The Validity of the Minnesota Multiphasic Personality Inventory-2 Correction Factors

by

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ABSTRACT

Endorsement of certain Minnesota Multiphasic Personality Inventory-2 (MMPI-2) items is thought to artificially inflate some standard clinical scales in patients with closed head injury (CHI). Correction factors have been established (e.g. Alfano et al., 1993; Artzy, 1994; Gass, 1991b) by comparing item endorsement by patients with CHI to that of controls, and selecting items unique to the CHI population.

The present study aimed to assess the validity of the correction factors by relating these to indices of head injury severity and to scores on standard neuropsychological measures. Results revealed no significant correlation between the correction factors and two commonly used measures of severity of CHI- loss of consciousness (LOC) and post traumatic amnesia (PTA). In addition, no significant correlations were found between correction factors and performance on neuropsychological tests. Significant correlations were found, however, between correction factors and the MMPI-2 depression content scale despite the fact that item overlap between the factors and the scale was minimal. These results suggest that the correction factors proposed for interpreting MMPI-2 protocols of head injured individuals may be more sensitive to depression than to closed head injury.

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TABLE OF CONTENTS

Page

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INTRODUCTION

Use of the Minnesota Multiphasic Personality Inventory (MMPI) and MMPI-2 in neuropsychological settings is problematic. In particular, it has been noted that in head injured populations, a number of conditions (e.g. bona fide medical problems) unjustifiably elevate the clinical scales. Thus, conventional interpretation of the MMPI-2 may result in unreliable or inaccurate representations of the psychological functioning of head injured persons (Alfano et al., 1993; Artzy, 1994; Chelune & Moehle, 1986; Gass, 1991b; Prigatano, 1987).

For this reason, a number of correction factors have been proposed to control for exaggerated elevations of the clinical scales. The correction factors are comprised of items found to be endorsed differentially by head injured individuals when compared to normal controls (Alfano et al., 1993; Artzy, 1994; Gass, 1991b) or other patient groups such as persons with chronic pain (Artzy, 1994). The underlying assumption has been that these correction factors are sensitive to head injury. However, little or no research has been done to establish whether these factors correlate with other measures of head injury such as loss of consciousness, post-traumatic amnesia, or performance on standardized neuropsychological tests. In addition, little is known about the relation between the factors and depression. Prior to discussing the use of the MMPI-2 and the associated correction factors with head injured persons, it is first necessary to review the research on this popular personality measure.

The Minnesota Multiphasic Personality Inventory (MMPI)

The MMPI is the most widely used and extensively studied self-report measure of psychopathology (Butcher & Pope, 1992; see Graham, 1993 for review; Piotrowski & Keller, 1989). This inventory was developed as a diagnostic tool by Hathaway and McKinley in the 1930s, and was first published in the early 1940s. At the time, the MMPI represented a very innovative approach in which test items were selected through empirical keying versus the previous logical keying approaches in which items were selected based on subjective opinion (Graham, 1993).

Deriving MMPI clinical scales through empirical keying consisted of first collecting a large pool of potential items from various sources such as psychological and psychiatric case histories and reports, textbooks, and previous personality measures. Endorsement of these items was then compared between psychiatric patients representing all the major psychiatric categories being used clinically at the time, and a large group of normal controls primarily consisting of relatives and visitors to the University of Minnesota Hospitals. Item analysis determined which items differentiated significantly between the specific clinical groups (e.g. schizophrenia) and the normal control group. The MMPI items able to discriminate the criterion group from the normal control group were then selected to construct the specific clinical scales. These scales were then cross-validated by administering them to new groups of normal control subjects, clinical subjects with various specified diagnosis and other clinical groups. The scales were considered to be sufficiently cross-validated when significant differences were found amongst these groups. Four validity scales were also derived for the purpose of detecting deviant testtaking attitudes or behaviour: the F scale comprised of items endorsed by less than 10 percent of the normative sample, the Cannot Say scale consisting of the total number of items omitted by the client, the L scale comprised of 15 items tapping attitudes and practices that are culturally laudable, but actually found only in the most conscientious persons, and the K scale aimed at identifying persons who display significant psychopathology yet have profiles in the normal range.

