The Influence of Subject Sophistication on the Ability to Feign Mild Head Injury Symptoms.

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THE INFLUENCE OF SUBJECT SOPHISTICATION ON THE
ABILITY TO FEIGN MILD HEAD INJURY SYMPTOMS

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Department of Psychology

by
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ABSTRACT

The present study examined the effects that personal experience with head injury, task specific instruction and brain injury knowledge have on the ability to feign postconcussive symptoms and neuropsychological performance patterns seen in mild head injured patients. A sample of non-head injured and head injured college students served as the experimental subjects. These subjects were randomly assigned to conditions in which they were told to either do their best, feign deficits consistent with mild head injury without task specific instruction, or feign deficits while given task specific instruction. Subjects were also classified into one of two head injury knowledge groups based upon above average or below-to-average performance on a head injury misconception survey. Postconcussive symptom complaints were affected by head injury knowledge, instruction, and gender. Coached male malingerers with above average head injury knowledge endorsed relatively higher rates of postconcussive symptoms than any of the other groups. However, other malingering groups accurately simulated levels of postconcussive symptoms seen in the mild head injured patients. Performance on malingering tests was affected by instruction to simulate head injury, however coaching was not shown to produce a more realistic pattern of performance on the malingering tests relative to the head injured patients. The results of this study indicate that analog malingerers can accurately replicate self-reported postconcussive symptoms reported in mild head injured patients. However, malingering subjects are unable to simulate (abstract, con'd.)
mild head injured patient’s performance on clinical malingering tests. These results suggest that self-report measures of postconcussive symptoms and clinical tests are differentially vulnerable to instructions to malinger. In summary, personal experience, accuracy of head injury beliefs, and test specific coaching did not contribute to a more realistic mild head injury profile.
INTRODUCTION

Neuropsychological assessment is concerned with identifying behavioral consequences of cerebral damage (Satz & Fletcher, 1981). Increasingly, neuropsychologists are being requested to detail their assessment findings in the context of forensic evaluations for the determination of personal injury, disability, and criminal responsibility (Matarazzo, 1990). However, numerous challenges have been raised questioning the diagnostic accuracy of clinical judgement, especially regarding the ability to identify malingered neuropsychological performance (Faust & Guilmette, 1990; Faust, Hart, Guilmette, & Arkes, 1988). This is nowhere more evident than in the area of mild to moderate head injury litigation where potentially large monetary settlements are awarded to individuals with disabling cognitive impairments, making dissimulation an attractive option for some seeking financial compensation (Lezak, 1983).

Recent attention within the neuropsychological and forensic literatures has focused on developing evaluation strategies that provide valid identification of malingered test performance among analog and brain injured populations (e.g., Binder, 1990; Hiscock & Hiscock, 1989; Pankratz, 1988). Particular attention has been directed toward quantifying unique performance patterns indicative of malingering within these subject populations. Although identifiable neuropsychological test performance patterns indicative of malingering have been documented for both analog and patient populations, little information yet exists on specific within-subject factors that may influence the ability to successfully
malinger neuropsychological impairment. A few studies have examined the effects of subject sophistication and ability to feign impairment. However, this line of research has produced mixed results on the importance of test knowledge in malingering behavior. Factors that have received almost no attention are the effects that personal experience with head injury and personal understanding of head injury sequelae influence the ability to fake realistic brain injury. The majority of existing research has examined analog malingering populations instructed to fake brain impairment. While this lends itself to well controlled experimental research, at issue is whether these results can be generalized to clinical populations. Of additional importance is that if generalization is inferred, to what are we generalizing to given that there exists no gold standard for identifying the clinical malingerer. Clinicians are rarely witness to the spontaneous self disclosure of deception within the neuropsychological assessment setting and clinical decisions often are derived on the basis of subjective clinical interpretation.

The present study will examine whether personal experience with head injury, personal understanding of head injury sequelae and task specific instruction can influence ability to feign realistic neuropsychological impairment. The current literature on neuropsychological and postconcussive sequelae following mild head injury, neuropsychological sequelae of closed head injury, and current research investigating malingered neuropsychological performance will be reviewed to provide a theoretical context for the present investigation.
Epidemiology of Mild Head Injury

Epidemiological research has identified closed head injury as a leading cause of mortality and morbidity in persons under the age of 46 who live in Western industrialized countries (Jennett, 1989). Estimates have placed annual USA incidence rates of closed head injury at levels approaching 9 million new cases per year (Caveness, 1977). Recent estimates established by the Intra-agency Task Force for the National Institute of Neurological Disorders and Stroke placed a conservative estimate of head injury with permanent concomitant brain sequelae at over 2 million per year, with 500,000 warranting hospitalization (Goldstein, 1990). In cases where hospitalization for head injury has been reported, most studies report approximately 70% or more cases as being classified as mild or minor in severity (e.g., Annegers, Grabow, Kurland, & Laws, 1980; Rimel, Giordani, Barth, Boll & Jane, 1981). In a review of published U.S. population-based studies of epidemiologic data regarding mild head injury, Kraus and Nourjah (1989) report that incidence rates per 100,000 population were from 131 to 284. Mild head injury makes up anywhere from 49-82% of these cases. Estimates of the economic impact of CHI approach 25 billion dollars annually (Goldstein, 1990).

In reviews of epidemiological studies of closed head injury victims, several consistent sample characteristics were found (Kraus & Nourjah, 1989; Sorenson & Kraus, 1991). Males were found to be twice as likely to have experienced closed head injury than females, except in the under 5 and over 65 age ranges. The age
group most at risk is consistently between the ages of 16-25, with males predominating in this bracket. Motor vehicle related accidents comprised approximately 40-60% of the total incidence of closed head injury, with falls, assault, and sporting events making up proportionally smaller percentages of the total.

Accurate estimation of mild head injury occurrence has been problematic since many instances go unreported because of the absence of medical complications and neurological sequelae. Recent surveys of at-large populations of college and high school students have found surprisingly higher prevalence rates for experienced head injury than previously estimated. Estimates have ranged from 3-4% to upwards of 20-30% of the population studied (Crovitz, Horn & Daniel, 1983; Segalowitz, Lawson, & Berge, 1993).

Pathophysiology and Neurologic Sequelae of Closed Head Injury

Primary Mechanisms of Closed Head Injury

The behavioral and neurologic sequelae following closed head injury (CHI) results mainly from two primary pathophysiological mechanisms: (1) rapid acceleration/ deceleration forces to the head, and (2) rotational forces within the cranium (Levin, Benton, & Grossman, 1982; Katz, 1992). Acceleration/ deceleration forces can be expressed as head to object impact ratios that indicate relative velocity of the head and external object at point of contact (Russell & Smith, 1961). When velocity of the object is greater than the head at time of impact this is referred to as acceleration. Deceleration refers to the greater velocity
of the head, than object, at point of impact. These two mechanical phenomenon, acceleration and deceleration, are generally considered the principal vectors of force contributing to damage to brain tissue, determining eventual neuropathophysiological outcome. Rotational forces are directional movement of brain tissue producing what are typically referred to as strains (Katz, 1992). Three types of strains exist and are defined by the direction of force. Those being tensile strains (detached from), shear strains (oppositional pulling), and compressive strains all of which lead directly to primary neuropathological changes in CHI (Katz, 1992).

Mechanical forces exerted against brain tissue at the time of impact characteristically produce a combination of macroscopic and microscopic lesions which in turn influence development of secondary brain injury (Levin et al., 1982). One of the primary effects of mechanical impact to the brain is cerebral bruising (contusion). Contusion results from inward depression of the skull whereby brain tissue is disrupted in part from this impingement of skull, and in part due to the propagation of concussive shock waves emanating from the focus of impact. Contusions generally take coup (area of direct impact) and contrecoup (area opposite of impact) form which can produce focal neurologic deficits. Orbitofrontal and anterior temporal lobe regions appear the most sensitive regions to contusion given the irregular bony protuberances on the surfaces of adjacent skull (Levin et al., 1982).
Diffuse axonal injury refers to the stretching, severing, and degeneration of axons following rotational acceleration shearing effects of CHI (Strich, 1969). Animal models, along with human studies, have demonstrated that progressive axonal swelling that is caused by focal stretching and compression of axons, leads to defective axonal transport and has been demonstrated in mild to moderate head injury (Oppenheimer, 1968; Povlishock & Coburn, 1989). Typically, areas of damage include the corpus callosum, hemispheric white matter, and dorsolateral brain stem (Katz, 1992). Severity of diffuse axonal injury has been shown to be positively related to prolonged coma and persistent vegetative state (Gennarelli et al., 1982; Ommaya, & Gennarelli, 1974).

Secondary Mechanisms of Closed Head Injury

In most cases of traumatic brain injury there is a relatively predictable pattern of recovery and stabilization of brain function. However, in many instances acute and post-acute development of neurologic complications result from primary brain injuries leading to further debilitation of cerebral status (Brachman, 1992). These secondary effects appear amenable to medical intervention with the goals of prevention of further neurological complications (Levin et al., 1982). A number of secondary effects of CHI are described including intracranial hemorrhages, ischemic hypoxia, brain edema/swelling, post-traumatic epilepsy and intracranial ventricular enlargement (Levin et al., 1982). Outcome investigations of the mortality and morbidity following traumatic brain injury have shown that early intervention that prevents the initial impact of secondary brain injury can
improve the eventually quality of recovery in terms of vocational, social and physical functioning (Jennett and Bond, 1975).

The vascular complications of blunt head trauma are numerous, with frequent evidence of intracranial hematoma, extradural hematoma, subdural hematoma, subdural hygroma, and subarachnoid hemorrhage present subsequent to primary brain injury (Levin et al., 1982). The incidence of traumatic hematomas following severe head injury have been placed at approximately 30-40% (Miller et al., 1981). However, as the severity of head injury declines, frequency of significant intracranial mass effects will also drop considerably. In a prospective study of 610 consecutive minor head injury patients, Darcy, Alves, Rimel, and Jane (1986) were able to identify only 1% of that sample with evidence of intracranial hematoma. However, it is known through animal research that considerable immediate and delayed brain parenchymal damage can result via hemorrhagic complications following mild and moderate severe head injury (Povlishock & Coburn, 1989). In addition, non-space occupying parenchial hemorrhages are rather more common and potentially serve as irritative foci for posttraumatic epilepsy (Levin et al., 1982).

Ischemic brain damage results from the reduction of blood flow to brain tissue following CHI and typically follows changes in intracranial pressure (Richardson, 1990). Changes in the cerebral perfusion pressure (difference between systemic arterial and intracranial pressure), cardiorespiratory insufficiency, and embolic infarction can be contributing factors to focal and
widespread ischemic hypoxic events (Richardson, 1990). Upwards of 50% of the fatal head injury victims have neuropathological evidence of hypoxic brain damage (Levin et al., 1982). Brain tissue necrosis appears particularly evident in hippocampal and thalamic regions as a result of ischemic process (Richardson, 1990).

Mass effects of edemic and swelling phenomenon frequently follow diffuse axonal injury and often contribute to a declining neurological status (Snoek, 1989). Brain edema refers to the immoderate gains in water accumulation within brain tissue, while hyperemic process is generally regarded as inability to rid brain tissue of toxins and metabolic byproducts eventually producing irritation and eventual swelling of brain tissue. A large minority of acute CHI patients show evidence of cerebral swelling on CT scan which shows compressed ventricles and cisterns, as well as an increased signal density (Snoek, Jennett, Adams, Graham, & Doyle (1979). In addition, heighten intracranial pressure can result when intracranial fluid (cerebrospinal or blood) accumulates beyond volumetric limitations and can lead to life-threatening uncal herniation syndrome (Miller et al., 1977). Development of post-traumatic epilepsy has been reported in approximately 5% of CHI patients, with positive relationships demonstrated between severity of injury and occurrence of seizure disorder, intracranial hematoma, and depressed skull fracture (Jennett & Teasdale, 1981). Annegers et al. (1980) report that approximately 13% of severe CHI patients, 2% of moderate CHI, and 1% of mild head injured patients exhibited seizures at 5 years post injury.
Ventricular enlargement is another common late appearing sequelae of CHI appearing in upwards of 75% of CHI patients (Levin et al., 1982). The etiology of ventricular enlargement is a product of ex vacuo, communicating and noncommunicating hydrocephalus. The primary cause of enlarged ventricles is what Brachman (1992) refers to as "ex vacuo hydrocephalus" (p. 53), which is the enlargement of the ventricle secondary to loss of brain substance without symptomatic hydrocephalus. All forms of hydrocephalus contribute to negative neurologic outcomes for CHI patients.

Povlishock and Coburn (1989) provide evidence from fluid-percussion animal models of traumatic brain injury for the view that mild to moderate closed head injury can produce a gradual progression of focal axonal damage. This damage is characterized by progressive reactive axonal swelling, caused by focal stretching and compression of axons, that eventually leads to defective axoplasmic transport. Interestingly, the idea that axons are literally torn apart in this level of injury has not been uniformly supported. Accompanying these microscopic alterations are changes in neurochemical functioning. Hayes, Jenkins, and Lyeth (1992) have recently outlined a model for the neurochemical process following closed head injury. In their model, they observe that the initial blunt trauma causes a widespread depolarization of neuronal units dramatically increasing the extracellular potassium and altering the permeability of the blood-brain barrier. This allows exogenous neurotransmitter (primarily acetylcholine and neuromodulators) into brain substance, which may activate inhibitory cholinergic
neuronal systems within brainstem regions and thereby contributes to transient unconsciousness.

**Classification of Closed Head Injury**

Assessing severity of closed head injury is widely considered critical to the examination of post-injury physical, cognitive, behavioral and social outcome (Long & Schmitter, 1992). Depth and length of coma, post-traumatic amnesia, and age at time of injury are considered the positive indicators of eventual outcome across all head injured populations (Long & Schmitter, 1992). Choi and colleagues (Choi, Ward, Becker, 1983; Choi et al., 1991) have found that outcome is best predicted by a combination of age at injury, early postinjury oculo-motor response and initial Glasgow Coma Scale score for severe head injured patients.

The most commonly utilized measure of brain injury severity has been coma duration, since severity of unconsciousness usually reflects the simultaneous presentation of neuropathological processes (e.g, diffuse axonal injury, hematoma) (Rowland & Sciarra, 1989). Brief disturbances of consciousness are referred to as concussion and are primarily attributed to only minor post-injury sequelae, which implies minimal residual brain damage. More protracted duration of unconsciousness is referred to as coma, and the measurement of coma duration has produced the most recognized index of the severity of brain dysfunction following CHI (Stambrook, Moore, Lubusko, Peters, & Blumenschein, 1993).

The Glasgow Coma Scale (GCS) (Teasdale & Jennett, 1974) has been the standard quantitative index of head injury severity and prognosis. The scale is
used as a serial measure indicating relative progression through stages of verbal response, eye opening, and motor response recovery following head trauma. Points are scored based upon integrity of functioning in each of the three areas of wakefulness, with the range of scores from 3 to 15, with lower scores indicating more severe impairment. Coma is typically defined as the absence of eye opening, inability to follow verbal commands, and failure to make recognizable utterances (Teasdale & Jennett, 1974). The GCS has been used quite successfully as a prognostic indicator of acute medical and long term psychosocial outcome (Klonoff, Costa, & Snow, 1986; Stambrook et al., 1993). Although, nonneurological organ system trauma, alcohol/drug intoxication, and other factors have been found to limit GCS predictive validity (Teasdale & Jennett, 1974).

Following temporary loss of consciousness, CHI patients will typically exhibit anterograde amnesia for events subsequent to the injury (Levin et al., 1982). Post-traumatic amnesia (PTA) refers to the period of time following brain trauma for which the victim is unable to continuously recall post-injury events and is traditionally viewed as the "length of interval during which current events have not been stored" (Russell & Smith, 1961, p. 16). The duration of PTA is related strongly to the duration of coma and appears to increase concomitantly with the presence of neurologic signs (e.g., anosmia, motor disorders) or skull fracture (Russell & Smith, 1961). In defining CHI severity, Russell and Smith (1961) introduced a widely recognized criteria of PTA severity, with PTA of one hour or less considered mild injury, PTA of > one hour and < 24 hours considered
moderate injury, PTA duration > 24 hours and < 1 week considered severe injury and PTA of > 7 days reflecting very severe injury. During PTA, the patient invariably experiences profound impairment in orientation to time and space, defective perception and information processing speed, reduced capacity to organize information into memory, impaired judgement and speech function (Gronwall & Wrightson, 1980). Assessment of PTA has been complicated by the traditional reliance upon retrospective qualitative estimation of PTA based upon patients recall for the amnestic period and the nonstandardized nature of the interview process (Levin, O’Donnell, & Grossman, 1979). However, recent development of quantitative measures of PTA have been introduced to overcome psychometric shortcomings of the informal assessment strategies of earlier investigations and have showed to be good indicators of brain injury severity (Richardson, 1990). Post-injury intellectual, memory and vocational functioning have been found to correlate with PTA duration (Hall & Bornstein, 1991; Mandleberg, 1976; McClelland, 1988; Stambrook, Moore, Peters, Deviaenes & Hawryluk, 1990). Criteria for mild head injury is quite variable across research centers, with differential emphasis upon loss of consciousness, PTA, GCS or other neurological indexes as quantitative markers (Williams, Levin & Eisenberg, 1990). The disparate selection criteria between studies lends itself to frequent inconsistencies across studies with regard to behavioral and cognitive outcome (Zappala & Trexler, 1992). Review of existing literature shows that mild head injury is generally defined as an index or combination of: (1) loss of consciousness
of less than 20 minutes, (2) Glasgow Coma Scale between 13-15, (3) PTA of less than 24 hours, and (4) negative neuroradiologic/neurologic examination at hospital admission (Binder, 1986).

The Postconcussive Syndrome

Head injury that is mild by neurologic definition frequently is accompanied by a variety of persisting somatic, and psychological complaints, which often endure for months and years, contributing to impairments in occupational and social functioning (Binder, 1986). The appearance of a broad symptom spectrum including headaches, dizziness, fatigue, memory and concentration difficulties, blurred vision, irritability, and depression has been referred to by a variety of terms that include accident neurosis (Miller, 1961), post-traumatic syndrome (Lishman, 1973) and postconcussive syndrome (Binder, 1986).

Considerable controversy surrounds the extent to which psychogenic and physiogenic factors play a role in the etiology of this diverse cluster of symptoms (Rutherford, Merritt, & McDonald, 1977). Miller (1961, 1966) has written strongly arguing for the influence of financial compensation as the principal mechanism for persisting symptoms. However, other researchers and clinicians have argued for more organically-based explanations for symptom persistence in light of pathophysiological evidence of microscopic brain lesions following mild head injury (e.g., Merskey & Woodforde, 1972; Oppenheimer, 1968; Taylor, 1967). Gronwall and Wrightson (1974) have maintained that exclusive organic or psychological views are inadequate to explain the post-injury sequelae, and that
acute symptomatology results primarily from organic effects. They support this contention with evidence demonstrating an inverse relationship between decreased speed of information processing and presence of multiple postconcussive symptoms. They postulate that despite the return of physical health and overall intellectual abilities, the patient is confronted with occupational demands beyond the processing resources of the individual which over time creates increased stress and subsequent postconcussive symptoms (PCS). The continued development and persistence of symptoms is thought to be secondarily related to individual predisposing personality features, environmental factors, and compensation/litigation involvement (Gronwall & Wrightson, 1974). Other efforts to explain PCS have focused upon the head injured patients' chronic, often unsuccessful, coping efforts to compensate for decreased cognitive abilities that result in continuation of PCS (Van Zomeren & Van den Burg, 1985).

Neuropsychological Sequelae in Mild Head Injury Performance

Neurobehavioral impairment following moderate and severe closed head injury is well established (Conzen et al., 1992; Levin et al., 1990). Neuropsychological deficits during early stages of recovery are widespread and include retrograde and anterograde amnesia, disorientation, accelerated forgetting, slowed reaction time, aphasia, and susceptibility to interference (Levin et al., 1982). Distinctive patterns of neurobehavioral recovery following CHI are elusive given the considerable variability of post-injury complications (e.g., focal lesions, post-traumatic epilepsy, intracranial hematoma) and the impact of premorbid
individual characteristics (Long & Schmitter, 1992). A number of studies have demonstrated residual long-term impairment on various neuropsychological measures despite good recovery as indicated by the Glasgow Outcome Scale (Stuss et al., 1985). Notable long-term neuropsychological sequelae following more severe CHI include reduced speed of information processing, impaired divided attention, impaired retrieval efficiency and executive functions (Levin, Grossman, Rose, & Teasdale, 1979; Mattson & Levin, 1990).

