADE | 45 | .80 |
| SPICE | 44 | .75 |
| STAND | 39 | .92 |
| SWEEP | 40 | .90 |
| THIEF | 44 | .88 |
| TIGER | 40 | .85 |
| TOAST | 36 | .89 |
| TREAT | 42 | .83 |
| TRIBE | 39 | .87 |
| TROOP | 42 | .81 |
| VITAL | 45 | .91 |
| WALTZ | 39 | .92 |
| WHEAT | 40 | .95 |
| ALLIGATOR | 40 | .95 |

| WORD | TIMES PRESENTED | TOTAL PROPORTION CORRECT |
|---|---|---|
| ASPARAGUS | 45 | .91 |
| BASEBALL | 35 | .89 |
| BEAUTIFUL | 40 | .95 |
| BRACELET | 45 | .80 |
| BUNGALOW | 40 | .85 |
| BUTTERFLY | 38 | .95 |
| CALENDAR | 38 | .92 |
| CARNATION | 44 | .91 |
| CATHEDRAL | 38 | .84 |
| CHAMPAGNE | 43 | .88 |
| CIRCULAR | 37 | .84 |
| CLARINET | 42 | .83 |
| CONSTITUTION | 38 | .79 |
| CRUCIFIX | 39 | .82 |
| DECORATE | 40 | .83 |
| DEVELOPMENT | 37 | 1.00 |
| ELEPHANT | 40 | .90 |
| ESCALATOR | 39 | .92 |
| FRATERNITY | 43 | .79 |
| FRECKLES | 40 | .90 |
| FRIVOLOUS | 41 | 1.00 |
| GARDENIA | 41 | .78 |
| HONEYMOON | 43 | .88 |
| HORIZONTAL | 37 | .89 |
| HOSPITAL | 37 | .84 |
| INFIRMARY | 42 | .86 |
| INSTITUTE | 39 | .85 |
| JUNCTION | 35 | .83 |
| KANGAROO | 42 | .93 |
| LEMONADE | 44 | .95 |
| LIEUTENANT | 44 | .93 |
| LIMOUSINE | 42 | .98 |
| MAGAZINE | 42 | .88 |
| MATTRESS | 44 | .93 |

| WORD | TIMES PRESENTED | TOTAL PROPORTION CORRECT |
|---|---|---|
| MINISTER | 37 | .95 |
| MONASTERY | 35 | .71 |
| MORPHINE | 34 | .88 |
| MOUTHPIECE | 44 | .86 |
| NECKLACE | 32 | .84 |
| NIGHTGOWN | 35 | .89 |
| ORCHESTRA | 44 | .93 |
| PATIENTS | 41 | .85 |
| PAVEMENT | 42 | .88 |
| PENICILLIN | 43 | .88 |
| PERPENDICULAR | 38 | .92 |
| RAINCOATS | 43 | .86 |
| RECEIVER | 40 | .85 |
| REFRIGERATOR | 37 | .91 |
| REHABILITATE | 44 | .98 |
| SCAVENGER | 42 | .88 |
| SECRETARY | 42 | .88 |
| SIDEWALK | 42 | .95 |
| SUBMARINE | 42 | .93 |
| SYNAGOGUE | 42 | .76 |
| THERMOMETER | 42 | .90 |
| TORTOISE | 41 | .83 |
| TROMBONE | 42 | .90 |
| UMBRELLA | 48 | .92 |
| XYLOPHONE | 43 | .91 |

Mean .88

## APPENDIX G (CONTINUED):

## SUMMARY OF ITEM ANALYSIS FOR PICTURES

| PICTURE | TIMES PRESENTED | TOTAL PROPORTION CORRECT |
|---|---|---|
| APPLE | 36 | .92 |
| ARROW | 45 | .96 |
| ASHTRAY | 46 | .93 |
| BALL | 42 | .95 |
| BALLOON | 46 | .89 |
| BANANA | 37 | .92 |
| BED | 35 | .94 |
| BELL | 46 | .91 |
| BELT | 43 | .88 |
| BOOK | 42 | .90 |
| BROOM | 41 | .88 |
| BUTTERFLY | 35 | .91 |
| CANDLE | 42 | .93 |
| CAT | 38 | .89 |
| CHAIN | 43 | .88 |
| CHAIR | 45 | 1.00 |
| CIGARETTE | 40 | .90 |
| CLOCK | 37 | .92 |
| DOOR | 37 | .86 |
| DRESS | 37 | .86 |
| DRUM | 42 | .98 |
| DUCK | 39 | .92 |
| FISH | 44 | .95 |
| FROG | 38 | .89 |
| GLASS | 37 | .84 |
| GLOVE | 38 | .92 |
| GUITAR | 41 | .98 |
| HAMMER | 35 | .94 |
| HAT | 41 | .98 |
| HELICOPTER | 42 | .95 |

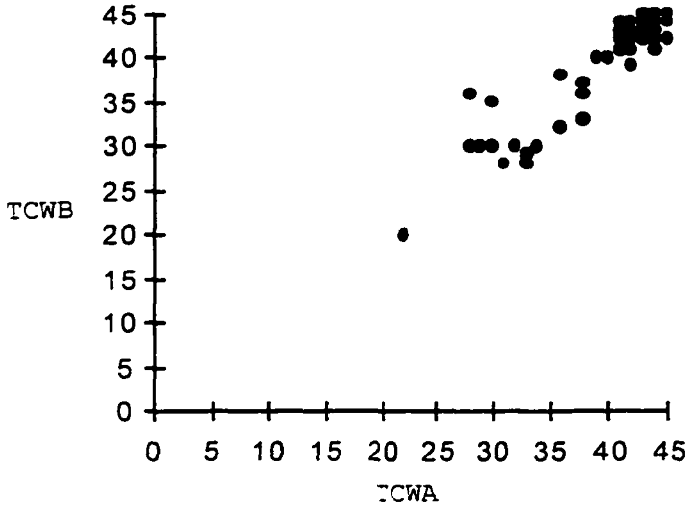
| PICTURE | TIMES PRESENTED | TOTAL PROPORTION CORRECT |
|---|---|---|
| HORSE | 42 | .98 |
| KITE | 40 | 1.00 |
| LADDER | 37 | .97 |
| LEMON | 37 | .95 |
| MUSHROOM | 38 | .95 |
| NAIL | 39 | .87 |
| ONION | 38 | .79 |
| OWL | 44 | .91 |
| PENCIL | 43 | .86 |
| PIPE | 32 | .94 |
| PUMPKIN | 43 | .86 |
| RABBIT | 37 | .86 |
| RULER | 44 | .89 |
| SANDWICH | 46 | .89 |
| SAW | 37 | .92 |
| SCISSORS | 37 | .92 |
| SCREWDRIVER | 41 | .83 |
| SHIRT | 40 | .93 |
| SLED | 45 | .82 |
| SNOWMAN | 41 | 1.00 |
| SOCK | 38 | .97 |
| SPOON | 44 | 1.00 |
| STOOL | 42 | .86 |
| TOASTER | 43 | .93 |
| TOOTHBRUSH | 42 | .93 |
| TREE | 47 | .94 |
| TURTLE | 46 | 1.00 |
| UMBRELLA | 41 | .98 |
| VEST | 34 | .97 |
| WHISTLE | 38 | .97 |

Mean .92

# APPENDIX H:

## SCATTERPLOTS FOR CORRELATIONS BETWEEN TEST FORMS

*Total Correct for Words Form 1 (TWCA) vs. Form 2 (TWCB)*



*Total Correct for Pictures Form 1 (TCPA) vs. Form 2 (TCPB)*