In its final form published in 1943, the MMPI comprised 566 items which yielded ten clinical scales and four validity scales. Subsequently, subscales, supplementary scales and content scales were derived. It soon became apparent, however, that this measure, though attractive due to its empirical approach and appearance, was not successful in meeting its original goal of diagnosis (Graham, 1993). It was observed that patients in any particular diagnostic category (e.g. Major Depression), while having elevated scores on the corresponding clinical scale (e.g. Scale 2: Depression), also had high scores on a number of other clinical scales (e.g. Scale 1: Hypochondriasis). Thus, the scales were not pure measures of the syndromes suggested by their names (Graham, 1993). As a result, MMPI interpretation was modified to describe personality traits rather than psychopathology.

The Minnesota Multiphasic Personality Inventory-2 (MMPI-2)

In the 1970s and 1980s, a number of concerns were expressed about the widely used and studied MMPI (see Graham, 1993 for review). It was noted that since its 1943 publication, this inventory had not been revised although a number of problems had been detected. For example, the original standardization sample was one of convenience, with little effort made to ensure that it was representative of the U.S. population (Butcher & Pope, 1992). Some concern was also expressed regarding the item content of the original MMPI: Some items were now considered to be archaic (e.g. reference to a now unpopular game "drop the handkerchief"), while the inclusion of others was no longer considered to be appropriate (e.g. questions regarding bowel and bladder function). As well, it was felt that more consideration should be placed on the manner in which the items were stated: Some items were found to be sexist, while others were grammatically incorrect or lacked proper punctuation. Finally, the item pool was not large enough to assess certain important characteristics such as substance abuse and suicidal ideations (Graham, 1993).

The 1989 publication of the MMPI-2 attempted to rectify some of the problems noted in the original inventory. The revised version of the MMPI offered a larger contemporary normative sample, revision of some of the content scales as well as the addition of 15 new content scales and 12 supplementary scales. In addition, 82 items were rewritten to improve clarity, modernize the language or to refine the content. Butcher and Pope (1992b), Duckworth (1991), and Graham (1993) offer a detailed description of the revised MMPI. Although some have questioned the comparability of the MMPI and MMPI-2, empirical evidence supports the compatibility and the general continuity between the original and revised version of the MMPI (Ben-Porath, 1990; Ben-Porath & Butcher, 1989 a & b; Graham, 1990; Graham, Timbrook, & Ben-Porath, 1991;

Ben-Porath, McCully, & Almagor, 1993). Statements herein regarding the MMPI are considered to be directly applicable to the revised version, the MMPI-2.

Clinical use of the MMPI-2 with head injured persons:

As mentioned previously, though the MMPI was created initially as a diagnostic instrument, the observed elevation on a number of clinical scales in established psychiatric populations suggested that this measure was perhaps better for personality description rather than for specific diagnoses (Graham, 1993). In practice, however, specific MMPI profiles continue to be associated with corresponding mental disorders and the MMPI is often used to suggest diagnosis or to support diagnosis derived through other means (Elwood, 1993). Helmes and Reddon (1993) point out that current reference materials on the MMPI-2 continue to include the original scale names, thus maintaining the link to the original diagnostic purpose of the inventory. The implications of this are far reaching, as MMPI-2 interpretations in neuropsychological settings are not only used to gain insight into the patient's personality characteristics and emotional states, but may also be used to guide the establishment of a treatment program (Gass, 1992).

The above noted possible impact of the MMPI-2 stresses the importance of cautiously approaching the interpretation of this inventory, especially when interpreting profiles of specific populations noted to have exaggerated scale scores due to non-psychiatric factors. In such instances, there is a greater risk of falsely detecting and assigning psychiatric difficulties, and consequently over prescribing psychotherapy or pharmacological interventions (Gass, 1992). An example of this risk is apparent in the work of MacNiven and Finlayson (1993), who did not account for the impact of head injury sequelae on MMPI profiles. They concluded that their findings of elevated MMPI scales in head injured persons supported previous findings of high rates of psychopathology in patients who sustain closed head injury. Similar cases of possible misinterpretation of MMPI-2 profiles have led some to question the validity of the use of this inventory with certain populations (e.g. head injured) who have bona fide medical problems which unjustifiably elevate some of the clinical scales (Alfano, Finlayson, Stearn, & Neilson., 1990; Alfano et al., 1993; Artzy, 1994; Gass, 1991b,1992). It has been suggested that conventional interpretation of MMPI profiles may not provide a reliable or accurate portrayal of the psychological functioning in these populations (Alfano et al., 1993; Artzy, 1994; Gass, 1991b, 1992).