The research conducted thus far is fraught with shortcomings due to methodological inconsistencies in the subject inclusion criteria, differential classification criteria of head injury, neuropsychological tests used, lack of appropriate control groups and time limited post-injury assessment (Zappala & Trexler, 1992).

The research literature investigating the acute and long-term neuropsychological consequences of mild head injury is relatively limited compared to studies examining neuropsychological sequelae of severe head injury (Binder, 1986). Hugenholtz, Stuss, Stethem, and Richard (1988) reported that patients with mild concussion (no focal neurological deficits, no loss of consciousness) presented with decreased choice reaction time over a period of 1-4 weeks post-injury, but did display gradual improved performance over 3 months. Additionally, neuropsychological deficits have been documented in speeded information processing (Gronwall & Wrightson, 1974; Gronwall & Wrightson, 1981), and
verbal learning/memory (Levin et al., 1987) over the initial one month post-injury period.

However, prolonged impairment in cognitive performances has been less conclusively demonstrated. Some studies have demonstrated impaired performance on tests of attention, verbal memory, visual memory, problem solving, executive functioning and information processing speed in a substantial minority of mild head injured patients at 3 months to one year post-injury (Barth et al., 1983; Leininger, Gramling, Farrell, Kreutzer, & Peck, 1990; Rimel et al., 1981). In particular, Leininger et al. (1990), utilizing a mild concussion patient sample without history of previous neurological insult or trauma, and negative drug/alcohol history, found that mild head injured patients performed significantly worse on neuropsychological tests when compared to age/education matched controls at 6 months post-injury. Other researchers have shown different results concerning post-acute neuropsychological outcome in mild head injured patients, in which there appears to be minimal to absent neuropsychological impairments when compared to controls at 3 to 6 months after injury (Levin et al., 1987; McLean, Temkin, Dikmen, & Wyler, 1983).

Longitudinal outcome studies have been virtually nonexistent within the mild head injury literature. However, Ewing, McCarthy, Gronwall, and Wrightson (1980) found that neuropsychological testing at 1 year or more post-injury showed evidence for persisting effects of mild head injury during exposure to hypoxic stress on tests of verbal memory and vigilance. Their head injured
sample performed relatively poorer than controls under the hypoxic stress condition, but comparable to controls under the no stress condition (Ewing et al., 1980). However, Dikmen, McLean, and Temkin (1986) examining psychomotor speed, attention, flexibility, verbal learning/memory, and reasoning abilities found no significant differences between minor head injured patients 12 months after their injury and age/education matched controls. They concluded that other factors involving noncerebral injury and preexisting psychosocial factors were more likely to account for continued patient difficulties at the later recovery stages. However, they did not place subjects under stress conditions like subjects in the Ewing et al. (1980) study. Ewing et al. (1980)'s study suggests that stress vulnerability may be a lasting sequela of mild head injury.

**Feigning Neuropsychological Impairment**

In the early 20th century, malingering was viewed as a form of mental disease by the psychoanalytic community (Resnick, 1984). However, Rogers (1990) notes a decided shift from a psychopathologic view of malingering to a more puritanical model that positions malingering as moralistic failing of the malingerer. This moralistic view is reflected in recent psychiatric diagnostic criteria which themes the idea of "badness" and propagates emphasis upon antisocial personality characteristics of the individual (Rogers, 1990, p. 183). The Diagnostic and Statistical Manual of Mental Disorders (DSM-III-R; American Psychiatric Association, 1987) defines malingering as the "intentional production of false or grossly exaggerated physical or psychological symptoms, motivated by
external incentives..." (p. 360). Recent theoretical writings have shifted the moralistic overtones of malingering to a position that views malingering as a adaptational behavior (Rogers, 1990). An adaptational model of malingering emphasizes the decision making process involved in malingering behavior in which the individual is constantly making choices concerning advantages and disadvantages to feign various behaviors to achieve some desired goal (e.g., avoidance of military inscription, monetary reward). This model is supported by historical literature documenting various shifts in the incidence of malingering behavior as a function of societal contingencies existing at the time (Rogers, 1990). Miller and Cartlidge (1972) assert that the incidence of simulation or "accidental neurosis" is a function of the emergence of accident disability and employer liability legislation during the industrial revolution of the late 1800's. No exact prevalence statistics exist for intentional fabrication of neuropsychological impairment, with estimates varying considerably depending upon the assessment context (Rogers, 1990). Recent estimates place malingering within personal injury and workers' compensation cases near or greater than 50% (Heaton, Smith, Lehman, & Vogt, 1978; Youngjohn, 1991 cited in Rogers, Harrell, & Liff, 1993).

Detection of feigned neuropsychological performance has been investigated through one of 2 research strategies: (1) simulator groups, or (2) known-group designs (Rogers et al., 1993). In simulation research designs, nonpatient subject groups are asked to feign some type of brain impairment on either a single test or battery of neuropsychological tests. These subjects are either naive or given
information as to the expected pattern of performance needed to successfully fake injury (Martin, Bolter, Todd, Gouvier, & Niccols, 1993; Wilhelm, Franzen, Grinvalds, & Dews, 1991). Within this design type, nonpatient malingerers are compared to brain injured samples, and group classification is attempted through clinical judgement or statistical procedure with accompanying sensitivity and specificity rates generated (Rogers et al., 1993). Challenges to this approach are the unknown generalizability to actual clinical populations given the difficulty emulating actual high stakes motivational involvement assumed in clinical cases (Rogers et al., 1993).

In the known-groups design, subjects have been identified as malingerers by clinicians independent of the particular research project, and are compared to various brain injured patients not identified as feigning impairment (Rogers et al., 1993). This strategy, while promising, is hampered by questionable classification procedures that are based upon current diagnostic systems (Rogers et al., 1993).

Neuropsychological Assessment and the Detection of Malingered Performance

Single Tests and Test Batteries

Early reports investigating the ability to fake neurological sequelae relied primarily on clinical observation and lore (c.f., Miller & Cartlidge, 1972). More systematic efforts have attempted to identify feigned brain injury investigating unique performance patterns on standard neuropsychological tests between malingering groups and brain injured patients (Benton & Spreen, 1961; Bruhn & Reed, 1975; Hunt & Oder, 1943 cited in Franzen, Iverson, & McCracken, 1990).
In the Benton & Spreen (1961) report, considerable performance overlap was seen between simulators and brain injured patient’s overall scores on a test of visual memory. However, simulators produced significantly greater number of distortion errors on the reproduction portion of the test. In the Bruhn & Reed (1975) study, 91% classification accuracy was achieved in identifying simulated performance. However, their scoring system was not presented and malingering subjects tended to produce gross figure distortions on the reproduction portion of the Bender-Gestalt Test. While these early studies made known identifiable differential performance patterns between groups, limited sample sizes and lack of cross-validation efforts limited their overall usefulness.

While the identification of differential performance between malingerers and brain injured patients using single psychometric instruments has produced interesting information regarding potential quantitative signs of simulated performance, in practice, reliance upon any single measure will inevitably raise the possibility for misclassification (Franzen et al., 1990). More recent research has attempted to uncover performance patterns exhibited by individuals instructed to fake brain damage employing composite test batteries. Heaton et al., (1978) examined neuropsychological test performance in a group of community volunteers who were asked to respond as if they had recently experienced a head injury. Subjects were administered a complete battery of tests including the Wechsler Adult Intelligence Scale, and Halstead-Reitan battery. Group differences emerged with the actual head injured patients performing worse on the Category Test and
Tactile Performance Test, while the malingerers demonstrated poorer performances on the sensory/motor tests, and higher elevations of the MMPI. Unfortunately, group classification based upon the clinical judgement of 10 neuropsychologists was no better than 20% above chance, while discriminant function analysis produced a 100% correct classification rate. However, as pointed out by Franzen et al. (1990), low subject to variable ratio and high correlations between predictor variables served to reduce the confidence in the generalizability of this study to other samples.

Goebel (1983) reported the successful application of a composite test battery (WAIS, Halstead-Reitan, Wechsler Memory Scale- verbal story immediate/delay recall subtests) to discriminate between nonneurologically impaired individuals instructed to fake focal or diffuse brain damage, and mixed etiology brain injured patient groups. Virtually every measure successfully discriminated between groups, with the fakers performing at an intermediate position between the brain injured patients and controls. Overall, the author was able to achieve a classification hit rate of 94% with only 2 of 102 fakers misdiagnosed as brain injured. Discriminant function analysis properly identified between 94 to 97% of the sample, depending upon base rate function. Limitations of this study were that the author had earlier performed the neuropsychological assessments on all of the brain injured patients, predictor variables were different for the subjective analysis and discriminant function analysis, and the patient group consisted of only severely injured patients.
In the only study examining malingering on the Luria-Nebraska Neuropsychological Battery (LNNB), Mensch and Woods (1986) found that nonneurologically impaired community volunteers were able to produce significant scale elevations on the LNNB. However, compared to normative data on brain injured patients, the malingering subjects produced lower Pathognomic scale (general index of brain damage) elevations and performance patterns inconsistent with brain damage. Although detectable differences emerged between simulators and normative data on brain injured patients, no information was provided regarding classification accuracy.

Strong challenges have been made by Faust and colleagues that neuropsychological performance deficits can by successfully fabricated when using standard neuropsychological tests, and that clinical judgement in detecting deception utilizing these techniques is poor (e.g., Faust & Guilmette, 1990). They argue that the empirical literature has not supported the contention that experienced clinical neuropsychologist can identify malingered test performance with reasonable accuracy. In a study conducted by Faust, Hart et al. (1988) adolescent malingerers asked to faked mild to moderate head injury went virtually undetected despite alerting clinicians to the potential of malingering. This assertion has not gone unchallenged, Bigler (1990) in particular counterargues that studies relying on diagnostic interpretation from a limited questionnaire format are insufficient to make reliable clinical decisions since useful sources of data (i.e., clinical interview, radiologic scans) are not available. However, Faust and Guilmette
(1990) reviewed research indicating that increasing the clinical information available for analysis by the clinician does little to increase diagnostic accuracy.

**Detection of Malingered Memory Impairment**

Recently, several studies have examined the potential to detect malingerers utilizing standardized memory tests (Bernard, 1990, Bernard & Fowler, 1990; Mittenberg, Arzin, Millsaps, & Heilbronner, 1993; Rawlings & Brooks, 1990). Within the context of forensic evaluations, the claims of impaired memory function are quite common (Brandt, 1988). Unfortunately, identification of malingering, using standardized memory instruments, has been handicapped by the heterogeneity of performance patterns seen in memory impaired patients (i.e., Butters, Milliotis, Albert, & Sax, 1984). Earlier studies employing nonstandardized memory tests showed that verbal recognition memory tended to be worse for subjects simulating amnesia as compared to actual amnestics. However, considerable performance overlap was found between these two groups (Brandt, Rubinsky, & Lassen, 1985; Wiggins & Brandt, 1988).

Bernard (1990) employing an analog malingering design found that malingering subjects performed uniformly poor across memory measures (WMS-R, AVLT, CFT) compared to controls, although the malingerers did not profoundly exaggerate their performances. Discriminant function analysis correctly classified 75% of the cases, with disproportionately poorer recognition scores than recall scores primarily determining group classification. Bernard (1990) concluded that standardized memory tests were vulnerable to feigned performance. Mittenberg,
Arzin, et al. (1993) compared the performances of nonlitigating brain injured patients and aged-matched simulators on the WMS-R and found that discriminant function analysis was able to correctly classify 91% of the subjects using subtest scores. They found that a differential score between the General Memory Index and Attention/Concentration Index was the most predictive index of malingered performance. Similar to the Bernard (1990) study, simulators in the Mittenberg, Arzin, et al. (1993) study were able to simulate many of the performances of the head injured group, especially on measures of global intelligence (WAIS-R scaled scores). In a study examining intellectual and memory performances in a group of mild and severe head injured patients, Rawlings and Brooks (1990) developed a qualitative classification system based upon analysis of error type on the tests. All mild head injured patients (PTA < 24 hours, no focal neurological abnormalities) presented several years after their accident with persistent and severe mental impairments, and were seeking financial compensation. The mild group was considered to be potential simulators. Qualitative analysis of performance patterns of the two groups revealed several pronounced types of errors made by the mild head injured patients, but not seen in the severe head injured group. Correct classification was obtained in 100% of the original sample, and in a cross-validation sample, using independently diagnosed simulators, 19/20 patients were correctly classified. The mild head injured group produced significantly more errors of gross distortion and on overlearned material, while errors of omission were more common in the more severely head injured patients.
Specialized Procedures and the Detection of Feigned Neuropsychological Performance

Assessment tools typically employed to assess neuropsychological functioning are not specifically designed to detect malingering (Hiscock & Hiscock, 1989). Additionally, identification of malingering using standardized neuropsychological instruments has been handicapped by the heterogeneity of performance recovery patterns seen in head injured populations (Binder, 1986). Although some success has been reported for identifying feigned performance across groups, substantial individual misclassification still exists (Pankratz, 1988).

Until recently, few tests existed that were explicitly designed to detect malingered neuropsychological performance. Rey (1941, 1964) introduced two tests for the detection of malingering which were presented in the English translation by Lezak (1983). These tests were the Dot Counting Test (DCT), and the Memorization of 15 Item Test. Both tests were designed to appear as face valid measures of neuropsychological abilities, but were instead relatively simple tests in which failure assumes poor motivational intention. Unfortunately, the Memorization of 15 Item test has not demonstrated strong sensitivity in simulation or known-group designs (Bernard and Fowler, 1990; Schretlen, Brandt, Krafft, & Van Gorp, 1991). The considerably low cutting score necessary for suspicion of feigned performance and the common finding of poor performance by neurologically impaired populations raises doubts about its utility as a marker of feigned performance (Lee, Loring, & Martin, 1992).
The DCT has likewise received little empirical attention since its presentation by Lezak (1983). However, initial research with the DCT has demonstrated its usefulness in discriminating between simulators, psychiatric populations and brain damaged patients and appears to exhibit strong reliability estimates (Binks, Gouvier, & Waters, 1993; Paul, Franzen, Cohen, & Fremouw, In Press).

Symptom validity testing has been offered as another alternative procedure for identifying malingered or exaggerated neuropsychological complaints (Pankratz, 1983). This two-alternative forced-choice procedure was originally designed in the identification of questionable neurological disability (e.g., Brady & Lind, 1961; Pankratz, Fausti, & Peed, 1975). The general procedure has the examiner presenting a stimuli the patient denies perceiving and then presenting a two-alternative forced-choice pair of stimuli, one of which being the original stimuli (Pankratz, 1979). This procedure capitalizes on two ideas: (1) that the patient feigning disability will perceive a 50% hit rate as too successful, and (2) the probability of correct response is always 50% and deviation below chance level violates probability estimates of binomial distributions (Pankratz, 1983). By utilizing a forced-choice procedure, intent to deceive is more confidently inferred, since markedly low scores suggest either intentional feigning or miscomprehension of instructions (Hiscock & Hiscock, 1989).

Pankratz (1983) adapted the symptom validity testing procedure to identify fabricated memory complaints by presenting a succession of simple visual stimuli
and requesting that the patient recall the original stimuli after a brief delay. This procedure has produced detection success as reported in a few case study reports (Binder & Pankratz, 1987; Pankratz, 1983). However, recent refinements in the forced-choice memory procedure were advanced to make the task appear more difficult in order to avoid arousing suspicion in patients who view the test as too simple (Hiscock & Hiscock, 1989).

In the Hiscock and Hiscock (1989) refinement, perception of performance success is manipulated by providing the subject with trial by trial feedback regarding performance accuracy. Then, following a number of trials at a particular time delay interval, the subject is informed that interstimulus delay will become longer because of their good performance. A case study presented by Hiscock and Hiscock (1989) demonstrated the effectiveness of this approach in which a suspected malingeringer performed at chance level on the first portion of the test, but when given positive feedback and told the task would become harder the subject began to perform significantly below chance.

Recently, Binder and Willis (1991) analyzed forced-choice performance in a larger group of brain injured patients, some of whom were seeking financial compensation. They also investigated forced-choice performance in dissimulating and nondissimulating control groups. Mild head injured patients seeking financial compensation were found to perform significantly above chance, but still performed significantly worse than the more seriously brain injured patients not seeking financial compensation. In addition, poorest performance was displayed by
the dissimulating nonpatients who achieved chance levels of performance. They suggested that the forced-choice technique provides an effective method for identifying motivational intent. However, some recent studies have revealed that suspected simulators and analog malingers do not typically perform below chance levels on forced-choice techniques. Thereby suggesting that absence of below chance levels of performance does not necessarily rule out malingered performance (Guilmette, Hart, & Guiliano, 1993; Martin, Gouvier, Todd, Bolter, & Niccolls, 1992). While levels of specificity (i.e., the proportion of subjects successful discriminated according to group) appear quite good (usually > than 90%), sensitivity levels (i.e., incidence of below chance performance in malingering groups) are rather poor (Amin & Prigitano, 1991; Binder & Willis, 1991). Numerous studies have shown that patients with documented severe brain trauma can achieve performance on forced-choice tasks above 75% correct and that levels below this figure may signal poor motivational intent of patients (Binder & Willis, 1991; Guilmette et al., 1993; Martin et al., 1993). However, Rogers et al. (1993) has concluded that the Symptom Validity Testing procedure, if based upon binomial probability levels, will result in quite low sensitivity rates. Rogers et al. (1993) further states that the alternative development of optimal cuttoff scores based upon normative data may improve these rates.
Environmental Variables Affecting the Ability to Feign Neuropsychological Impairment

**Financial Incentive**

The potential for large financial compensation following traumatic brain injury is usually at issue when neuropsychological assessment is requested to help determine post injury sequelae (Guilmette et al., 1993). Often the neuropsychological evaluation will be a critical piece of evidence supporting or disputing claims of residual cognitive dysfunction, or the presence of poor motivation (Guilmette and Giuliano, 1991). Investigations of postconcussive symptom persistence and neuropsychological performance in brain injured samples have found differential levels of performance as a function of compensation/litigation involvement (c.f., Miller, 1961; Binder, 1986). In a recent series of studies by Binder and colleagues (Binder, 1990; 1993; Binder, Villanueva, Howieson, & Moore, 1993; Binder & Willis, 1991) has consistently shown that patients seeking financial compensation following mild head injury perform worse on forced-choice procedures than in more severely brain injured patients not involved in compensation procedures. Binder (1993) interpreted these results as evidence for the presence of exaggerated memory deficits by patients seeking financial compensation. However, there are numerous reports documenting the persistence of post-concussive symptoms and neuropsychological deficits in the absence of, or following, the resolution of financial compensation (e.g., Leininger et al., 1990; Merskey & Woodforde, 1972; Rimel et al., 1981). It appears that a more complex interaction of factors may exist in producing
malingering behavior than the simple presence or absence of litigation (Rogers, 1990). Within analog malingering studies, the use of incentives has been used to simulate actual clinical malingering situations by rewarding deception success. However, research has shown rather negligible results when using incentive to enhance malingering performance (Bernard, 1990; Wilheim et al., 1991; Martin et al., 1993). At issue is whether comparable stakes can be achieved in an experimental analog setting, as compared to, the clinical arena where the potential risks and benefits are considerably greater (Rogers, 1988).

Subject Variables Affecting the Ability to Feign Neuropsychological Impairment

Subject Understanding/Knowledge Base

The idea that the degree of success a malingerer has in feigning neuropsychological impairment depends upon the level of their personal knowledge, beliefs and intuition regarding a particular brain disorder has been presented as an important variable for investigation (Schacter, 1986). Research on the identification of psychopathology and malingering has demonstrated that knowledge of a particular disorders and information regarding test taking strategies, may enhance deception in previously naive test takers (Hare, 1985; Rogers, Gillis, Dickens, & Bagby, 1991).

The influence of a priori knowledge and experience have been cited has important factors in the determination of one's ability to fabricate particular mental disorders. For example, several clinical case examples within the psychiatric literature have profiled individuals who had for a time successfully fabricated post-
traumatic stress disorder (Lynn & Belza, 1984; Sparr, & Pankratz, 1983). Lynn and Belza (1984) cited the case of a non-combat Vietnam era war veteran who incorporated his personal contacts with Vietnam vets, as well as readings of the personal experiences of Vietnam vets diagnosed with PTSD into a fabrication so successful that he was employed at one time as a PTSD outpatient counselor. While these case reports give support to the idea that knowledge of disorder can enhance factitious or malingered behavior, research has demonstrated the ability to fabricate or exaggerate the symptoms of more severe psychopathology (i.e., schizophrenia, severe psychoneurosis) has been proven more difficult than other less severe forms of psychopathology (i.e., reactive depressions, anxiety, adjustment disorders and somatoform symptoms) on psychological testing (Schretlen, 1988). This pattern seems to hold even with the inclusion of knowledgeable malingering subjects (i.e., mental health workers) attempt to fabricate schizophrenia (Powell & Wagner, 1991).

Systematic investigation of a priori knowledge of brain disease and malingered neuropsychological impairment has only recently been investigated. A few studies have begun to examine the role of subject knowledge of particular brain diseases in the ability to feign neuropsychological impairment. In a study by Hayward, Hall, Hunt, & Zubrick (1987), nurses having experience working with neurological patients attempted to simulate left fronto-temporal brain impairment on a battery of neuropsychological tests. Questionnaire data indicated that approximately 30-60% of the nurses identified either language related disorders,
generalized memory problems, concentration difficulties, mood/personality changes, right-sided weakness, or psychomotor slowing problems as likely sequelae to left fronto-temporal damage. However, the nurses performed considerably worse on most of the tests, and were more likely to show impairment on tests not sensitive to left fronto-temporal brain injury (e.g., digit span and information subtests from the WAIS-R). These results are interesting in that the nurses appeared to have difficulty translating their reasonable working knowledge of brain injury into realistic levels of performance on neuropsychological tests.

In another study addressing the possible influence of subject knowledge of traumatic brain injury, Kerr et al. (1989) examined the extent to which education concerning head injury and subject intelligence influenced ability to simulated head injury. High intelligence malingerers (lawyers and physicians with mean IQ estimates of 119) and average intelligence malingering subjects (college students with mean IQ estimates of 108) were found to perform similar to a group of mixed severity head injured patients. All malingering subjects read an article describing the effects of head injury prior to being tested. Results suggested that intelligence level was not an effective discriminator of feigning ability, but head injury information given subjects may have had a positive effect upon malingering ability, Wilheim et al. (1991) however has pointed out that brief exposure to head injury information may not allow ample time for assimilation and utilization of that information within a analog malingering paradigm. Therefore, conclusions regarding the influence of knowledge are probably limited. Interestingly, lawyers
simulated head injury performance more closely than the other malingering groups. No explanations were provided as to the possible implications for this finding.

Martin and Franzen (1993) investigated the ability of psychology graduate students and Ph.D. level psychologist to feign memory deficits. These groups were assumed to possess more sophisticated levels of brain-behavior knowledge and more skilled test-taking behavior. Results demonstrated that these subjects were able to perform above established cutoff scores on a test of forced-choice word recognition (Iverson, Franzen, & McCracken, 1991) by utilizing their knowledge of binomial probabilities. However, most of these subjects were identified as malingers based upon exceptionally poor digit span performances compared to cutoff scores. In a similarly designed study employing graduate psychology students and faculty, Wilheim et al. (1991) found no significant differential performance between simulating subjects provided with brief information regarding brain injury behavioral sequelae or those without such information.

One recent survey of community volunteers indicated that "substantial levels of misconception" exist regarding common effects of head injury, most notably those of amnesia, unconsciousness, and recovery from injury (Gouvier, Prestholdt, & Warner, 1988). However, this same survey found that the average layperson was reasonably accurate in their understanding of the behavioral effects of brain damage. For example, nearly 75% of the adults surveyed correctly understood the negative potential of head injury without actual loss of consciousness.
Mittenberg and colleagues (Mittenberg, DiGiulio, Perrin, & Bass, 1993; Mittenberg, D’Attilio, Gage, & Bass, 1990) recently conducted a series of studies investigating the ability to produce realistic patterns of post concussive symptoms in a community sample. They have found that, somewhat unexpectedly, controls endorsed a virtually identical pattern of postconcussive symptoms to those reported by patients with head trauma. They concluded that patient expectation regarding possible somatic and psychological symptoms following head injury may contribute to symptom persistence. These findings indicate that postconcussive symptoms may be frequently and accurately fabricated. In a related study, Gouvier, Uddo-Crane, and Brown (1988) reported that several subjective symptoms endorsed frequently by head injured individuals were just as likely to be endorsed by nonsimulating college students and their relatives. Notable similarities in the frequency of impatience, fatigue, irritability, anger control and memory problems were reported by both patient and nonpatient groups. Wong, Regennitter, and Barrios (1994) have also found that college students without history of head injury will report frequent occurrence of several "classic" post-concussive symptoms. Both, the Gouvier, Uddo-Crane et al. (1988) and the Wong et al. (1994) studies support the view that post-concussive symptoms may be relatively easy to simulate. However, in another recent study investigating college students perceptions concerning sequelae of minor head injury and whiplash, college undergraduates were more likely to expect physical symptoms rather than cognitive symptoms following mild brain injury (Aubrey, Dobbs, & Rule, 1989). The authors
concluded that a limited knowledge of the diversity of common sequelae associated
with mild head injury existed within their subject sample, thus suggesting analog
malingers would be unlikely to simulate cognitive impairment if relying solely
upon their knowledge base (Aubrey et al., 1989).

Typically, self-report measures of postconcussive symptoms have relied
upon the presence or absence of a particular symptom (i.e., Oddy, Humphrey, &
Uttley, 1978) without reference to other behavioral dimensions. Recently,
Gouvier, Cubic, Jones, Brantley, & Cutlip (1992) introduced a 10-item self-report
measure for postconcussion symptoms which measures these symptoms on three
dimensions: (1) frequency, (2) intensity, and (3) duration. These three symptom
dimensions have been found to reliably discriminate between analog malingers
and normals, with malingers endorsing significantly higher levels on all three
dimensions (Wong et al., 1994).

**Personal Experience with Head Injury**

As mentioned earlier, malingering research has relied heavily upon analog
populations to simulate neuropsychological impairment and compare results to
known groups of brain impaired patients. Several authors have discussed the need
to expand the experimental analog paradigm to include clinical samples because
having actual clinical samples feign neuropsychological deficits will allow
examination of similarities and differences in malingering performance patterns of
the clinical and analog populations (Binder & Willis, 1991; Rogers, 1988).
Within the psychopathology literature, clinical evidence exists suggesting that malingering is difficult to identify with individuals having a history of mental illness (Resnick, 1984). Such individuals may utilize a combination of their personal experience with psychotic symptoms, observation of other patients and knowledge of the psychiatric inpatient setting to successfully attain desired goals (i.e., avoidance of criminal responsibility, attainment of shelter). Berry, Baer, and Harris (1988) performed a metaanalysis of the existing research investigating the detection accuracy of the Minnesota Multiphasic Personality Inventory in identifying malingered mental illness, and found considerably smaller effect sizes for patient groups requested to malinger than normal groups. That is, patients requested to malinger were less accurately categorized as malingerers than were the non-patient malingering groups. These results suggest that in some way experience may enhance the believability of the patient malingerer.

In an investigation of ability to malinger on the Bender-Gestalt Test (Bruhn & Reed, 1975), the authors discovered post-hoc that a small portion of the group had previously sustained a mild concussion and that these subjects were less likely to be detected as malingerers by clinical judges despite being given instruction to malinger brain damage. The non-head injured subjects performance was characterized by gross distortion of the figure reproductions. These results suggest that personal experience with head injury may have contributed to more realistic expectations about cognitive capabilities, as manifested in less exaggerated memory
impairment on formal testing. To date no other study has investigated this possibility further.

Research by Gouvier, Prestholdt et al. (1988) found misconception of brain-behavior sequelae following head injury among community residents. Misconceptions were also present in subjects reporting a history of prior head injury, or history of a family member suffering head injury in the past. Their findings suggest that personal experience with head injury adds little to the understanding of brain injury. Unfortunately, no information was given regarding the severity of brain injury in this sample, or whether there was a relationship between degree of injury and understanding of brain injury sequelae.

**Subject Test Taking Sophistication**

Although prior or gained knowledge of brain injury may have some translation to more sophisticated malingering, providing specific task instruction or "coaching" may be another variable affecting the ability to successfully feign neuropsychological impairment. A recent series of studies has examined the effect of "coaching" (task specific instruction) on reducing the chances of being detected as a malingeringer on a forced-choice recognition memory task. Analog malingering subjects who received specific task instruction were significantly less likely to demonstrate gross distortion on a forced-choice task than were malingering subjects receiving no specialized instruction (Martin et al., 1992; Martin et al., 1993). Although "coached" malingerers were found to perform more poorly than actual head injured subjects on the forced-choice task, their performances were much
more similar to the head injured patients than to performances of the "uncoached" malingerers (Martin et al., 1993). The idea that client coaching in forensic settings may seem farfetched. However this type of behavior does indeed occur based upon court documented testimony and the personal experiences of many clinical neuropsychologists (Miller, Hartledge, & Lees-Haley, 1993). "Your honor, I would feel it to be malpractice on my part if I did not coach my clients on how to take on MMPI" statement made in court by plaintiff's attorney (Jay Youngjohn, personal communication, November, 1993).
PURPOSE

The present review identified common neurological, neuropsychological and behavioral sequelae following closed head injury, with primary attention to sequelae of mild head injury. Although inconsistencies exist regarding the level of permanent disability, research has demonstrated a consistent set of short-term negative consequences subsequent to mild head injury (e.g., Levin et al., 1987). However, considerable controversy exists regarding factors that play a role in the continuance of persisting symptoms following mild head injury. While a majority of persons experiencing mild head injury are able to return very nearly to premorbid levels of occupational/social functioning, a minority of patients continue to present post concussive symptoms that interfere with full recovery in social and occupational roles (Binder, 1986).

Neuropsychological assessment often contributes to disability determination in cases of head injury. The presence of cognitive, behavioral or physical impairments will likely enhance the probability for receiving some form of financial compensation. Often large monetary settlements are awarded to those deemed to have persisting negative consequences from a head injury. Mild head injury may present persisting cognitive deficits or subjective postconcussive complaints that may linger for years (e.g., Binder, 1986). Neuropsychologists are increasingly being requested to determine the extent of postconcussive sequelae following mild head injury and to render an opinion about whether evidence exists for symptom exaggeration or fabrication. Therefore, determining those factors
impacting the ability to deliberately falsify neuropsychological deficits is of considerable importance.

As outlined by Rogers et al. (1993), investigators have primarily employed analog (i.e., simulator group design) and known-groups design methodologies in an attempt to identify factors involved in fabricated neuropsychological performance. Except for the sporadic case report, the known-group design has been infrequently utilized within neuropsychological research. Central to the limited utilization of this design strategy is the necessity for positive identification of malingering which is rarely accomplished without a frank admission of guilt from the patient (Rogers, 1988). Studies that have employed clinical populations of potential malingerers (i.e., "differential prevalence designs", Rogers et al., 1993, p. 257), or at least poorly motivated patients (i.e., Binder & Willis, 1991), have classified patients' motivational status based upon questionable test performance. While this strategy is typical in actual clinical assessment, without forthright admission of fraudulent intent by the patient true diagnostic accuracy is debatable.

Within the analog design strategy, threats to external validity have been a primary concern to researchers attempting to extrapolate findings to actual clinical settings (Rogers et al., 1993). Analog research has failed to devise methods differentiating subjects based upon level of motivation (i.e., financial incentive). Creating compatible levels of incentive in clinical versus experimental populations has been quite difficult. What has been suggested (c.f., Rogers, 1988) is to incorporate an identified group of nonlitigating mildly head injured subjects and
have them attempt to simulate levels of brain injury worthy of financial compensation. To date, no research study has attempted this strategy. One advantage to this strategy is that confirmation of malingering would be known a priori in a experimental group more akin to clinical populations rather than the typical analog undergraduate research subject.

Financial incentive, understanding of head injury sequelae, personal experience with head injury, and test-taking knowledge have each been reviewed as potential contributors in ability to feign neuropsychological impairment. How each variable influences malingering behavior in a test situation has not been conclusively determined. Previous research within the malingering literature has largely ignored the influence of intrasubject variables in the production of malingered behavior. What has been emphasized is the development of tests that differentiate between malingerers and non-malingerers, and only by having both sets of data pointing toward malingering. If the test data is off and the sample characteristics match up, then the probability of correct identification and the level of confidence in our testimony both are enhanced.

Financial incentive appears to contribute, under litigating circumstances, to the greater likelihood for symptom exaggeration within clinical settings (Binder, 1993). However, manipulating level of financial incentive within laboratory settings has consistently failed to affect malingering behavior (e.g., Bernard, 1990; Martin et al., 1993). The primary obstacle is establishing environments where experimental subjects face the prospect of obtaining comparable levels of financial
reward as actual clinical cases. However, understanding and experience of head injury, and test-taking knowledge are variables readily adaptive to investigation within controlled experimental investigation.

Test knowledge, understanding, and personal experience may all produce effects upon the client's ability to present themselves as impaired in a realistic manner on neuropsychological testing. Research has demonstrated that analog malingerers often display performance on neuropsychological measures that differs drastically from actual head injured patients (Heaton et al., 1978). However, malingerers can also produce similar performance patterns to brain damaged patients (Bernard, 1990). So far, inadequate attention has been paid to potential subject variables in malingering research and how such variables might impact malingering performance.

Test specific knowledge has been proposed to affect ability to fabricate neuropsychological impairment (Rogers et al., 1993) and initial investigations have provided support to this contention (Martin et al., 1992; Martin et al., 1993). However, instruction alone does not produce equal performance in malingerers and head injured subjects as evidenced by malingerers continued poorer performance than brain injured patients. This suggests that other factors may be necessary to fully simulate the head injured neuropsychological profile. One such factor that has not been systematically investigated is the amount of performance-based feedback the malingerer receives in the course of analog research or in the real life situation where a client may receive multiple feedback sessions for their attorney.
Research within the social psychology area has found that practiced lairs (i.e., salespersons) are quite successful deceivers in experimental (and real world) settings (Ekman, 1992).

A priori knowledge and personal experience with head injury are variables that may contribute to the ability to feign cognitive and behavioral impairments. Descriptive evidence suggests that brain injured individuals may be less likely to be detected as malingerers (Bruhn & Reed, 1975). However, conflicting results have been reported regarding the impact of personal contact with brain damaged patients and ability to avoid detection in a malingering paradigm (Haywood et al., 1987; Kerr et al., 1990). Research has also shown inconsistent understanding for the post-concussive behavioral, physical and cognitive symptoms in community and college populations (Aubrey et al., 1990; Gouvier, Prestholdt et al., 1988; Gouvier, Uddo-Crane et al., 1988; Mittenberg et al., 1993). The possibility exists, although unexplored at present, that experiencing the behavioral and cognitive sequelae following head injury, or having a knowledgeable understanding of the accompanying sequelae of head injury may be utilized within a forensic assessment setting to produce a less pronounced exaggeration of neuropsychological deficits. Neither head injury experience or knowledge has been systematically investigated as to possible effects upon the capacity to feign neuropsychological impairment.

All three variables, test instruction, personal experience and a priori knowledge of head injury have been presented as possible factors effecting the
ability to malinger realistic cognitive and behavioral impairments demonstrated by the head injured patient. Previous research has either ignored, or singularly focused upon these subject variables within the malingering literature. Potential implications are that no single intraindividual factor exclusively contributes to malingering ability. It is possible that head injury experience, a priori knowledge, and test knowledge all effect performance on neuropsychological tests sensitive to malingering. What may be contributing to the inconsistent findings within the malingering detection research, is the failure to address the possibility that test specific instruction, personal experience and head injury knowledge each may effect the ability to create a realistic brain injured profile within neuropsychological assessment. The question remains to what extent do these variables influence a persons ability to malinger performance within the context of neuropsychological evaluation of the head injured patient.

An initial step in this determination will be to explore possible interactions between these variables. The literature reviewed suggests that all three variables may impact the ability to fabricate particular mental disorders. Several possibilities exist as to the relationship among these variables. It is possible that head injury knowledge may encompass the experience variable since head injury experience could be considered one of several possible means to gaining a knowledge/understanding of the head injury sequelae. However, it is possible that head injured individuals are more knowledgeable because of their exposure to the injury. If head injured individuals are found to be more understanding of the
sequelae of head injury then it seems reasonable to subsume the knowledge variable under the rubric of head injury experience. If no relationship is found then knowledge of head injury sequelae should be considered an independent factor for investigation.

Once the effect brain injury experience has upon head injury sequelae knowledge has been determined, further examination will be conducted as to the effects experience (with or without knowledge as an independent variable) and instruction have upon performance on clinical tests of malingering and post-concussive symptom endorsement.

Finally, whether these variables effect the ability to more accurately simulate the neuropsychological performance patterns of clinical samples of nonlitigating mild closed head injury patients will be examined.

**Hypotheses**

**Hypothesis 1**

Mild head injury subjects, demonstrating above average levels of head injury sequelae understanding, and provided instructions to malinger the cognitive and behavioral symptoms associated with mild head injury will perform significantly more like controls on measures of postconcussion symptom ratings and motivational effort than will malingering instructed subjects without such experience or knowledge.
**Hypothesis 2**

Subjects who have experienced mild head injury, demonstrate above average levels of head injury understanding, and provided task specific malingering instruction will demonstrate neuropsychological test performance and post-concussive symptom endorsement that is more similar to mild head injury patients than subjects without the presence of those variables.
METHOD

Subjects

A total of one hundred and fifty-nine Louisiana State University undergraduate students served as research subjects. Seventy two students were selected on the basis of having experienced mild closed head injury within the past five years. This mild closed head injury sample was selected from a pool of LSU undergraduates having indicated by survey data a positive history of closed head injury. The remaining 87 students were recruited by standard university procedures for the recruitment of university undergraduate students.

Subjects meeting the following set of criteria were included in the mild head injury group: (1) Reported loss of consciousness of 30 minutes or less, (2) reported posttraumatic amnesia not greater than 24 hours, (3) had any alteration in mental state at the time of the accident (e.g., feeling dazed, disoriented or confused, (4) not currently involved in litigation pertaining to the head injury, (5) occurrence of head injury within the past 5 years, and (6) not currently taking any psychotropic medication. Inclusion criteria 1-3 were established as criteria for defining mild head injury by the Mild Traumatic Brain Injury Committee of the Head Injury Interdisciplinary Special Interest Group of the American Congress of Rehabilitation Medicine (Kay et al., 1993).

An additional 19 mild closed head injured patients, either referred for neuropsychological evaluation or recruited some time following neuropsychological evaluation through the Department of Behavioral Medicine and Psychiatry at West
Virginia University in Morgantown, West Virginia, served as our clinical comparison group. Given that the head injured college students selected for this study likely represent the upper end of the mild head injured population distribution in terms of recovery of function, the patient group was used solely for better comparison to represent the population of mild closed head injury patients who are referred for neuropsychological evaluation. All head injured patients selected were 35 years of age or younger, experienced their injury no more than 5 years prior to inclusion in the study, not involved in litigation or compensation proceedings at time of testing, and meet at least one of the following: 1) loss of consciousness $\leq$ 30 minutes, 2) post traumatic amnesia $< 24$ hours, or 3) Glasgow Coma Scale or other comparable coma scale score in the mild to moderate range at time of initial hospitalization (Kay et al., 1993).

Materials

Premanipulation Test Measures

Prior to the experimental manipulations, all subjects were administered tests of new verbal learning/memory and intellectual ability. The Rey Auditory Verbal Learning test (AVLT) (Rey 1964 presented in Lezak, 1983) was used as the measure assessing verbal learning and memory. The North American Adult Reading test (NAART) (Blair & Spreen, 1989) was employed as an estimate of intellectual ability. Any subject scoring 2 SD below age-equivalent samples on the AVLT's verbal learning or delayed memory scores (Savage & Gouvier, 1993) was considered as displaying memory impairment and therefore not included in the
final experimental analyses. Likewise, any subject who performed 2 SD below age-equivalent samples on the NAART (Weins, Bryan, & Crossen, 1993) were not included in the statistical analyses. Likewise, any head injured patient scoring 2 SD below age-equivalent norms on the AVLT or NAART were not be included in the final patient group.