The use of the MMPI-2 with head injured individuals has raised a number of concerns one of which is centered around the method employed to construct this inventory. As previously mentioned, when the MMPI was created, the criterion-keyed method was used to discriminate patients with psychiatric problems from normal controls. However, there was no consideration as to whether or not the items selected were correlated with other bona fide medical problems unrelated to psychiatric functioning. In other words, the possibility that the items selected applied to more than the syndromes associated with the scales was not addressed.

Since the initial publication of the MMPI, it has been noted that a number of items are in fact relevant for some non-psychopathological groups and that these items can differentiate these groups from normal control subjects (Alfano et al., 1990; Gass, 1991b, 1992). For example, it would not be surprising to find a head injured person endorsing MMPI-2 items suggesting cognitive problems or physical complaints such as #31 "I find it hard to keep my mind on a task or job" or #247 "I have numbness in one or more regions of my skin". Consequently MMPI studies of head injured individuals have almost invariably found elevations on a number of the clinical scales highly loaded with neurologically relevant items; the Schizophrenia (Sc), Depression (D), Hypochondriasis (Hs), and Hysteria (Hy) scales (Alfano et al., 1990, 1992; Artzy, 1994; Burton & Volpe, 1994; Dikmen & Reitan 1974; Gass, 1991b; O'Jile, Ryan, Parks-Levy, Gouvier, Betz, Groves, Coon, & Tretter, 1995). Alfano and colleagues (1993) point out that manifestations of head injury can have considerable impact on MMPI profiles and must thus be taken into account.

Concerns have also been raised about the fact that the MMPI was originally developed for, and standardized on, psychiatric populations. It is thus questionable to what extent this test instrument can be validly and uncritically generalized to the assessment of personality and emotional status in neurologic cases (Alfano et al., 1990; Cripe 1989; Cullum & Bigler, 1988).

Noting the difficulties associated with interpreting MMPI profiles for the purpose of gaining insight into the psychological functioning of head injured persons, it has been suggested that this inventory may best serve to detect brain injury. This alternative use of the MMPI was first attempted by Hovey in 1964, who tried to develop an MMPI scale specifically for the purpose of detecting the presence of brain dysfunction. Such attempts, however, have generally been only partially successful and consequently, the MMPI is now considered inadequate for this purpose (Buchholz, 1984; Mack, 1979).

In short, it has been noted that there are both physical and cognitive consequences to head injury which can manifest themselves artificially as psychiatric problems on the MMPI-2. This has led to the development of correction factors aimed at rectifying the effects that nonpsychiatric consequences of head injury have on MMPI-2 profiles.

MMPI Correction Factors:

A number of researchers have attempted to identify MMPI items which, when removed, would correct the unjustified elevations of the clinical scales in head injured populations. Alfano and colleagues (1990) asked 18 medical specialists in the clinical neurosciences (5 neurologists; 4 neurosurgeons; 5 psychiatrists; 4 physiatrists) to use their "clinical experience and judgment" to identify items that were "potentially tapping valid symptoms or manifestations of neurological damage or dysfunction". Through item analysis, 44 questions were identified which had been selected by at least 12 of the 18 experts, with at least 2 from each specialist category.

These neurologically related items were found to load primarily on the Hs, Hy, and Sc scales. MMPI protocols from 66 male and 49 female neurologic patients suffering from primary neurologic diseases (cerebrovascular disease; infectious/metabolic disease; neurodegenerative disease; tumours/cysts; head injury; seizure disorder; alcohol dementia; mixed or miscellaneous) were then evaluated in the conventional manner.

It was noted that the Hs, D, Hy, Pt (Psychasthenia), and Sc scales were among the most frequently elevated clinical scales on the MMPI profiles produced by their sample. The 44 neurologically related items were then deleted from the protocols which were then rescored. Due to the high degree of item overlap on the clinical scales, a total of 84 items were deleted. The resulting neurocorrected-44 MMPI profiles (NC44) were found to have a distinctively different configuration when compared to the original profiles. The previously elevated scales were noted to be significantly reduced. These researchers thus concluded that in neurologic cases, some of the elevated scales may be partially reflecting valid manifestations of neurologic dysfunction and that a neurocorrective approach may therefore be both desirable and necessary.