**North American Adult Reading Test.** The North American Adult Reading Test (Appendix A) is a 61 item word list employed to estimate premorbid intellectual ability and has been adapted from the National Adult Reading Test (NART) developed in England by Nelson and O'Connell (1978). The NART was based on the assumption that reading of irregularly pronounced words reflects prior familiarity with those words and is relatively insensitive to the effects of dementia (Weins et al., 1993). The NAART was created to reflect North American pronunciation rules. Strong positive correlations have been reported between WAIS-R FSIQ, VIQ, and PIQ scores and the NAART (.75, .83, and .40, respectively) (Blair & Spreen, 1989). NAART correlations have been reported to be stronger than demographically based regression equations for the estimation of premorbid IQ (Barona, Reynolds, & Chastain, 1984). Blair and Spreen (1989) report excellent interscorer reliability (.99) and internal consistency estimates (coefficient alpha, .94).

**Rev Auditory Verbal Learning Test.** The Auditory Verbal Learning Test (Appendix B) is a brief screening instrument used to assess verbal learning and memory abilities (Spreen & Strauss, 1991). This test has been demonstrated as an
effective measure of immediate verbal memory span, new learning, proactive and retroactive inhibition and delayed verbal recall (Geffen, Moar, O'Hanlon, Clark, & Geffen, 1990).

The AVLT is comprised of 5 learning trials in which an examiner reads aloud 15 words per trial and the subject is requested to recall the words. The identical word list is read for each of the five trials. Following the fifth trial, the examiner reads to the subject a new list of 15 words for immediate recall. After the interference list is recalled, the examiner requests the subject to recall words from the first word list. The test contains a 20-minute delayed free recall condition. Also, a recognition portion is administered requesting subjects to identify from among 50 words the original 15 words from the first list. Adequate psychometric characteristics of this test have been presented. Test-retest reliability coefficients range from .64 to .79 (Lezak, 1983). The AVLT has been shown to discriminate between distinct brain impaired populations (e.g., Bigler, Rosa, Schultz, Hall, & Harris, 1989). Normative data is readily available, with specific regional norms also presented (Weins, McMinn, & Crossen, 1988; Savage & Gouvier, 1992).

Head Injury Misconception Survey. The Head Injury Misconception Survey (HIMS, Gouvier, Prestholdt et al., 1988, Appendix C) is a 25 item questionnaire grouped into 5 topic areas related to head injury: (1) use of seatbelts, (2) effects of unconsciousness, (3) amnesia, (4) brain damage, and (5) recovery. This instrument has been designed as a measure of general misconception regarding the
effects of head injury (Gouvier, Prestholdt et al., 1988). Each question has subjects rate their agreement or disagreement concerning a particular topic along a four-point scale of false, probably false, probably true, and true. For this study, credit will be given for a correct answer if an item is scored in the correct or near correct direction. For example, on question 1. ("Wearing seatbelts causes as many injuries as it prevents") credit would be received if the subject choose either "False", or "Probably False". A maximum of 25 points could be scored, with higher scores indicating more accurate understanding of head injury (i.e., more correct).

Postmanipulation Test Measures

Multi-Digit Memory Test. The Multi-Digit Memory Test (MDMT, Bolter & Nicolls, 1991) is a computerized 72 item forced-choice digit recognition memory test adapted from the manual version introduced by Hiscock and Hiscock (1989). For each of the 72 trials, subjects view a 5 digit number presented on a computer screen for 2 seconds and then the stimulus number is removed. Following a short delay, two 5 digit numbers are presented to the subject, the original and a distractor. The task is divided into three blocks of 24 trials with each block having increased interstimulus delays (3 seconds, 7 seconds, and 15 seconds, respectively).

The symptom validity testing procedure has received considerable attention in recent years as a useful technique in the detection of faked memory impairment.
Research has demonstrated that even severely brain damaged patients can perform remarkably well on this type of task (Martin et al., 1993).

**Postconcussive Symptom Checklist.** The Postconcussive Symptom Checklist (PCSC) (Gouvier et al., 1992, Appendix D) rates ten common symptoms associated with head injury, with each symptom rated on the dimensions of frequency, intensity and duration. Each symptom is rated on a 5 point Likert-type scale, with higher numbers indicating increasing subjective impairment for each dimension. Four symptom scores are obtained with this checklist: (1) frequency total, (2) intensity total, (3) duration total, and (4) total score across dimensions. Gouvier et al. (1992) reported that the PCSC reliably differentiated between populations of head injured and normal control subjects, with the scale correctly classifying 64% of their sample. Positive correlations have been found between the PSCS and the Postconcussion Checklist of Oddy, Humphrey, and Uttley (1978).

Mittenberg and colleagues (1990; 1993) have showed that postconcussive symptoms may be frequently and accurately simulated in groups of malingerers. Typically, self-report measures of postconcussive symptoms have relied upon the presence or absence of a particular symptom (i.e., Oddy et al., 1978) without reference to other behavioral dimensions. Evidence for the utility of employing multiple behavioral dimensions in postconcussion self-report has been reported (Wong et al., 1994). In their study, analog malingerers endorsed a higher number of symptoms as well as obtaining higher scores on all three scale dimensions.
compared to control subjects. However, this strategy has not been examined in populations of head injured patients.

**Dot Counting Test.** The Dot Counting Test was developed by Rey (cited in Lezak, 1983, Appendix E) as a measure to identify malingered test performance. The DCT consists of twelve 3 x 5 cards each containing a set of either grouped or ungrouped dots presented to the subject. The first set of dot cards consists of a random pattern of 11, 19, 15, 23, 27, and 7 dots, respectively. The second set of six cards consists of grouped dots arranged in easily detected visual patterns consisting of 20, 16, 24, 28, 12, and 8 dots respectively. The subject is requested to silently count the number of dots for each card as quickly as possible and then give verbally report their answer to the experimenter. This is done for each individual card. Subject's response time in seconds and accuracy count are recorded for each card.

Test-retest reliability coefficients have been found to be adequate, ranging from .96 (total response time), to .57 for number of correctly counted ungrouped cards (Paul et al., In Press). Utilizing discriminant function analysis, the DCT has been found to successfully classify relatively unsophisticated malingersers and normal controls, but poorer classification among groups of sophisticated malingersers who were disproportionately more often misclassified as either neurologic patients or naive malingersers (Binks et al., 1993).

**Digit Span subtest of the WAIS-R.** The Digit Span Test is one of the 11 subtests of the Wechsler Adult Intelligence Scale-Revised (WAIS-R, Wechsler,
and is widely thought of as a measure of primary memory and attention (Spreen & Strauss, 1991). This test is comprised of two parts being the digits forward and digits backward subtests. On the digits forward subtest, subjects are requested to repeat strings of orally presented digits. Subjects continue repeating increasingly longer series of digits until two consecutive incorrect repetitions occur or they correctly repeat 9 digits. The digits backward subtest consists of subjects repeating orally presented series of digits in reverse serial order. This subtest is terminated when either two consecutive misses occur or if the subject correctly repeats 8 digits in reverse order. Scores are derived by total number of correct recall trials for both forwards and backwards portions and then converted to a scaled score equivalent (Wechsler, 1981).

Available psychometric information on the Digit Span Test has established the psychometric soundness of the test. Test-retest reliability estimates at one to seven weeks for the standardization sample has been reported at .83 (Wechsler, 1981), and .64 for a head injured sample at 12 months (Rawlings & Crewe, 1992). The Digit Span test consistently loads on a factor considered to measure attention/concentration (Leonberger, Nicks, Goldfader, & Munz, 1991; Roth, Conboy, Reeder, & Boll, 1990) and appears an important contributor to pattern cluster analysis profiles in closed head injury patient samples (Crossen, Greene, Roth, Farr, & Adams, 1990). The Digit Span test is sensitive to the residual effects of mild head injury at 3 month post-injury (Levin et al., 1987), although
Leininger et al. (1990) reported comparable digit span backward performance for mild head injured patients and controls.

The Digit Span Test has been found to be a sensitive discriminator of litigating mild head injured patients and non-litigating severe head injured patients (Mittenberg, Arzin, et al. 1993; Rawlings & Brooks, 1990). In these studies, the mild head injured patients were found to perform significantly worse on the Digit Span test compared to the severe closed head injured patients.

**Design and Procedure**

The design employed was a 3 (malingering instruction), x 2 (head injury experience), x 2 (level of head injury understanding) between groups factorial. Head injured and nonhead injured subjects were randomly assigned to one of three levels of malingering instruction: 1) no instruction-controls, 2) uncoached malingerers, or 3) coached malingerers. Control subjects were asked to perform their best on all test administered with no instruction to malinger. Uncoached malingerers were asked to malinger performance on the postmanipulation neuropsychological and self-report tests without any specific instruction. Coached malingerers were asked to malinger performance on the postmanipulation tests, but with task specific instruction on how to minimize their chances of being identified as malingering.

To investigate the effects personal experience with head injury had upon malingering performance, subjects were selected according to whether they have had a history of head injury. The experienced group were those subjects having
suffered a head injury and the unexperienced were subjects not having experienced a head injury. Any non-head injury subject having known someone (i.e., family member, close friend) who experienced a head injury were excluded from the experiment. This controlled for the potentially confounding effects of vicarious experience with head injury.

As outlined earlier in this study, if no significant relationship was found between head injury experience and HIMS score, then the knowledge variable would be considered independent of experience and utilized as an independent factor for subsequent analyses. Therefore, to investigate the impact that knowledge of head injury had upon malingering performance a three-way ANOVA (gender x head injury experience and instruction level) was calculated for the Head Injury Misconception Survey score (HIMS). A significant two-way interaction was found for head injury experience and gender on the HIMS score \( F(2,152) = 6.9, p < .009, \eta^2 = .04 \) with head injured males (M=16.5, sd=1.9) and nonhead injured females (M=16.0, SD=2.3) scoring slightly higher on the questionnaire than head injured females (M=15.5, SD=1.7) and nonhead injured males (M=15.1, sd=2.3). However, post-hoc Tukey-Kramer (Hinkle, Wiersma, & Jurs, 1988) analyses correcting for chance findings revealed no significant between groups differences. Given the lack of clear relationship between presence of head injury and head injury understanding, a further independent variable was created to investigate the impact of knowledge of head injury sequelae on malingering performance.
To determine the appropriateness of categorizing the HIMS score a frequency distribution was performed. Total scores ranged from 9 correct to 21 correct out of a possible 25 with a grand mean of 16.0 ($\text{SD}=2.2$). The sample distribution approximated normality, with 50% of the subjects scoring between 1/2 standard deviations of the mean. An equivalent distribution pattern was revealed between the head injured subjects and nonhead injured subjects scoring above and below-to-average the mean value. Thirty nine head injured subjects score at or below the mean value (39/72, 54%) compared to 46 of the nonhead injured (46/87, 53%). Thirty three head injured subjects scored above the mean value (33/72, 46%) compared to 41 of the nonhead injured subjects (41/87, 47%). Given the number independent variables under investigation it was decided to classify subjects into one of two groups on the HIMS score. The first group consisted of subjects who scored 16 correct or below (85/159) and were considered the below-to-average head injury informed group. Subjects scoring at or above 17 (74/159) were considered the above average head injury informed group.

All subjects were tested in the same location, a 10' x 10' testing room located in the L.S.U. Psychology Department building. All subjects were instructed to read a brief description of the study, followed by an informed consent form (Appendix G). Upon completing the informed consent, all subjects completed a demographic questionnaire (Appendix H). Next, subjects were asked to complete the premanipulation battery of tests described in the materials section. All subjects received in the following order: (1) AVLT, (2) HIMS and (3)
NAART. The AVLT was administered initially to allow for ample time between the learning portion and the delayed free recall conditions. All postmanipulation tests were administered in randomized order.

Upon completion of the premanipulation tests, control subjects were requested to read a short statement explaining the importance of undergraduate students in psychological research (Appendix I) and a short description of the research rationale (Appendix J). Controls read these statements to counterbalance the amount of material to be read by the malingering subjects. Then the control subjects were administered the postmanipulation tests as described in the methods section.

Following administration of the premanipulation questionnaires and test materials, all subjects assigned to the malingering groups read a statement regarding the rationale for their efforts at malingering (Appendix K).

The uncoached malingers then read a scenario (Appendix L) asking them to assume the role of an automobile accident victim who exhibited post-concussive symptoms, and was currently involved in compensatory litigation. They were requested to perform on the postmanipulation tests in a manner documenting their physical and cognitive impairments.

The coached malingers read an identical scenario to the uncoached malingers, but with additional instruction on how to best perform on the tests to avoid detection (Appendix M). They were then requested to perform on the
postmanipulation test in a manner documenting their physical and cognitive impairments.

Upon completion of the tests, all subjects were administered a 5-item questionnaire asking them to rate their efforts and perceived success at the tasks (Appendix N). All subjects then read a debriefing statement (Appendix O).

The clinical group consisted of mild head injury patients who had been previously evaluated in the context of a formal neuropsychological evaluation through the Department of Behavioral Medicine and Psychiatry at West Virginia University in Morgantown, West Virginia. The patient group were administered the identical tests employed in the present study. All patients were administered the tests as described in the materials section. They received an informed consent form (Appendix P) to review and sign prior to the time of their testing. No patient data was used for the present study unless the patient gave formal consent.

**Overview of Analyses**

Initial analyses provided calculation of the descriptive statistics. One-way ANOVAs were employed to examine between-group differences for subject variables (e.g., age, education), and for premanipulation measures. Factor analysis was performed to examine the relationships among the post-manipulation dependent variables. Multivariate analyses of variance (MANOVA) were then conducted to examine between-group differences on the neuropsychological test dependent variables and postconcussion symptom checklist dependent variables for the experimental groups (undergraduate students). Significant MANOVA effects were
then followed up with multiple Hotelling’s $T^2$ analyses further examining group differences on the dependent variables. Tukey-Kramer (TK) post-hoc method (Hinkle et al., 1988) was performed to examine any significant ANOVA results. The Tukey-Kramer method was employed as a means to adjust for the unequal sample sizes of the groups.

Following completion of statistical analyses for the experimental groups, subsequent analyses were performed comparing the clinical sample of mild head injured patients to the experimental groups. Minimizing the number of analyses performed, the experimental groupings were collapsed according to the preceding MANOVA results. For each dependent measure, separate one-way ANOVAs were performed to examine between-group differences for the mild head injury patient group and the aggregated experimental groups. Significant interactions were followed by post-hoc testing to reveal differential performance between patient and experimental groups. Tukey-Kramer correction was employed to adjust for possible inflated Type I error rate.

Determining appropriate sample size is an important element in establishing statistical power and detecting statistically significant effects (Cohen, 1992). Stevens (1986) provides power estimates within a MANOVA framework and explains that 148 subjects will be required for the present design if having a large effect size, power set at .80, and alpha level at .05.
RESULTS

All data analyses were conducted using the SPSS\PC+ V3.0 (Norusis, 1988). Final experimental sample size was 159 subjects. Seventy two mild head injured college students (39 females, 33 males) and 87 nonhead injured students (68 females, 19 males) completed the study. Of the 71 head injured subjects, 23 (32%) received no medical treatment for their injury, while 18 (25%) were treated in the emergency room and released. Only 6 subjects were admitted to the hospital for longer than one day (< 1%). Unfortunately, treatment information was mislocated for 23 of the head injured subjects. One female subject from the head injured group had to be excluded from the data analysis because she had a history of a pituitary tumor. Data was also collected on 19 mild head injured patients (12 females, 7 males).

A Pearson chi-square statistic was computed to examine relative frequencies of the nominal variable gender for our head injured patients and college students. A substantially greater proportion of females were present in the nonhead injured student sample (females=68, males=19) than in the patient sample (females=12, males=7) or head injured student sample (females=39, males=33), $X^2 (3, N = 178) = 12.02, p < .007$. However, females outnumbered males in all groups. No significant gender distribution differences were found across levels of malingering instruction (controls: Females = 33, Males = 18; uncoached malingerers: Females = 36, Males = 16; coached malingerers: Females = 38, Males = 18), $X^2 (3, N=159) = .88, p < .97$.  

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Separate three way ANOVAs (gender x head injury experience x instruction level) were calculated for age, education, FSIQ estimate, and the AVLT learning score and delayed recall score to examine for possible demographic variable confounds in the experimental sample. Table 1 lists demographic information and test data across groups. A significant effect of age was found for the head injury experience variable \( F(1,146)=7.3, \ p < .008, \eta^2 = .05 \), where head injured students \( (M=22.0, \ SD=6.3) \) were older than non-head injured students \( (M=20.1, \ SD=1.8) \). Examination of the sample distribution revealed that 5 of the subjects fell outside the 3 SD units from the overall sample group age mean value and were considered outliers (Tabachnick & Fidell, 1983). The 5 subjects were from the head injured group and were all over 35 years old. These subjects all performed within 1 SD or less of the non-head injured mean values for the FSIQ estimate, AVLT learning and delayed recall scores. Therefore, these older subjects were viewed as displaying comparable levels of intellectual and memory abilities to the younger subjects and were retained for subsequent analysis. For the 2 older head injured subjects who received no malingering instructions, they performed within 1/2 SD of the control group mean on the malingering measures. Reanalysis of the age effect, excluding the 5 older subjects revealed no significant age effect between the brain injured groups \( F(1,153) = 1.9, \ NS \).
Table 1

Mean and Standard Deviation Values for Age, Education, FSIQ Estimate, AVLT Summary Score, and AVLT Delay Recall Score Across Gender, Head Injury Experience, HIMS Score and Malingering Instruction.

Female Head Injured Subjects (n = 39)

<table>
<thead>
<tr>
<th></th>
<th>Below-to-Average HIMS</th>
<th>Above Average HIMS</th>
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<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Controls (n=11)</td>
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</tr>
<tr>
<td>Age</td>
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<tr>
<td>Education</td>
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<tr>
<td>FSIQ Est.</td>
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<tr>
<td>AVLT Sum.</td>
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<tr>
<td>AVLT Delay</td>
<td>11.6</td>
<td>2.4</td>
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Uncoached Malingers (n=12)

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<td></td>
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<td>Age</td>
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<tr>
<td>Education</td>
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<tr>
<td>FSIQ Est.</td>
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Coached Malingers (n=16)

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<tr>
<td>Age</td>
<td>28.3</td>
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<td>Education</td>
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<td>AVLT Sum.</td>
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<tr>
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<td>3.2</td>
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Female Nonhead Injured Subjects (n = 68)

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<td>SD</td>
</tr>
<tr>
<td>Controls (n=22)</td>
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</tr>
<tr>
<td>Age</td>
<td>19.8</td>
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<td>Education</td>
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<td>FSIQ Est.</td>
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<td>AVLT Sum.</td>
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</tr>
<tr>
<td>AVLT Delay</td>
<td>9.5</td>
<td>1.6</td>
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<tr>
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<th>Above Average HIMS</th>
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</thead>
<tbody>
<tr>
<td><strong>M</strong></td>
<td><strong>SD</strong></td>
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<tr>
<td><strong>Uncoached Malingerers (n=24)</strong></td>
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<td>Education</td>
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<td>AVLT Sum.</td>
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<td><strong>Coached Malingerers (n=22)</strong></td>
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<td>Education</td>
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<td>FSIQ Est.</td>
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<td>AVLT Delay</td>
<td>9.4</td>
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<tr>
<td><strong>Male Head Injured Subjects (n=33)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Below-to-Average HIMS</strong></td>
<td></td>
</tr>
<tr>
<td><strong>M</strong></td>
<td><strong>SD</strong></td>
</tr>
<tr>
<td><strong>Controls (n=12)</strong></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>19.5</td>
</tr>
<tr>
<td>Education</td>
<td>14.0</td>
</tr>
<tr>
<td>FSIQ Est.</td>
<td>101.5</td>
</tr>
<tr>
<td>AVLT Sum.</td>
<td>48.3</td>
</tr>
<tr>
<td>AVLT Delay</td>
<td>9.7</td>
</tr>
<tr>
<td><strong>Uncoached Malingerers (n=11)</strong></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>21.0</td>
</tr>
<tr>
<td>Education</td>
<td>15.2</td>
</tr>
<tr>
<td>FSIQ Est.</td>
<td>107.7</td>
</tr>
<tr>
<td>AVLT Sum.</td>
<td>50.5</td>
</tr>
<tr>
<td>AVLT Delay</td>
<td>9.8</td>
</tr>
<tr>
<td><strong>Coached Malingerers (n=10)</strong></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>20.0</td>
</tr>
<tr>
<td>Education</td>
<td>14.7</td>
</tr>
<tr>
<td>FSIQ Est.</td>
<td>103.0</td>
</tr>
<tr>
<td>AVLT Sum.</td>
<td>41.7</td>
</tr>
<tr>
<td>AVLT Delay</td>
<td>7.3</td>
</tr>
</tbody>
</table>

(table con'd.)
Nonhead Injured Male Subjects \((n=19)\)

<table>
<thead>
<tr>
<th></th>
<th>Below-to-Average HIMS</th>
<th>Above Average HIMS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Controls ((n=6))</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>25.5</td>
<td>0.7</td>
</tr>
<tr>
<td>Education</td>
<td>16.0</td>
<td>1.4</td>
</tr>
<tr>
<td>FSIQ Est.</td>
<td>98.6</td>
<td>20.5</td>
</tr>
<tr>
<td>AVLT Sum.</td>
<td>44.0</td>
<td>4.2</td>
</tr>
<tr>
<td>AVLT Delay</td>
<td>6.0</td>
<td>1.4</td>
</tr>
<tr>
<td>Uncoached Malingers ((n=5))</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>21.0</td>
<td>0.8</td>
</tr>
<tr>
<td>Education</td>
<td>15.0</td>
<td>0.8</td>
</tr>
<tr>
<td>FSIQ Est.</td>
<td>99.5</td>
<td>10.8</td>
</tr>
<tr>
<td>AVLT Sum.</td>
<td>43.5</td>
<td>5.9</td>
</tr>
<tr>
<td>AVLT Delay</td>
<td>6.5</td>
<td>3.5</td>
</tr>
<tr>
<td>Coached Malingers ((n=8))</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>19.3</td>
<td>1.2</td>
</tr>
<tr>
<td>Education</td>
<td>13.8</td>
<td>0.9</td>
</tr>
<tr>
<td>FSIQ Est.</td>
<td>106.7</td>
<td>4.8</td>
</tr>
<tr>
<td>AVLT Sum.</td>
<td>52.2</td>
<td>3.3</td>
</tr>
<tr>
<td>AVLT Delay</td>
<td>10.3</td>
<td>4.1</td>
</tr>
</tbody>
</table>

A significant gender by instruction interaction was found for education \([F(2,146) = 5.8, p < .03, \eta^2 = .05]\). Post-hoc Tukey-Kramer testing revealed a significant between groups effect \([F(5,153) = 4.0, p < .02, \eta^2 = .08]\). Male subjects in the uncoached malingering condition \((M=15.2, SD=1.0)\) had more years of education than the other groups \((M=14.3, SD=1.2)\). Examination of the data distribution revealed considerable overlap among the groups. Educational differences of this magnitude are not likely to contribute to differences on neuropsychological tests (Spreen & Strauss, 1991). Groups were therefore felt to be essentially equivalent in education level.
A significant head injury x instruction x gender interaction was found for the FSIQ estimate [$F(2,146) = 5.5, p < .005$]. However, strength of association between the interaction effect and the dependent variable was weak, $n^2 = .05$. Table 2 provides FSIQ estimate mean values across groups. However, correcting Table 2

**Mean and Standard Deviation values for FSIQ Estimate Across Gender, Head Injury Experience, and Malingering Instruction.**

<table>
<thead>
<tr>
<th></th>
<th>Head Injured Subjects</th>
<th></th>
<th>Nonhead Injured Subjects</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males</td>
<td>Females</td>
<td>Males</td>
<td>Females</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>n</td>
<td>M</td>
</tr>
<tr>
<td>Controls</td>
<td>103.5</td>
<td>6.3</td>
<td>12</td>
<td>107.4</td>
</tr>
<tr>
<td>Uncoached Malingerers</td>
<td>108.3</td>
<td>7.8</td>
<td>11</td>
<td>102.3</td>
</tr>
<tr>
<td>Coached Malingerers</td>
<td>107.5</td>
<td>9.5</td>
<td>10</td>
<td>106.7</td>
</tr>
</tbody>
</table>

for multiple contrasts post-hoc Tukey-Kramer testing revealed no significant between groups differences ($p < .13$). FSIQ estimate scores ranged from 84 to 118, with overall group mean score at 105.7(7.1). Nine subjects fell below 2 standard deviations from published age-appropriate NAART norms (Wiens et al., 1993). Three subjects were from the head injury sample and 6 were from the
nonhead injured sample. Since comparable proportions of low FSIQ estimate scores were found across the two groups these subjects were retained for analysis.

Examination of frequency distributions on the RAVLT learning score and delayed recall score revealed that 9 subjects (5 head injured, 4 nonhead injured) scored below 2 SDs compared to age and gender matched normative data (Savage & Gouvier, 1992). Subjects scoring at such low performance levels were originally considered to exhibit memory impairment. However, further examination revealed no differential performance on the post-manipulation measures for these subjects when compared to overall group mean performances. Therefore, these subjects were retained for further analysis.

A main effect was found on the AVLT learning score as a function of gender \([F(1,143) = 8.33, p < .005, n^2 = .05]\) where females recalled significantly more words across the 5 learning trials than males \((M=51.1, SD=6.6, M=48.4, SD=6.8, \text{ respectively})\). This finding is not surprising given the considerable research documenting a female advantage for verbal memory performance (e.g., Savage & Gouvier, 1992). Head injury experience was found to significantly effect score on the AVLT learning score \([F(1,143) = 9.2, p < .003, n^2 = .05]\). Interestingly, subjects with history of head injury recalled significantly more words across trials \((M=51.5, SD=6.9)\) than did subjects with no head injury experience \((M=49.2, SD=6.5)\). This suggests that as a group, the head injured subjects were well within normative ranges for verbal learning performance. Finally, AVLT learning score was significantly different in the three malingering instruction
conditions \[F(1,143)=5.8, \ p < .004., \ n^2 = .07\]. Coached malingerers recalled significantly more words across the learning trials \(\bar{M}=51.7, \ \text{SD}=6.3\) than the uncoached malingerers \(\bar{M}=48.1, \ \text{SD}=7.0\). The control subjects were at an intermediate position \(\bar{M}=50.8, \ \text{SD}=6.4\). However, for all between group comparisons mean values were within published normative levels (Savage & Gouvier, 1992).

When examining group differences on the AVLT delayed recall task, two separate 2-way interactions were found. A significant gender by instruction level interaction was found \[F(2,142) = 4.4, \ p < .01, \ n^2 = .06\] and a significant instruction level by head injury experience interaction was found \[F(2,142) = 3.3, \ p < .04, \ n^2 = .04\]. Post-hoc Tukey-Kramer testing revealed no significant between-groups differences for either the gender x instruction level or head injury experience x instruction level interactions. All group mean values for the delayed recall task were within published normal limits (Savage & Gouvier, 1992).

To further explore relationships between the demographic variables and the post-manipulation dependent variables Pearson Product Moment correlations were calculated (see Table 3). FSIQ estimate was significantly correlated with all the PCSC measures and was included as a covariate in further analysis of the PCSC variable. Age was significantly correlated with Dot Counting performance and included as a covariate in further analysis of the Dot Counting variable. The AVLT delayed recall score was significantly related to the Dot Counting Test
ungrouped minus grouped timed difference score and was included in further analysis of the timed difference score.

Maximum likelihood factor extraction with varimax rotation was performed through SPSS/PC+ (Norusis, 1988) on the post- manipulation dependent variables for each of the three coaching groups. The maximum likelihood factor analysis extracted two factors (i.e., eigenvalues > 1.0) for the control group (N = 52), as well as for the two malingering groups. All factors were distinguishable.

Table 3

Intercorrelations Between Demographic Variables and Post-Manipulation Dependent Variables.

<table>
<thead>
<tr>
<th></th>
<th>Age</th>
<th>Education</th>
<th>FSIQ est.</th>
<th>AVLT Learning</th>
<th>Delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCSC Frequency</td>
<td>.09</td>
<td>.00</td>
<td>.16*</td>
<td>.07</td>
<td>.00</td>
</tr>
<tr>
<td>Intensity</td>
<td>.05</td>
<td>.00</td>
<td>.18*</td>
<td>.02</td>
<td>.00</td>
</tr>
<tr>
<td>Duration</td>
<td>.08</td>
<td>-.02</td>
<td>.19*</td>
<td>.06</td>
<td>-.03</td>
</tr>
<tr>
<td>PCSC Total</td>
<td>.09</td>
<td>.00</td>
<td>.18*</td>
<td>.05</td>
<td>.02</td>
</tr>
<tr>
<td>DCT Total</td>
<td>-.15*</td>
<td>.00</td>
<td>.00</td>
<td>.10</td>
<td>.06</td>
</tr>
<tr>
<td>DCT Timed</td>
<td>-.08</td>
<td>-.13</td>
<td>.13</td>
<td>.00</td>
<td>-.16*</td>
</tr>
<tr>
<td>Difference</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DST Total</td>
<td>-.11</td>
<td>.14</td>
<td>.13</td>
<td>.03</td>
<td>.02</td>
</tr>
<tr>
<td>MDMT Total</td>
<td>-.08</td>
<td>-.06</td>
<td>-.03</td>
<td>.03</td>
<td>.06</td>
</tr>
</tbody>
</table>

Note. AVLT = Auditory Verbal Learning Test; FSIQ est. = Full Scale Intelligence Quotient estimate; PCSC = Post Concussion Symptom Checklist; DCT = Dot Counting Test; DST = Digit Span Test; MDMT = MultiDigit Memory Test.

*p < .05, 2-tailed probability.
and well defined for the groups. Therefore, groupings were collapsed and factor analysis was performed for the entire sample (N = 159). The two factor solution accounted for 68% of the variance in the dependent variables (see Table 4).

Results of the factor analysis revealed two clearly defined factors, with

Table 4

Eigenvalues with Percent Variance and Rotated Factor Matrix of the Control Sample Factor Analyses.

<table>
<thead>
<tr>
<th>Eigenvalue</th>
<th>% Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>4.08</td>
</tr>
<tr>
<td>2.</td>
<td>1.37</td>
</tr>
<tr>
<td>3.</td>
<td>.37</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>.93</td>
<td>-.25</td>
</tr>
<tr>
<td>Intensity</td>
<td>.94</td>
<td>-.19</td>
</tr>
<tr>
<td>Duration</td>
<td>.93</td>
<td>-.24</td>
</tr>
<tr>
<td>PCSC Total</td>
<td>.98</td>
<td>-.19</td>
</tr>
<tr>
<td>DCT Total</td>
<td>-.17</td>
<td>.43</td>
</tr>
<tr>
<td>DCT Timed Difference</td>
<td>.01</td>
<td>.03</td>
</tr>
<tr>
<td>Digit Span Test</td>
<td>-.21</td>
<td>.97</td>
</tr>
<tr>
<td>MDMT Total</td>
<td>-.27</td>
<td>.61</td>
</tr>
</tbody>
</table>

the first relating to postconcussive symptom endorsement, the second factor related to performance on the two malingering measures and the Digit Span test. A third weaker factor seemed to reflect a combination of speeded visual tracking and MDMT performance. Given the considerable intercorrelations among the three PCSC dimensions and total score it was decided to simplify further analysis and only examine group differences on total PCSC score. Since Dot Counting total score, Digit Span total score and Multi Digit Memory test total score were found to load significantly on a single factor, these measures were considered
conceptually related and appropriate for further exploration of group differences using an MANOVA procedure.

Since the timed difference score on the Dot Counting test was found to load on a separate factor from the other dependent variables, further analysis with this variable utilized a univariate procedure.

**Postconcussion Symptom Checklist**

A 2 x 3 x 2 between-groups analysis of covariance was performed on postconcussive symptom endorsement. Independent variables consisted of two levels of head injury (yes, no), three levels of instruction (controls, malingerers without test specific instruction, malingerers with test specific instruction) and two levels of head injury symptom understanding (HIMS score: below-to-average, above average). Since a strong correlation was found between the PCSC score and the FSIQ estimate, the FSIQ estimate was included as a covariate in the present analysis. Analyses were performed using SPSS/PC+ ANOVA, using a default strategy that accounted for unequal cell sample sizes.

Testing for homogeneity of variance using Bartlett-Box test revealed no significant dispersion across condition \(F=1.3, p = .05\). A significant main effect for instruction was found for the PCSC total score \(F(2,134) = 11.2, p < .0001\) after controlling for the effect of the covariate. The FSIQ estimate covariate was significantly associated with levels of the dependent variable \(R^2 = .18, p < .02\) and accounted for significant adjustment of the dependent variable \(F(1,134) = 6.3, p < .01\). In addition, a gender by HIMS score by instruction
interaction was found \( F(2,134) = 3.7, p < .03 \). Post-hoc Tukey-Kramer testing for the instruction main effect revealed a significant between groups difference \( F(2,157) = 7.5, p < .0001 \). Control subjects had lower postconcussion symptom scores (\( M=59.5, SD=18.3 \)) than either uncoached malingerers (\( M=76.3, SD=26.5 \)) or the coached malingerers (\( M=80.8, SD=27.1 \)). No significant differences were found between the two malingering groups. The strength of the relationship between adjusted PCSC total score and the 3-way interaction was minimal, with \( n^2 = .02 \). A larger association was found between PCSC total score and the main effect of instruction, \( n^2 = .16 \).

Post-hoc Tukey-Kramer multicontrast comparison, adjusting for inflated alpha level, found a significant between groups difference for the 3-way interaction effect \( F(11,147) = 3.5, p < .0002 \). The above average HIMS scoring male coached malingerers and the above average HIMS scoring female uncoached malingerers had significantly higher PCSC scores than the control subjects. No other group differences were significant. Examination of Figure 1 shows that the other malingering groups endorsed approximately the same amount of postconcussive symptoms.

Qualitative examination of the group mean performances suggest that the groups with the higher IQ estimate scores were more likely to endorse more postconcussive symptoms. IQ has not been found to consistently predict more sophisticated levels of malingering in analog situations (Kerr et al., 1989; Martin
Figure 1. Mean PCSC Total Score Across Gender, HIMS Score, and Instruction.

Note: BM=below-to-average HIMS scoring males, BF=below-to-average HIMS scoring females, AM=above average HIMS scoring males, AF=above average HIMS scoring females, MHI=mild head injury.
& Franzen, 1992). Individuals with average to low average IQ scores have been shown to perform similar to individuals with higher IQ scores.

Of note, while not statistically significant (F(1,134) = 3.4, p < .07) the head injured control subjects (M = 63.1, SD = 20.0) endorsed slightly higher levels of postconcussive symptoms than the nonhead injured students (M = 56.6, SD = 16.6). These differences are generally consistent with previous research examining head injured and nonhead injured college students postconcussion symptom endorsement (Gouvier et al., 1992).

**Dot Counting Test, Digit Span Test, and MDMT**

A 2 x 2 x 3 x 2 between-subjects multivariate analysis of covariance (MANCOVA) was performed on the three dependent variables: Dot Counting total correct, Digit Span total raw score, MDMT total correct. Independent variables were head injury experience (yes, no), gender (female, male), instruction level (control, malingerers without instruction, malingerers with instruction) and level of head injury understanding (below-to average HIMS score, above average HIMS score). Age was the single covariate used. SPSS/PC+ MANCOVA (Unique) method was employed to adjust for the unequal cell sizes within this design.

Results of the multivariate test for homogeneity of dispersion matrices revealed a significant heterogeneity with the pooled variance-covariance matrices across groups [Box’s M, F(150,5690) = 3.0, p < .0001]. Results of heterogeneity of matrices may lead to misleading estimates of error variance and effect estimation of overall significance levels (Tabachnick & Fidell, 1983). However, Box’s M test
is notoriously sensitive test of homogeneity of variance-covariance matrices and use
of Pillai's criterion may improve the robustness of multivariate analysis
(Tabachnick & Fidell, 1983).

Using Pillai's criterion a significant main effect was found for instruction
[F(6,266)= 6.8, p < .0001] across the composite dependent variable. Age was
found to significantly produce adjustment on the Dot Counting Test variable (B =
-.20, t-value=2.3, p < .02), but not on the other two dependent variables.

In addition, a significant gender by HIMS score by head injury experience
interaction was found [F(3,132) = 4.6, p < .004]. However, strength of
association between the interaction effect and the composite dependent variable was
quite weak, $n^2 = .04$. Examination of the univariate analysis revealed that the
groups differed significantly on only the Digit Span Test [F(1,134) = 9.0, p <
.003], but not the Dot Counting Test [F(1,134) = .57, p < .45], or the MDMT
[F(1,134) = 1.9, p < .17].

An additional 2 x 2 x 3 x 2 ANOVA was performed using the Digit Span
Test dependent variable and age as the covariate. Bartlett-Box F test was
performed to test homogeneity of variance. No significant heterogeneity was found
(.57, p < .78). A significant 3-way interaction for gender, HIMS score and head
injury experience was found [F(1,134)= 9.97, p < .002, $n^2 = .05$]. However,
examination of the strength of associations revealed that gender showed the
strongest association to the DST variable ($n^2 = .01$) compared to head injury
experience ($n^2 = .001$) or HIMS score ($n^2 = .005$). Post-hoc Tukey-Kramer
testing, correcting for multicontrasts, did not find any significant between groups differences. However, qualitative examination of the group means showed that below-to-average HIMS scoring head injured male subjects (M=17.5, SD=4.2) and the above average HIMS scoring nonhead injured male subjects (M=18.5, SD=4.8) scored higher on the Digit Span Test than below-to-average HIMS scoring nonhead injured males (M=11.7, SD=5.8) or females (M=14.6, SD=5.5), the below-to-average head injured females (M=12.1, SD=6.2), or the above average HIMS scoring head injured males (M=12.4, SD=5.6), females (M=13.2, SD=5.9), and above average HIMS scoring nonhead injured females (M=12.4, SD=6.3) (see Figure 2).

The main effect for malingering instruction was also significant \[ F(2,134) = 18.1, \ p < .0001, \eta^2 = .19 \]. Univariate F tests were significant for each of the dependent variables, Dot Counting total \[ F(2,156) = 8.0, \ p < .0001 \], Digit Span total correct \[ F(2,156) = 18.2, \ p < .0001 \], and MDMT total \[ F(2,156) = 24.3, \ p < .0001 \]. Post-hoc Tukey-Kramer testing was performed on each of the dependent variables to examine between-groups effects.

For the Dot Counting score, a significant between-groups difference was found \[ F(2,156) = 8.2, \ p < .0005 \] were controls achieved higher scores (M=10.6, SD=1.5), than either the uncoached malingerers (M=8.7, SD=2.8), and the coached malingerers (M=8.9, SD=3.1).

For the Digit Span test, a significant between-groups effect was found \[ F(2,156) = 18.2, \ p < .0001 \] were controls achieved higher scores (M=17.3,
Figure 2. Mean Digit Span Total Score Across Gender, HIMS Score, and Head Injury Experience.

Note: BM=below-to-average HIMS scoring males, BF=below-to-average HIMS scoring females, AM=above average HIMS scoring males, AF=above average HIMS scoring females, MHI=mild head injury.
than either the uncoached malingerers ($M = 12.3, SD = 5.9$) and the coached malingerers ($M = 11.5, SD = 6.3$).

Finally, for the MDMT total score a significant between-groups difference was found [F(2,156) = 24.3, p < .0001] were the controls scored significantly better ($M = 71.3, SD = 1.2$) than the uncoached malingerers ($M = 62.1, SD = 12.5$) who in turn scored better than the coached malingerers ($M = 56.0, SD = 14.9$).

**Grouped minus ungrouped Dot Counting time**

A 2 x 2 x 3 x 2 between-groups analysis of covariance was performed on the Dot Counting time difference score. Independent variables consisted of gender (male, female), head injury experience (yes, no), instruction level (control, malingerer without instruction, malingerer with instruction) and two levels of head injury understanding (below-to-average HIMS scorers, above average HIMS scorers). AVLT delayed recall score was used as a covariate for this analysis since delayed recall and the timed difference scores were significantly related on correlational analysis. The same SPSS\PC+ program was employed as with the PCSC analysis.

A significant 2-way interaction was found for gender and head injury experience [F(1,123) = 3.7, p < .05] after controlling for the effect of the covariate. The AVLT delayed recall score accounted for a significant adjustment of the dependent variable [F(1,123) = 4.3, p < .04]. Post-hoc Tukey-Kramer testing revealed a significant between-groups difference [F(3,155) = 3.4, p < .02, $\eta^2 = .06$] where nonhead injured male subjects ($M = 26.9, SD = 26.4$) had larger
difference scores than the nonhead injured female subjects ($M=14.9$, $SD=9.0$).

Head injured male subjects ($M=16.9$, $SD=14.1$) and female head injured subjects ($M=19.6$, $SD=15.3$) had intermediate difference scores.

In addition, main effects for gender [$F(1,123)=4.5$, $p < .04$, $n^2 =.03$] and HIMS score level [$F(1,123)=5.2$, $p < .02$, $n^2 = .03$] were found on the initial analysis. Male subjects had larger difference scores than females subjects ($M=20.7$, $SD=19.8$ vs. $M=16.7$, $SD=11.9$, respectively). Also, below-to-average HIMS scorers had larger difference scores than above average HIMS scorers ($M=19.6$, $SD=15.3$ vs. $M=16.2$, $SD=14.5$). No significant effect was found for the instruction manipulation [$F(2,123)=2.0$, $p < .13$].

Since no significant instruction level effect was found, a question was raised as to whether the time scores for the ungrouped and grouped dots were different across the control and malingering groups. Calculation of mean group performance for ungrouped and grouped dots was performed to informally examine potential group differences. Examination of timed scores for the ungrouped and grouped dot counting times revealed that the uncoached and coached malingers took a longer time to count the ungrouped dots compared to the controls ($M=41.8$, $SD=23.9$; $M=36.1$, $SD=12.6$; $M=29.9$, $SD=6.3$, respectively), and also the grouped dots ($M=21.8$, $SD=16.8$; $M=20.1$, $SD=12.0$; $M=13.7$, $SD=4.0$). As seen by these group means, the malingering groups took longer to count all dots, but not to a level of statistical significance, because of the high standard deviations of the malingers and especially the uncoached ones.
Across all analyses comparing the control and malingering groups, the malingering groups consistently exhibited greater heterogeneity of variance than the control group. Analog malingers are often found to exhibit greater heterogeneity of performance than controls since individuals can vary considerably in their approach to the malingering task (Bernard, 1990; Rogers et al., 1993). Also, many measures used in malingering research, such as the MDMT, are specifically designed to be quite easy tasks that produce ceiling effects in control samples. Instead of focusing on eliminating performance heterogeneity within analog malingering samples there could be a productive future examination of the underlying reasons for this variability. Initially investigations have begun exploring interindividual differences in malingering behavior within the context of neuropsychological assessment (Iverson, 1993).

**Post-Battery Questions (manipulation check)**

Previous malingering research employing college samples have reported that many subjects do not follow through on instructions to malinger brain impairment (e.g., Bernard, 1990). As recommended by Rogers (1988), manipulation checks were employed to screen for level of effort and perceived probability for successfully simulating head injury profile.

**Question 1.** As best as you can remember, what were you supposed to do in this study? All subjects were able to accurately describe the overall intent of the study and how they were to respond.
Question 2. Indicate how hard you tried to follow the instructions: 1 (not at all)--2--3 (somewhat)--4--5 (very hard)

Overall, 94% (134/143) of the subjects endorsed at least a level of 3 (somewhat) on the effort scale indicating that subjects gave a reasonable effort at complying with the instructions. Subjects in each of the instruction conditions displayed adequate effort levels (i.e., 3/5 or higher score): controls (42/46, 91%), no instruction malingers (46/49, 94%), and instructed malingers (46/48, 96%). No significant effect of gender was found, t(141) = 1.23, p < .22. Groups did not differ significantly in their level of effort.

Question 3. Predict how successful you were at producing the results asked of you in the instructions: 1 (not at all)--2--3 (somewhat)--4--5 (very successful)

Overall, 89% (130/143) of the subjects felt that they had been at least somewhat successful in following the instructions. One-way univariate analysis revealed a significant between-groups difference for the three instruction level groups [F(2,140) = 6.8, p < .002]. Controls (M=3.8/5, SD=.8) felt they were significantly more successful than either no instruction malingering group (M=3.3/5, SD=.78) or the instruction malingering group (M=3.2/5, SD=.8). No significant effect of gender was found, t(141) = .60, p < .55. These results are not surprising since controls were asked only to perform at their best and given no malingering instruction.

Question 4. Do you think you convinced the examiner that you really suffered from the problem you were asked to demonstrate? : Yes/No.
Only 43% of the malingering subjects felt that they had accurately portrayed someone with a head injury. Uncoached malingers 43% (21/49) felt as if they had portrayed themselves in an accurate manner, and only 46% (22/48) of the coached malingers felt that way. No significant effect for gender was found, t(141) = .76, p < .45.

**Question 5.** Would the possibility of earning more extra credit for a convincing performance cause you to work harder? : Yes/No.

Only 39% (18/48) of the control subjects would have worked harder if given more extra credit. However, 47% (20/49) of the uncoached malingers and 56% (27/48) of the coached malingers said they would have worked harder for more extra credit. No significant effect for gender was found, t(141) = .42, p < .68.

**Mild Head Injured Patients**

Data was collected on 19 mild head injured patients according to previously outlined selection criteria. Demographic and test performances are presented in Table 6. Compared to the experimental head injured and nonhead injured subjects the mild head injured patients were significantly older [F(2,175) = 11.2, p < .0001], had less education [F(2,177) = 7.2, p < .0009], but were not statistically different for FSIQ estimate, AVLT learning score and delayed recall score. Age and education level differences of this magnitude have not been shown to significantly impact neuropsychological performance, so patient and experimental
Table 5

**Mean and Standard Deviation Values for the Demographic Information and Test Performances in the Mild Head Injured Patients.**

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>25.4</td>
<td>6.1</td>
</tr>
<tr>
<td>Education</td>
<td>13.2</td>
<td>2.1</td>
</tr>
<tr>
<td>FSIQ est.</td>
<td>102.0</td>
<td>8.7</td>
</tr>
<tr>
<td>AVLT Learning Score</td>
<td>48.7</td>
<td>9.7</td>
</tr>
<tr>
<td>Delayed Recall</td>
<td>9.8</td>
<td>3.2</td>
</tr>
<tr>
<td>PCSC Total Score</td>
<td>72.9</td>
<td>22.2</td>
</tr>
<tr>
<td>DCT Total</td>
<td>10.9</td>
<td>2.0</td>
</tr>
<tr>
<td>DCT Timed Difference Score</td>
<td>17.1</td>
<td>14.4</td>
</tr>
<tr>
<td>Digit Span Test</td>
<td>15.4</td>
<td>3.4</td>
</tr>
<tr>
<td>MDMT Total Score</td>
<td>71.6</td>
<td>0.8</td>
</tr>
</tbody>
</table>

groups were viewed as being essentially equivalent on these demographic characteristics.

Since several gender differences were found for the experimental subjects, univariate analysis was conducted examining possible gender effects in the patient sample. No significant effects were found for gender across demographic characteristics or test scores. Therefore, the head injured patients were collapsed across gender for subsequent comparisons with the experimental subjects.
A significant gender x HIMS score x instruction level interaction was found on the PCSC with the experimental subjects. Male above average HIMS scoring coached malingerers and female above average HIMS scoring uncoached malingerers endorsed considerably more postconcussive complaints than other groups. With the inclusion of the head injured patient sample, a Tukey-Kramer multi-contrast procedure revealed a significant between-groups difference \[F(6,171)= 4.4, p < .0003\]. The head injured patient’s \((M=72.9, SD=22.2)\) postconcussive symptom endorsement was not statistically different from any other group, but were more similar to the malingering groups except for the above average HIMS scoring male coached malingerers and the above average HIMS scoring female uncoached malingerers.

Mild head injured patients total correct Dot Counting, Digit Span, and MDMT scores were compared with the experimental subject’s scores on these measures across the instruction level variable. Oneway analysis of variance on the Dot Counting Test revealed a significant between groups effect \([F(3,174)= 7.7, p < .0001]\). Experimental control subjects and the mild head injury patients performed nearly identical \((M=10.6, SD=1.5\) and \(M=10.9, SD=2.0,\) respectively), but significantly better than either malingering group (uncoached malingerers: \(M=8.7, SD=2.8;\) coached malingerers: \(M=8.9, SD=3.1,\) respectively).

Oneway analysis of variance for the Digit Span Test revealed a significant between groups effect \([F(3,174)= 13.6, p < .0001]\). Controls and mild head
injured patients demonstrated no statistical difference on this measure ($M=17.4$, $SD=3.4$ and $M=15.4$, $SD=3.4$, respectively). The patients performed significantly better than the coached malingerers ($M=11.5$, $SD=6.3$), but not so when compared to the uncoached malingerers ($M=12.3$, $SD=5.9$).

One way analysis of variance for the MDMT score revealed a significant between groups effect [$F(3,174)=21.8$, $p < .0001$] where controls and patients performed nearly identical ($M=71.3$, $SD=1.2$ and $M=71.6$, $SD=0.8$, respectively). Patients performed significantly better than either of the malingering groups.

Patients were not formally compared to the experimental subjects on the Dot Counting ungrouped minus group timed difference score, since no significant effects for the malingering instruction variable were found. However, informal examination of cell means between the groups shows that the patient group performed nearly identical to the coached malingering group ($M=21.5$, $SD=18.2$ and $M=21.3$, $SD=22.3$, respectively) and demonstrated larger difference scores compared to the controls ($M=16.1$, $SD=5.6$) and uncoached malingerers ($M=16.4$, $SD=10.6$).
DISCUSSION

The purpose of the present study was twofold. First, this study investigated the effects that head injury experience, head injury sequelae understanding, and malingering instruction had upon experimental subject's endorsement of postconcussive symptoms and performance on clinical tests of malingering. Secondly, the experimental subjects were compared to a group of mild head injured patients to examine whether head injured subjects, who had above average levels of understanding about the sequelae associated with head injury and who were provided with instruction on how to malinger on clinical tests would perform more similarly to the head injured patients.

Head injury understanding was assessed using the Head Injury Misconception Survey (Gouvier, Prestholdt et al., 1992). Knowledge regarding aspects of head injury is a relatively new area of investigation. To date only one instrument has been introduced that surveys level of informativeness about aspects of head injury (Gouvier et al., 1988). The HIMS was developed as a means to examine common misconceptions regarding head injury that have developed over the years in the general public. The survey asked questions from a broad range of domains related to head injury. This survey is the best available, empirically based measure of head injury knowledge, and was therefore thought to provide a general indication of an individual's level of accuracy of the consequences and ramifications of head injury.
Previous research with this instrument had found that individuals with head injury experience were no more informed regarding the sequelae accompanying head injury as were nonhead injured individuals. The present study found that, similar to the Gouvier et al. (1992) study, head injured subjects were no more informed about head injury than nonhead injured individuals. If no effect of head injury experience was found then an assumption was made that head injury understanding was independent of head injury experience. However, a significant gender by head injury experience interaction was found, in which male head injured subjects and nonhead injured female subjects were more informed about head injury sequelae than their counterparts. This is the first study, to the author's awareness, that has examined and subsequently found gender differences which interacted with the presence of head injury experience. However, further post-hoc analysis correcting for multiple comparisons revealed no statistically significant between-groups differences on the HIMS score. While group differences were found the magnitude of these differences was small enough to justify using the HIMS score as a separate independent variable for investigation.

In the Gouvier et al. (1988) study gender was not examined. While that study failed to find differences in knowledge of issues involving head injury, they did not directly examine the effects of gender. There exists no research to date that has examined this question. The present study found that while gender differences did exist it was in combination with head injury experience. Why head injured males and nonhead injured females appeared somewhat more
knowledgeable than their counterparts is unclear. No information was collected that investigated whether groups differed in quantity or quality of information source concerning head injury effects. In addition, group mean differences were within 1/2 standard deviations of each other and may reflect chance variation. Whether gender and head injury experience reflect phenomenological reality or chance variation awaits further investigation.

Research investigating the utility of various test procedures in the detection of malingering have generally found that greater sensitivity of malingering detection is achieved by employing multiple test procedures rather than single instruments (Franzen et al., 1990). Employment of discriminant function classification schemes has been found to produce rather robust detection accuracy in many cases (Rogers et al., 1993). In employing multivariate techniques there is an assumption that the dependent measures used in the prediction equation are conceptually related (Bray & Maxwell, 1985). In the present study multiple types of information were being collected on malingering performance. Subjects were asked to mangle both in their postconcussion symptom complaints and on laboratory malingering tests. While it would be reasonable to assume strong relationship between tests of malingering, tests of the relationship among these measures has not been systematically performed.

Results of the factor analysis revealed a strong 2-factor solution with a weaker third factor that accounted for 72% of the variance in the post-manipulation dependent variables. The first factor reflected the Postconcussion Symptom
Checklist dimension scores, while the second factor represented the Digit Span, Dot Counting and MDMT tests. The third factor had overlap with the second factor with inclusion of the Dot Counting and MDMT tests but also the grouped minus ungrouped dots time score. It was clearly seen that the PCSC measure was not significantly related to the other measures and was not appropriate for inclusion in a MANOVA procedure with the other dependent variables. The Dot Counting timed difference score, while demonstrating a positive relationship to the Dot Counting Test and MDMT total correct scores, was not accounted for on the second factor and was therefore analyzed individually. It appears from the results of this analysis that measures of postconcussion symptom complaints are separable from laboratory-based measures used to detect malingering, and should be viewed as measuring meaningfully different dimensions within any investigation of malingering detection strategies.

Malingering instruction, gender and level of HIMS score were found to effect performance on the Postconcussion Symptom Checklist (PCSC; Gouvier, Uddo-Crane et al., 1988). However, contrary to Hypothesis #1, head injury experience did not impact performance on this questionnaire. Contrary to recent speculations on the potential importance of head injury experience to subject's ability to fake postconcussive self report measures (Wong et al., 1994), the present study found that head injury experience did not alter postconcussive symptom endorsement under malingering conditions.
While all malingering groups endorsed a larger proportion of the postconcussion symptoms than controls, this difference was especially pronounced for the above average HIMS scoring coached male malingerers and the above average HIMS scoring uncoached female malingerers. This finding is consistent with previous research demonstrating that analog malingerers will simulate postconcussive complaints by increasing them to a degree that is significantly higher than in control subjects. In addition, above average HIMS scoring male coached malingerers produce disproportionately more symptoms than the other malingering groups. The combination of above average HIMS scores and coaching produced postconcussive profiles more deviant from controls and the mild head injured patient group. This is in direct contrast to Hypotheses #1, and #2 which predicted that coaching and above average head injury understanding would attenuate symptom endorsement to more closely approximate the mild head injured patient group.

Interestingly, a recent study by Lamb, Berry, Wetter, and Baer (1994) demonstrated that malingering subjects who were provided with information on closed head injury symptoms scored substantially higher on the MMPI-2 validity and clinical scales compared to controls and uniformed malingerers. This suggests that newly informed malingering subjects are being sensitized to the potential negative effects of head injury and possibly contributing to an exaggerated symptom profile. However, in the present study malingering subjects were not introduced to any new information regarding the effects of head injury, but relied
upon their own apriori understanding in their attempts at simulation. Given that well-informed malingerers in the present study often exaggerated their performance, relative to controls and below average-to-average informed malingerers, it appears that awareness of head injury sequelae produces a more striking deviation of performance. The implications from these results suggest that being informed about the effects of head injury potentiates more symptom endorsement.

However, the present study found that, in general, malingering subjects were able to accurately portray the mild head injured patient's postconcussive profile. This is generally consistent with the research of Mittenberg and colleagues (1990, 1992) who have demonstrated that analog malingerers can produce a cluster of symptoms remarkably similar to the postconcussive syndrome reported by patients with head trauma. The research of Gouvier et al. (1992) has shown that laypersons endorse experiencing many of the same symptoms as do head injured patients, although not necessarily to the same extent. It appears that there exist a common perception across head injured and nonhead injured groups as to the expected pattern of postconcussion symptoms. Aubrey et al. (1989) have suggested that head injured patients have premorbid expectations for postconcussive symptoms and following their injury will interpret such symptoms as a direct result of the head injury, or overinterpret the symptoms cause.

This study did not specifically examine individual symptom endorsement as did the Mittenberg et al. (1992) study which found a common expectation of
symptom sequelae among head injured patients and community samples. They found that the 2 groups produced similar expectations for the frequency of postconcussive symptoms. The symptoms which were the most commonly expected were headaches, anxiety, depression, concentration problems, vertigo, diplopia, confusion, irritability, fatigue, photophobia and memory problems. The present study evaluated only total postconcussion symptom score and not each individual symptom. Therefore, the present study was unable to determined whether patterns of individual symptom endorsement differed between malingering and nonmalingering subjects or the head injured and nonhead injured subjects. However, the PCSC assesses a similar symptom profile cluster to that reported in Mittenberg et al. (1992), thereby suggesting reliable expectations by simulators and laypersons towards postconcussion symptom endorsement. As previously mentioned, the above average HIMS scoring male coached malingerers were the exception to this pattern, they produced considerably more symptom complaints than any other group including the mild head injured patients. They appeared to overplay the extent of postconcussive symptoms in head injury.

Another finding to note from the analyses of the PCSC was the finding of differential gender effects when given instruction to simulate brain injury. The possible role that gender plays in simulation of brain injury has seldom been examined in the malingering literature. It is noteworthy to point out that the majority of clinically reported cases of suspected malingering involving brain injury have been of male patients and in the majority of analog malingering studies
gender sampling distributions, if they are at all reported, usually have far larger numbers of females. One recent study (Wong et al., 1994) investigating potential gender differences in malingering ability found no significant gender effects when examining postconcussive symptom endorsement under control and malingering conditions. However, their female subjects did display slightly higher postconcussion symptom endorsement rates when under malingering instructions compared to male subjects. Given the limited research within this area, further investigation will be necessary to provide a more detailed explanation for its occurrence and possible impact upon current malingering research.

Related to this question of gender effects in neuropsychological malingering research is the research literature within the social psychology area investigating self-presentation, deception and role playing (DePaulo, 1992). Research in this area has demonstrated that gender differences "... may be one of the most pervasive and important of all individual differences in the use of nonverbal behavior for self-presentation purposes" (DePaulo, 1992, pg. 222). Females have been shown to be more spontaneous in speech and describe themselves as more emotionally expressive than males. When lying affective expression men appear more likely to "ham it up" than females (DePaulo & Rosenthal, 1979). That is, males seem better able to suppress their true feelings and are more likely to embellish a simulated feeling of attraction or affection. To some extent, this appeared to have carried over to the testing situation in the present study. Male
malingerers tended to overplay their roles as head injured victims, more so than females.

In addition, FSIQ estimate was found to be significantly related to postconcussive symptom endorsement. However, examination of mean estimated FSIQ scores revealed that, in general, those groups with the highest mean estimated IQ scores were also the groups with the most endorsed postconcussion complaints. Intellectual level has not been found to consistently predict more sophisticated levels of malingering (Kerr et al., 1989; Martin & Franzen, 1992). In the current sample the mild head injured group were essentially equivalent in intellectual ability to the college subjects sample. Therefore, statements regarding malingering ability on the PCSC in individuals with average to above average seems appropriate. However, limiting the generalizibility of this statement is that this and other studies have limited sampling to largely college educated populations who demonstrate mostly average to above average intellectual ability. Research is needed that more closely resembles the clinical situation (i.e., males with less than 12 years of education; Levin et al., 1982).

The present sample of head injured experimental subjects and patients was not representative of the population at large in terms of gender distribution. Epidemiological estimates place the ratio of young head injured victims at 4:1 in favor of males (Levin et al., 1982). This clearly restricts the generalizability regarding statements of head injury impact on postconcussion symptom complaints or clinical malingering test performance since any effect of head injury may have
been masked by disproportionetly low number of male subjects. The present experimental sample of head injured subjects consisted entirely of college educated individuals who likely possess different academic and intellectual abilities than the typical young head injured patient (i.e., male with < 12 years of education) (Richardson, 1990). As discussed by Wong et al. (1994) differential enviromental demands, and degrees of understanding regarding the sequelae of head injury, as well as, more sophistication regarding testing situations my produce meaningful distinctions between college samples and the typical young male head injured patient.

Head injury experience, level of HIMS score, gender and malingering instruction were all found to impact performance on the Factor 2 composite variable (Dots, Digit Span Test, MDMT). Unlike the findings for a significant gender influence on postconcussion symptom endorsement, no main effect of gender was found on these three measures. Analysis revealed a gender by HIMS score by head injury experience 3-way interaction and a separate malingering instruction main effect. The main effect for instruction level clearly produced the strongest effect on the composite variable, while gender, HIMS score and head injury experience all combined to demonstrate only a weak association to the composite dependent variable. In addition, results of this analysis failed to confirm Hypothesis #1 which stated that coached head injured above average HIMS scorers would demonstrate test performance more like nonmalingering subjects than the uncoached nonhead injured, below average-to-average HIMS scoring malingering
subjects. What did significantly impact performance on the malingering tests was the request to simulate head injury. Subjects who received malingering instruction performed quite differently than control subjects on the Factor 2 composite variable. Similar to other studies using these measures and employing analog malingerers (Binks, et al., 1994; Martin et al., 1993), the simulating subjects consistently altered their performance in the direction of poorer performance when compared to the controls. What was unexpected was that coached malingerers performed as poorly if not more so on these measures than the uncoached malingerers.

Previous research employing coaching manipulations within a analog malingering framework have shown that test specific instruction enhances the malingerer’s ability to simulate more realistic test performance on a forced-choice recognition memory task (Martin et al., 1993). Additionally, researchers investigating the susceptibility of malingering of closed head injury on the MMPI-2 found that subjects given instruction on the rationale of the validity scales had lower validity and clinical scale scores compared to uncoached malingerers (Lamb et al., 1994). However, the present study failed to find an effect for coaching. Coached malingerers performed similarly or worse than uncoached malingerers across both postconcussion symptoms and malingering tests.

It could be argued that the coached malingerers were less motivated to perform well (i.e., did not give their best effort). Previous research has demonstrated that a minority of subjects do not attempt to malinger despite being
given instruction (Bernard, 1990). Obviously failure to ensure adequate effort on
the part of malingering analog subjects would jeopardize the interpretability of
findings. However, 95% of the malingering subjects in the present study stated
that they had attempted to follow the malingering instructions provided. None of
the malingering subjects stated that they had given no effort in their simulation
attempt. No significant differences were noted on effort level as a function of
malingering instruction. That is, coached malingerers attempted to perform as
requested as much as the uncoached malingerers or controls. It appears that in the
present study malingerers were reasonably well motivated to perform in accordance
to instructions.

Another issue regarding the failure to find an effect for the coaching
manipulation may be in the amount of material that had to be learned and the time
allowed to learn it. In the Martin et al. (1993), study coached malingerers were
instructed on only one task (MDMT). Subjects were given ample time to study the
instructions, which consisted of 3 brief statements about how to perform on the
task to avoid detection. For that particular study the demands upon new
information learning appear low. In the Lamb et al. (1994) study, in addition to
the allotment of "study time", all coached simulating subjects had to pass a 10-item
quiz about the instructions prior to receiving the MMPI-2 and participation in the
remainder of the study. The present study did not systematically check coached
malingering subjects understanding of the instructions. There exists a possibility
that they did not fully understand or were overwhelmed by the amount of new
information they were attempting to incorporate into the testing situation. However, subjects were encourage to refer to their instruction sheets at any point during the testing. In any event, it seems that to maximize the effects of any coaching manipulation, subject’s understanding and mastery of the newly learned information should be checked.

Across each of the dependent variables (Dot Counting Test, Digit Span Test, and MDMT), malingerers performed worse than either the control subjects or the mild head injured patients. Specifically, on the Dot Counting test, both coached and uncoached malingerers scored on average 2 correct items less than either control subjects or head injured patients. This finding is consistent with that of the Binks et al. (1993) study that also found failure for coaching manipulation and fewer correct dot identifications in the malingering groups. For the Digit Span test, the coached malingerers scored slightly lower than the uncoached malingerers. Both groups of malingerers scored significantly poorer than either controls or head injured patients. Mittenberg et al. (1993) has also demonstrated that uncoached malingerers and litigating mild head injured patients will demonstrate poorer performance on this test of auditory memory span. Both this study and the Mittenberg et al. (1993) study demonstrate the failure of malingering subjects to appreciate the relative preservation of auditory memory span despite brain injury. Martin and Franzen (1992) presented data showing that even psychology graduate students and faculty who were well grounded in the theoretical notions in cognitive
psychology failed to recognize how auditory memory span could be preserved in head trauma patients.

On the MDMT, the coached malingerers actually performed significantly worse than uncoached malingerers. Both groups of malingerers again performed much worse than either the controls or head injured patient groups. These results suggest that coaching is not attenuating test performance as has previously been demonstrated (Martin et al., 1993; Lamb et al., 1994) and that in this instance actually seems to have accentuated the simulated deficit.

In addition to the instruction level main effect, a weaker 3-way interaction was found that included the variables of gender, HIMS score and head injury experience. Examination of the univariate analysis revealed that this interaction effect was produced by group differences on the Digit Span test. Groups were not statistically different on the Dot Counting test or MDMT. When examining each independent variable's strength of association to the dependent variable gender produced the strongest association, while head injury understanding and experience produce considerably weaker associations. Post-hoc multicontrasts revealed no significant between group differences on the Digit Span Test, again implicating relatively weak contribution of these variables to performance on the Digit Span, Dot Counting, and MDMT tests.

The Dot Counting Test timed difference score (ungrouped dot time minus the grouped dots counting time) has been proposed as a potential measure of questionable motivational performance (Lezak, 1983). The rationale for the test is
that malingerers will not take advantage of the grouped arrangement of the grouped dots and will demonstrate little difference or time taken to count the grouped dots and ungrouped dots. In an attempt to replicate, Binks et al. (1994) demonstrated that uncoached analog malingerers produced smaller timed difference scores than coached analog malingerers and control subjects.

In the present study, Dot Counting ungrouped minus grouped timed difference scores varied as a function of gender, HIMS score and head injury experience. An interaction effect was found were nonhead injured male subjects demonstrated significantly larger dot timed difference scores than either head injured male subjects or head injured and nonhead injured female subjects. The effects of gender were again found to influence task performance, with male subjects demonstrating larger timed difference scores than females. Also, a significant main effect was found for the HIMS score variable were the below-to-average HIMS scorers demonstrated larger difference scores than above average HIMS scorers.

Surprisingly, no significant effects were found for the instruction variable. However, examination of the counting times for the grouped and ungrouped times separately revealed that malingerers demonstrated slower overall counting times, but no greater differential timed score compared to the control group. Demonstration of slower dot counting times in the malingering groups suggests that they were altering their performance relative to controls by taking longer to complete the task. These results are in contrast to the findings of Binks et al.,
(1994) who showed that the timed difference score was a strong contributor to a discriminate function which was able to successfully classify 81% of their malingering subjects. The results of the present study suggest that malingers will lengthen counting times for both ungrouped and grouped dots. When compared to the mild head injured patient group, the mild head injured students performed nearly identical in counting time.

The most obvious limitation of the present study was the failure to obtain equal cell sizes for the experimental design. Preference is always stated for obtaining equal cell sizes to help ensure meeting the assumption of homogeneity of variance. Failure to meet homogeneity assumptions can lead to considerable alterations in interpretability of the F test (Hinkle, Wiersma, & Jurs, 1988). If larger variances are obtained with the larger sample cell size, the F test will be too conservative. If the larger variances are associated with the smaller sized cells, then the F test will be too liberal. Examination of the variance-covariance matrices for the MANCOVA design revealed mixture of large and small variances for both the large cell and small cell groups. However, since within groups samples sizes were within a 4:1 ratio (with one exception), and within group variances were within a 20:1 ratio assumption of homogeneity of variance was felt to be satisfactorily meet (Tabachnick & Fidell, 1983).

Recent questions have been brought forth concerning the potential ethical dilemmas involved with presentation and conduction of coaching malingering studies (Ben-Porath, 1994; Berry, Lamb, Wetter, Baer, & Widiger, 1994). The
general issue is one of balancing between a clinician’s desire to know if clinical tests are susceptible to faking and the upholding of the "...integrity and security of tests and other assessment techniques consistent with the law, contractual obligations, and in manner that permits compliance with the requirements of this ethics code" (Ethical Standard 2.10 of the American Psychological Association’s Ethical Principles of Psychologists and Code or Conduct; APA, 1992). In adhering to sound methodological tenets, reporting simulation instructions may actually undermine the security of tests and allow the very persons not intended to have such information the means to avoid detection that researchers are trying to develop. Potential solutions to this sensitive issue have been brought forth (Berry et al., 1994). One possibility is to place restrictions on who could have access to publications that include malingering instruction to professionals bound by APA ethical codes. Another is to not include coaching instructions in the published reports, but require that persons interested contact the researchers personally. As pointed out by Berry et al. (1994), researchers and journal editors will invariably differ on what is reasonable exclusion of material for publication in this area, but in any event sensitivity to the ethical dilemmas involved will by paramount.

Clinical and Research Implications

Self-report measures of postconcussive symptoms have been shown to be vulnerable to malingering when employing nonhead injured college samples (Wong et al, 1994). When asked to simulate symptoms present following mild head injury malingering subjects endorsed symptom levels similar to that seen in the mild head
injured patient group (Wong et al., 1994). The present study also found similar results with malingering subjects endorsing postconcussive symptoms at levels comparable to that of mild head injured patients. This study strengthens the notion that self-reported measures of postconcussive symptoms are ineffective when attempting to differentiate between actual symptom presentation and malingering or exaggeration. Also, the general public is becoming more educated through the efforts of the medical and public health communities. This in turn may contribute to the unintentional paradox of having a more knowledgeable laypublic, but with some individuals using that information to defraud these same medico-legal institutions. However, Lamb et al (1994) have suggested that the opposite pattern may occur with higher symptom endorsement resulting from greater levels of awareness of head injury sequelae. This issue certainly warrants further investigation.

In contrast to the Wong et al. (1994) study, this study included a clinical sample of mild head injured patients, as well as, a sample of college students having sustained mild head injury for direct comparison. The inclusion of these groups enables more conclusive statements regarding differential response levels than relying upon normative data. However, since the head injured subjects in the present study displayed discordant demographic features compared to population based demographic characteristics of young mild head injured patients the generalizability of these findings to actual clinical settings is limited.
This study demonstrated that these same malingering subjects who displayed similar postconcussive symptoms endorsement to clinical patient group were also clearly distinguishable from that same patient group on clinical testing. Neither the coached or uncoached malingering groups were able to simulate performance of the mild head injured patient group for the MDMT, Dot Counting Test and the Digit Span Test. However, the Dot Timed Difference score was not significantly different as a function of malingering instruction. These results suggest that self-report and clinical tests are differentially sensitive to instruction to mangle with self-reporting of postconcussive symptoms more likely to be successfully mangled than performance on standardized clinical tests.

It has already been demonstrated that laypersons have a reasonably good understanding of postconcussive sequelae following head injury (Mittenberg et al., 1992), and when asked to mangle these symptoms do so in a manner that is quite similar to head injured patients (Wong et al., 1994). However, laypersons expectations of neuropsychological test performance following head injury is much less accurate as demonstrated by substantially poorer performance on clinical neuropsychological tests and clinical tests of malingering (Mittenberg et al., 1994). Martin and Franzen (1991) have already demonstrated that even professionals in behavioral science-related fields, who are familiar with cognitive theory and psychometric methods, are only able to partially reproduce patterns of neuropsychological test performance displayed by head injured patients. That is,
the general public is less sophisticated regarding likely performance on clinical tests then they are towards postconcussive symptoms as measured by self-report.

Also, the nature of inquiry of postconcussive symptoms by the clinician (or attorney) could actually produce indistinguishable self-report profiles of the malingerer compared to actual head injured patients. Standardized postconcussive symptom questionnaires do not typically contain "false-positive errors" (Wong et al., 1994, p. 412). That is, items rarely endorsed by the particular diagnostic group. Mittenberg et al. (1990) demonstrated that many analog malingerers endorsed experiencing problems with procedural and remote memory, problems that are rarely encountered in the mild head injured population and contradict the theoretical conceptualization of memory disorders in head injury. This suggests that the inclusion of atypical or unusual symptoms should be included in any self-report measure to help establish complaint legitimacy (Wong et al., 1994). This strategy has been successfully utilized within the psychopathology literature in which atypical symptom endorsement has been applied to identify feigned mental illness (Rogers et al., 1991).

Recently, Nies and Sweet (1994) provided an excellent review article addressing both state of the art investigations and future directions for research. It is clear from their discussion that several particular methodological improvements need to be addressed. Future studies should make concerted effort to select subject samples more representative of the head injury population at large. As previously mentioned in this study, including a disproportionate number of females thereby
limiting the generalizability of these findings to the clinical situation. Further investigation should address the extent to which coaching enhances malingering deception and what types of information and practice is required in order for subjects to successfully simulate brain injury. Previous research has shown that coaching can enhance deception in the experimental setting, but applicability of this information to the clinical situation is still limited. A particularly good notion presented by Nies and Sweet (1994) is the idea of utilizing multivariate methods to the malingering paradigm. That is, incorporate systematic multitrait-multimethod strategies (i.e., Campbell and Fiske, 1959) in which different methods are used in the assessment of malingering. Nies and Sweet (1994) provide the example of incorporating physiologic, neuropsychological, interview data, and self-report measures into the evaluation protocol to enhance convergent validity of the diagnostic process.
REFERENCES


Appendix A
# North American Adult Reading Test (NAART)
## Word List Page One

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Debt</td>
</tr>
<tr>
<td>2.</td>
<td>Debris</td>
</tr>
<tr>
<td>3.</td>
<td>Aisle</td>
</tr>
<tr>
<td>4.</td>
<td>Reign</td>
</tr>
<tr>
<td>5.</td>
<td>Depot</td>
</tr>
<tr>
<td>6.</td>
<td>Simile</td>
</tr>
<tr>
<td>7.</td>
<td>Lingerie</td>
</tr>
<tr>
<td>8.</td>
<td>Recipe</td>
</tr>
<tr>
<td>9.</td>
<td>Gouge</td>
</tr>
<tr>
<td>10.</td>
<td>Heir</td>
</tr>
<tr>
<td>11.</td>
<td>Subtle</td>
</tr>
<tr>
<td>12.</td>
<td>Catacomb</td>
</tr>
<tr>
<td>13.</td>
<td>Bouquet</td>
</tr>
<tr>
<td>14.</td>
<td>Gauge</td>
</tr>
<tr>
<td>15.</td>
<td>Colonel</td>
</tr>
<tr>
<td>16.</td>
<td>Subpoena</td>
</tr>
<tr>
<td>17.</td>
<td>Placebo</td>
</tr>
<tr>
<td>18.</td>
<td>Procreate</td>
</tr>
<tr>
<td>19.</td>
<td>Psalm</td>
</tr>
<tr>
<td>20.</td>
<td>Banal</td>
</tr>
<tr>
<td>21.</td>
<td>Rarefy</td>
</tr>
<tr>
<td>22.</td>
<td>Gist</td>
</tr>
<tr>
<td>23.</td>
<td>Corps</td>
</tr>
<tr>
<td>24.</td>
<td>Hors d'oeuvre</td>
</tr>
<tr>
<td>25.</td>
<td>Siev</td>
</tr>
<tr>
<td>26.</td>
<td>Hiatus</td>
</tr>
<tr>
<td>27.</td>
<td>Gauche</td>
</tr>
<tr>
<td>28.</td>
<td>Zealot</td>
</tr>
<tr>
<td>29.</td>
<td>Paradigm</td>
</tr>
<tr>
<td>30.</td>
<td>Facade</td>
</tr>
</tbody>
</table>
North American Adult Reading Test (NAART)
Word List Page Two

31. Cellist 46. Leviathan
32. Indict    47. Prelate
33. Detente  48. Quadruped
34. Impugn  49. Sidereal
35. Capon   50. Abstemious
36. Radix    51. Beatify
37. Aeon     52. Goaled
38. Epitome  53. Demesne
39. Equivocal  54. Syncope
40. Reify    55. Ennui
41. Indices  56. Drachm
42. Assignate  57. Cidevant
43. Topiary  58. Epergne
44. Caveat   59. Vivace
45. Superfluous  60. Talipes
61. Synecdoche
Rey Auditory Verbal Learning Test

Scoring Sheet: Form 1

Name: ___________________________  Date: ______________________

(Note: Do not re-read List A for Recall Trial 6)

<table>
<thead>
<tr>
<th>Recall Trials</th>
<th>Recall Trials</th>
</tr>
</thead>
<tbody>
<tr>
<td>List A</td>
<td>List B</td>
</tr>
<tr>
<td>A1 A2 A3 A4 A5</td>
<td>B1</td>
</tr>
<tr>
<td>drum</td>
<td>desk</td>
</tr>
<tr>
<td>curtain</td>
<td>ranger</td>
</tr>
<tr>
<td>bell</td>
<td>bird</td>
</tr>
<tr>
<td>coffee</td>
<td>shoe</td>
</tr>
<tr>
<td>school</td>
<td>stove</td>
</tr>
<tr>
<td>parent</td>
<td>mountain</td>
</tr>
<tr>
<td>moon</td>
<td>glasses</td>
</tr>
<tr>
<td>garden</td>
<td>towel</td>
</tr>
<tr>
<td>hat</td>
<td>cloud</td>
</tr>
<tr>
<td>farmer</td>
<td>boat</td>
</tr>
<tr>
<td>nose</td>
<td>lamb</td>
</tr>
<tr>
<td>turkey</td>
<td>gun</td>
</tr>
<tr>
<td>color</td>
<td>pencil</td>
</tr>
<tr>
<td>house</td>
<td>church</td>
</tr>
<tr>
<td>river</td>
<td>fish</td>
</tr>
</tbody>
</table>
Rey Auditory Verbal Learning Test

Recognition Task

Form 1

Instructions: Circle as many of the following words from the FIRST list as you can remember.

bell   home   towel   boat

glasses window fish curtain

hot stocking hat moon

flower parent shoe barn

tree color water teacher

ranger balloon desk farmer

stove nose bird gun

rose nest weather mountain

crayon cloud children school

coffee church house drum

hand mouse turkey stranger

toffee pencil river fountain

garden lamb
Head Injury Questionnaire

Instructions: Please indicate whether you think each statement about certain aspects related to head injury is true, probably true, probably false, or false. Circle the appropriate number corresponding to each answer.

<table>
<thead>
<tr>
<th></th>
<th>True</th>
<th>Probably True</th>
<th>Probably False</th>
<th>False</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. SEATBELTS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Wearing seatbelts causes as many injuries as it prevents.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>2. It is safer to be trapped inside a wreck than to be thrown clear.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>3. You don’t need seatbelts as long as you can brace yourself before a crash.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4. It is more important to use seatbelts on long trips than in driving around town.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5. A head injury can cause brain damage even if the person is not knocked out.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>6. Problems with speech, coordination, or walking are usually due to brain damage.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>7. Whiplash injuries to the neck can cause brain damage even if there is no direct blow to the head.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>8. Most people with brain damage are not fully aware of its effect on their behavior.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Head Injury Questionnaire (con't.)
**Instructions:** Please indicate whether you think each statement about certain aspects related to head injury is true, probably true, probably false, or false. Circle the appropriate number corresponding to each answer.

<table>
<thead>
<tr>
<th>Statement</th>
<th>True</th>
<th>Probably True</th>
<th>Probably False</th>
<th>False</th>
</tr>
</thead>
<tbody>
<tr>
<td>9. A little brain damage doesn't matter much, since people only use a part of their brain anyway.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>10. Emotional problems after head injury are usually not related to brain injury.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>11. Most people with brain damage look and act retarded.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>12. When people are knocked unconscious, most wake up shortly with no lasting effects.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>13. Even after several weeks in a coma, when people wake up, most recognize and speak to others right away.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>14. People in a coma are usually not aware of what is happening around them.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>15. People can forget who they are and not recognize others, but be normal in every other way.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>16. Sometimes a second blow to the head can help a person remember things that were forgotten.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
Instructions: Please indicate whether you think each statement about certain aspects related to head injury is true, probably true, probably false, or false. Circle the appropriate number corresponding to each answer.

<table>
<thead>
<tr>
<th>Statement</th>
<th>True</th>
<th>Probably True</th>
<th>Probably False</th>
<th>False</th>
</tr>
</thead>
<tbody>
<tr>
<td>17. People with amnesia for events before the injury usually have trouble learning new things too.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>18. People usually have more trouble remembering things that happen after an injury than remembering things from before.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>19. How quickly a person recovers depends mainly on how hard they work at recovering.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>20. People who have had one head injury are more likely to have a second one.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>21. A person who is recovered from a head injury is less able to withstand a second blow to the head.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>22. Once a recovering person feels &quot;back to normal&quot;, the recovery process is complete.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>23. It is good advice to rest and remain inactive during recovery.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>24. &quot;No pain-no gain&quot; is good advice for a recovering patient.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>25. Complete recovery from a severe head injury is not possible, no matter how badly the person wants to recover.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
Appendix D
Postconcussion Symptom Checklist (PCSC)

Subject Number: _____ Date: ______

Please rate the frequency, intensity and duration of each of the following symptoms based on how they have affected you TODAY according to the following scale:

<table>
<thead>
<tr>
<th>FREQUENCY</th>
<th>INTENSITY</th>
<th>DURATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 = Not at all</td>
<td>1 = Not at all</td>
<td>1 = Not at all</td>
</tr>
<tr>
<td>2 = Seldom</td>
<td>2 = Vaguely present</td>
<td>2 = A few seconds</td>
</tr>
<tr>
<td>3 = Often</td>
<td>3 = Clearly present</td>
<td>3 = A few minutes</td>
</tr>
<tr>
<td>4 = Very often</td>
<td>4 = Interfering</td>
<td>4 = A few hours</td>
</tr>
<tr>
<td>5 = All the time</td>
<td>5 = Crippling</td>
<td>5 = Constant</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FREQUENCY</th>
<th>INTENSITY</th>
<th>DURATION</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>
Appendix E
Appendix F
### 3. DIGIT SPAN

Discontinue after failure on BOTH TRIALS of any item.
Administer BOTH TRIALS of each item, even if subject passes first trial.

<table>
<thead>
<tr>
<th>DIGITS FORWARD</th>
<th>Pass-Fail</th>
<th>Score 2, 1, or 0</th>
<th>DIGITS BACKWARD</th>
<th>Pass-Fail</th>
<th>Score 2, 1, or 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 5-0-2</td>
<td></td>
<td></td>
<td>1. 2-4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6-0-4</td>
<td></td>
<td></td>
<td>2. 6-2-0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. 6-4-3-0</td>
<td></td>
<td></td>
<td>2. 4-1-5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7-2-0-6</td>
<td></td>
<td></td>
<td>3. 3-2-7-9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. 4-2-7-3-1</td>
<td></td>
<td></td>
<td>3. 4-9-8-8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7-5-8-3-6</td>
<td></td>
<td></td>
<td>4. 1-5-2-6-6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6-1-9-4-7-3</td>
<td></td>
<td></td>
<td>4. 6-1-8-4-3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-9-2-4-6-7</td>
<td></td>
<td></td>
<td>5. 5-3-9-4-1-8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5-9-1-7-4-2-8</td>
<td></td>
<td></td>
<td>5. 7-2-4-8-5-6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4-1-7-9-3-8-6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. 5-8-1-9-2-0-4-7</td>
<td></td>
<td></td>
<td>6. 8-1-2-9-3-6-5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-8-2-9-5-1-7-4</td>
<td></td>
<td></td>
<td>6. 4-7-3-9-1-2-8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. 2-7-5-9-6-2-5-8-4</td>
<td></td>
<td></td>
<td>7. 9-4-3-7-8-2-5-0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7-1-3-9-4-2-5-8-6</td>
<td></td>
<td></td>
<td>7. 7-2-0-1-9-6-5-3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Total Forward** Max=14

**Total Backward** Max=14

*Administer DIGITS BACKWARD even if subject scores 0 on DIGITS FORWARD.
CONSENT FORM

You are being asked to participate in a research project that is examining the validity of a number of psychological/neuropsychological tests. These tests are intended for use on clinical patients who report having physical, cognitive and emotional problems that might be due to physical or psychological causes. This is why you were asked to indicate whether you have previously experienced a stroke, head injury, or other problem. It is important to find out how well college-aged persons, with a history of neurological condition, and who are currently functioning in a normal social environment compare to healthy, noninjured people. The performance of these two groups of subjects gives test users a standard against which they can compare the performance of their clinical subjects.

We are currently collecting norms on these particular tests. Your responses will help us understand how well a nonclinical population performs on these tests, and will help us to establish a score value which identifies which people may have potential neuropsychological problems, and which people don’t.

Please pay close attention to these tasks, and try to do your best on them.

By signing this form, you agree to participate in the study described above. By signing, you indicate that you have read and understand the following assurances made to all research participants:

1. I understand that my participation in this study is voluntary
2. I understand that I may withdraw from the study at any time without adverse consequences
3. I understand that all data is to be held in the strictest confidence and my name will in no way be associated with the data from this study
4. I have been informed of the nature of the experiment
5. I understand that data from this study may be used in additional research projects.
6. I have been given the opportunity to ask questions concerning this experiment
7. I understand that I may ask questions after the study has been completed
8. I understand that if I have any questions during the course of the study, I can call Jill Hayes, Paul Binks, or Dr. Gouvier at 388-8745

Student's Name __________________________ Date ________________

Researchers Name ________________________ Date ________________
Subject # _______  DEMOGRAPHIC QUESTIONNAIRE

Age:______  Sex:  M  F  Race:_____  Occupation:____

Marital Status: Single  Married  Separated  Divorced

Education (In number of years):_____  Special Educ:  Y  N

Involved in Criminal Litigation:  Y  N

Involved in Personal Injury Litigation:  Y  N

Medical Diagnosis:_________________________________________

Psychiatric Diagnosis:______________________________________

Current Medications:________________________________________

Have you ever experienced:

Head Injury_____  Seizure disorder_____  Stroke_____  Drug Addiction_____  Meningitis_____  Alcoholism_____  Encephalitis_____  Electroconvulsive (Shock) Therapy_____  Depression_____  Anxiety_____  Chronic Pain_____  Psychosis_____  

Other Medical Conditions Requiring Treatment______________________________________________

If receiving treatment for one of the above medical diagnoses, what type of treatment? (example- experienced a head injury and went to the emergency room and received a brain scan and stitches for a cut).

_____________________________________________________________________________________

Have you ever had a family member experience a head injury in the past?  YES NO

If so, how long ago was their injury?
Appendix I
The Importance of Control Subjects in the Study of Psychology

To understand the complexities of human action, we must have systematic ways in which to investigate human thought and behavior. Over the years, psychologists have developed many methods by which they can study questions of human behavior. Psychologists, like other scientists, utilize experimental methodologies to test hypotheses (propositions or beliefs) about certain aspects of human behavior. By testing these hypotheses, psychologists can confirm or support various theories (sets of logically related statements) about how humans behave.

Psychologists use many means by which to investigate the accuracy of hypotheses. Often used are self-report questionnaires asking people their opinions or beliefs about a topic or personal issue. Sometimes people will participate in an experiment. An experiment is a way to control the presence, absence, or intensity of factors possibly affecting certain types of behavior under study. Many different kinds of behaviors have undergone formal experimental research. Some of the more famous experiments in the history of psychology have examined how infants learn language, circumstances under which people will obey or defy authority, and factors of importance to the development of attraction and romance. Therefore, experiments help researchers understand the relationship between variables and how one variable may impact upon another.

There are usually two types of groups in a psychology experiment, the control group and the experimental group. The experimental group is exposed to the independent variable (the variable under investigation), while the control group is left unexposed to the independent variable. For example, a researcher may want to examine the effect alcohol has on learning new information. In this experiment, the researcher will need to expose two groups of subjects to a learning situation, say learning a list of words (this is usually called the dependent variable), and then have one group drink a certain amount of an alcoholic beverage (e.g., beer) and the other group drink a nonalcoholic drink (e.g., Sharp’s beer). The researcher will then compare the experimental group’s performance on the word list to that of the control group. By this method, the researcher can determine the effects of a certain variable (i.e., alcohol) on word list learning. This approach helps psychologists make more confident conclusions about their hypotheses.

Control groups are important to experimental research for they help establish a base of comparison to test the effect of the independent variable on the experimental group. Without the control group, researchers would be unable to determine whether a particular variable had an effect on a particular behavior or behaviors.
Research Rationale
(Controls)

You are being asked to participate in a research project that is examining the validity of a number of psychological and neuropsychological tests. These tests are intended for use on clinical patients who report having physical, cognitive and emotional problems that might be due to physical or psychological causes. This is why you were asked to indicate whether you have previously experienced a stroke, head injury, or other problem. It is important to find out how well college-aged persons, with a history of a neurological condition, and who are currently functioning in a normal social environment compare to healthy, non-injured people. The performance of these two groups of subjects gives test users a standard against which they can compare the performance of their clinical subjects.

For the past five years, Dr. Wm. Drew Gouvier and his graduate students have been collecting information about the medical histories of many of Baton Rouge’s community members. This effort has been done in an attempt to study the occurrence and impact of a variety of medical conditions including stroke, dementia, head injury and epilepsy. This data enables researchers to investigate possible risk factors associated with these particular medical conditions. In addition, many of these people who completed the survey data have participated in research projects investigating the impact of disease, injury on a variety of psychological variables including memory and attention.

We are currently collecting norms on these particular tests: (1) Auditory Verbal Learning Test- a test of new learning and memory, (2) Multi-Digit Memory Test- a test of short-term memory, (3) Digit Span Test- a test of auditory immediate memory, (4) Dot Counting Test- a test of visual processing speed, and (5) a self-report questionnaire asking you to rate the occurrence of a variety of physical, emotional and cognitive complaints. Your responses will help us understand how well a nonclinical population performs on these tests, and will help us to establish a score value which identifies which people may have potential neuropsychological problems, and which people don’t.

As someone who may have experienced a head injury, you can remember what it was like following your injury. You may have experienced physical and cognitive sequelae after the injury that made your life more difficult. You may have even taken test similar to these as part of a medical evaluation. This investigation is designed to understand factors related to the head injury experience.

Please pay close attention to these tasks, and try to do your best on them.
Financial compensation as a result of closed head injury is not uncommon. A person can sometimes experience persisting medical, cognitive and emotional problems that impede their ability to return to premorbid level of functioning. In most situations, the compensation received is a justified means to help that person overcome the financial and psychological challenges following the head injury. HOWEVER, it is known that in some cases people will deliberately try to exaggerate their problems or possibly make up problems to try and receive large monetary reimbursement from insurance companies, and workers compensation.

What the present research is attempting to accomplish with your help is to determine how someone might perform on a variety of commonly used neuropsychological tests to enhance their appearance of having suffered traumatic injury that warrants large financial compensation. Litigation can go on for years, but postconcussive symptoms may clear before the settlement of litigation. The person may feel he/she has to stay with the symptoms to collect the compensation. Litigation can go on for years, but postconcussive symptoms may clear before settlement of litigation. Therefore, the person may feel they have to stay with the symptoms to collect the compensation they feel they deserve.

We need people such as yourself who realize the dangers of allowing a few people to deliberately get away with fabricating injury so as to gain unwarranted financial compensation. If ways are not developed to detected these impostors, then individuals who ARE justified may not be able to obtain appropriate compensation.

Following completion of the tests, a psychologist will examine your test results and try to determine the legitimacy of your scores.
Appendix L
Scenario #1
Malingering without Instructions

I would like you to imagine that some time in the recent past you were involved in an accident. During the course of the accident, you suffered a blow to your head that resulted in a brief lapse of consciousness. From the scene of the accident, you were taken to a local hospital for emergency treatment. You can recall arriving at the hospital and being seen by the emergency room physician. After an examination and a few x-rays, you were told that you probably suffered a mild concussion. You were advised to return home and rest for a few days before trying to go back to work. Except for a bad headache, you were not aware of any immediate problems when you returned home. During the next few days, you continued to suffer from persistent headaches, and additionally experienced occasional dizziness and memory lapses. The headaches lasted for some time after the accident. Because the memory problems were interfering with your daily activities, you were not able to return to work and have remained away from work to the present.

Shortly after the accident, you were advised to seek an attorney for assistance in obtaining compensation for your injury. The attorney has filed a suit for damages on your behalf. Your legal case has progressed very slowly but your headaches, dizziness and memory problems have since completely vanished despite your not returning to work. You are well aware of the fact that you may get a considerable amount of money if you continue to complain of persistent memory problems. It is therefore in your best interest to present your complaints in a manner that will increase your chances of obtaining what you feel is rightly due as a result of being injured. You have been referred to a psychologist who will attempt to evaluate the nature of your neuropsychological complaints.

As someone who may have experienced a head injury, you can remember what it was like following your injury. You may have experienced physical and cognitive sequelae after the injury that made your life more difficult. You may have even taken test similar to these as part of a medical evaluation. This investigation is designed to understand factors related to the head injury experience.

I would like you, in the best way you know how respond to the tests in a manner that demonstrates impaired neuropsychological functioning. That is, you want to make sure that the tests document your continued problems.
Scenario #2
Malingering with Instructions

I would like you to imagine that some time in the recent past you were involved in an accident. During the course of the accident, you suffered a blow to your head that resulted in a brief lapse of consciousness. From the scene of the accident, you were taken to a local hospital for emergency treatment. You can recall arriving at the hospital and being seen by the emergency room physician. After an examination and a few x-rays, you were told that you probably suffered a mild concussion. You were advised to return home and rest for a few days before trying to go back to work. Except for a bad headache, you were not aware of any immediate problems when you returned home. During the next few days, you continued to suffer from persistent headaches, and additionally experienced occasional dizziness and memory lapses. The headaches lasted for some time after the accident. Because the memory problems were interfering with your daily activities, you were not able to return to work and have remained away from work to the present.

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As someone who may have experienced a head injury, you can remember what it was like following your injury. You may have experienced physical and cognitive sequelae after the injury that made your life more difficult. You may have even taken test similar to these as part of a medical evaluation. This investigation is designed to understand factors related to the head injury experience.

I would like you, in the best way you know how respond to the tests in a manner that demonstrates impaired neuropsychological functioning. That is, you want to make sure that the tests document your continued problems.

Your best chance of doing this successfully on:
Memory Tests-
1) miss more difficult items than easy items
2) try to be fairly consistent in your responses by not
missing easy items and then getting more difficult ones
3) be sure to perform at a level better than chance
4) most persons with or without head injury can recall between 5 and 9 units of information in forwards order and between 3 and 7 units of information in backwards order

Visual Scanning-
1) be sure to perform better and quicker on items in grouped arrangement than ungrouped arrangement
2) The more items, the longer it should take you to complete

Post-Concussive Symptom Endorsement-
1) When reporting symptoms only endorse a few and be sure to avoid selecting extreme levels on these symptoms
Post-Battery Questions for Experimental Subjects

1. As best as you can remember, what were you supposed to do in this study?

2. Indicate how hard you tried to follow the instructions:

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<th>3</th>
<th>4</th>
<th>5</th>
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<tr>
<td></td>
<td>Not at all</td>
<td>Somewhat</td>
<td>Very Hard</td>
<td></td>
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3. Predict how successful you were at producing the results asked of you in the instructions:

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</thead>
<tbody>
<tr>
<td></td>
<td>Not at all</td>
<td>Somewhat</td>
<td>Successful</td>
<td></td>
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<tr>
<td></td>
<td>Successful</td>
<td>Successful</td>
<td>Successful</td>
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4. Do you think your performance will convince the rater that you really suffered from the problem you were asked to demonstrate?

.................YES NO

5. Would the possibility of earning more extra credit for a convincing performance cause you to work harder?.................YES NO
Appendix O
Debriefing Statement.

You have just completed a study examining performance on a number of tests either with instructions to do your best or to malinger brain injury. If you were told to do your best your score, along with other "control" subjects, will be compared to subjects instructed to malinger deficits. If you were told to try and fake impairment on the tests, your test perform will help us better understand how people go about faking bad on neuropsychological tests. We hope to be able to identify common patterns of performance under instruction to fake and apply this information in a clinical setting. By being better able to detect faking we may be able to ensure that deserving brain injured individuals receive just compensation, while people trying to cheat the system do not mistakenly receive compensation they do not deserve.

In addition, we hope to better understand to role that personal experience with head injury, level of understanding of head injury and task specific instruction have upon the ability to malinger neuropsychological impairment on various tests. That is why we asked you to indicate whether you have had previous head injury, and also asked you to complete the head injury questionnaire.

We appreciate your participation in this study and if you have further questions please do not hesitate to contact Dr. Gouvier, or Jill Hayes at 388-8745.
Appendix P
CONSENT FORM
Memory Performance and Symptom Knowledge in Mild Head Injured Patients

Introduction: I, ____________________________, have been asked to participate in this research study, which has been explained to me by ____________________________. This study is being conducted by Dr. Michael D. Fransen and Roy C. Martin at the Neuropsychological Laboratory at Chestnut Ridge Hospital. This research is being conducted to fulfill the requirements for a doctoral dissertation in Psychology at Louisiana State University.

Purpose of the study: The purpose of the present study is to understand the neuropsychological performance of mild head injured patients.

Description of Procedures: I understand that my participation in this research will involve completion of a neuropsychological test designed to assess memory, and a questionnaire about my knowledge of the effects of a head injury. These tests will be administered to me during the course of the neuropsychological evaluation for which is required for my treatment.

I will have the opportunity to review the tests before signing the consent form. I have been informed that I have the right to refuse to answer any question if I am uncomfortable with doing so. Approximately 20 subjects will be entered in this study.

Risks and Discomforts: This study is not expected to produce risk to my health or well being. Past research using these tests have not resulted in any known effects of frustration or discomfort to participants.

Financial Consideration: There are no special fees for participating in this study, but any expenses associated with standard treatment will be billed to me or my insurance company.

Benefits: I understand that I may not directly benefit from this study. I understand that the knowledge gained from this study may lead to improving the understanding of brain injury symptoms.

Contact Persons: For more information about this research and about other related research, I should contact Dr. Michael D. Fransen, Ph.D. at 293-2411, or Roy C. Martin, M.S. at 293-2411. For information regarding my rights as a research subject, I may...
I willingly consent to participating in this study.

Signature of Subject ___________________________ Date __________

Signature of Investigator or Investigator's Representative ___________________________ Date __________

Signature of Attending clinician ___________________________ Date __________
VITA

Roy Clayton Martin was born in St. Petersburg, Florida on March 1, 1961. He is the son of James and Barbara Martin of Seminole, Florida. He has been married for the past 8 years to Cindy Lawrence of Modoc, South Carolina and they have one 5 year old son, James Douglas Martin. Roy received his Bachelors of Arts degree in Psychology from Augusta College, Augusta, Georgia in June, 1984. He received his Masters of Science in Psychology from Augusta College, Augusta, Georgia in June, 1987. Roy worked from June, 1987 to July, 1990 in the Department of Neurology at the Medical College of Georgia as a psychometrist. Roy began his doctoral training in Clinical Psychology at Louisiana State University in August, 1990 and has since successfully completed all degree requirements. He defended his dissertation research project on December 2, 1994. Roy has also completed a 12-month clinical training internship placement at the West Virginia University, School of Medicine in the Department of Behavioral Medicine and Psychiatry in June, 1994. He is currently completing a 12-month postdoctoral fellowship in clinical neuropsychology at West Virginia University, School of Medicine in the Department of Behavioral Medicine and Psychiatry.
DOCTORAL EXAMINATION AND DISSERTATION REPORT

Candidate: Roy Clayton Martin

Major Field: Psychology

Title of Dissertation: The Influence of Subject Sophistication on the Ability to Feign Mild Head Injury Symptoms

Approved:

Major Professor and Chairman

Dean of the Graduate School

EXAMINING COMMITTEE:

Date of Examination:

December 2, 1994