Alfano and colleagues (1993) then decided to look specifically at a more homogenous group: patients with closed head injury (CHI). This study evaluated the MMPI protocols of 77 males and 25 females who, with scores of 8 or less on the Glascow Coma Scale, post traumatic amnesia (>24h) and loss of consciousness (>5h), had been judged to have sustained a moderate to severe CHI. It was found that 24 of the 44 neurologically related items from their previous study were endorsed in a pathological direction by at least 30% of the CHI patients. Factor Analysis of these 24 items revealed 7 factors, the first of which accounted for 25% of the total variance. This factor, labeled the Neurobehavioural factor, was comprised of 13 items primarily related to complaints of attention or concentration, sensory or motor dysfunction, or problems with major life activities. These items were found on 9 of the 10 clinical scales. The Neurobehavioural factor was employed for the neurocorrection and the items were deleted from the protocols, which were then rescored in the usual fashion. As in their 1990 study, Alfano and colleagues found that neurocorrection of MMPI protocols resulted in a reduction of the artificial elevation of the clinical scales, producing MMPI profiles with no significant elevations. They concluded that neuropsychologists using the MMPI with head injured individuals should score the protocols twice, once with and once without the 13 Neurobehavioural items. It was suggested that this procedure would take into account the confounding effect of the genuine manifestations of CHI.

Gass (1991b) also looked at MMPI protocols of CHI patients but suggested a different correction approach which closely resembled the manner in which the original clinical scales were established. Seventy-five patients with established brain damage, as determined by standard neurodiagnostic examination, were administered the MMPI. Instead of using items selected by medical experts, item endorsement by the CHI patients was compared to that of the 1,138 normal adult men that constituted part of the contemporary national normative sample used for the MMPI-2. Principle Component Analysis was used to determine which items differentiated the CHI group from the normal sample. Two criteria were used for item selection: a) the degree of discriminative power and b) frequency of endorsement within the CHI group (endorsed by at least 25% of sample). Through application of these criteria, 23 items emerged as differentiating CHI from normal controls. Factor analysis of these items revealed two factors, the first of which accounted for 24.8% of the variance and was termed Neurologic Complaints. This factor was comprised of 14 items related to complaints of cognitive inefficiency, weakness, and problems with speech, tremor, and movement. The 14 items loaded most heavily on scales Hs, D, Hy, Pt, and Sc. It was suggested that the Neurologic Complaints items should be deleted from the protocols and that rescoring of these modified MMPI-2s would produce a more accurate estimate of psychological functioning in closed-head-injured patients.

However, as Alfano et al. (1990) noted, one problem with deleting MMPI-2 items is that the resulting protocols may not have the same validity and generalizability. To address this concern, Gass and Russell (1991) proposed an alternative method of dealing with 42 neurologically related items (NRI) which were selected by three neurologists. Instead of deleting these items, they determined the weighted value of the NRI's, depending on the number of non-NRI's endorsed for each clinical scale. Therefore, if a person endorsed many of the non-NRI's comprising a particular scale, the resulting elevation was considered a more accurate reflection of his/her psychological functioning and consequently, the NRI's comprising that scale were weighted more heavily.

Artzy (1994), using criteria similar to Gass (1991b), also compared the item endorsement frequency of CHI persons to that of the normal sample used for the MMPI-2. This analysis yielded 60 items found to be endorsed differentially by both female and male closed-head-injury patients. Of these items, 18 were found that could also differentiate CHI patients from chronic pain patients. These items were proposed to serve specifically as a correction factor for head injured populations. It was suggested that these items be eliminated and that the protocols be rescored in order to gain a more accurate representation of the psychological functioning of patients with closed-head-injury.

In summary, Alfano and colleagues (1993), Artzy (1994), and Gass (1991b) have proposed correction factors to be applied to MMPI-2 protocols of head injured individuals. These correction factors are suggested to rectify the confounding effects of head injury sequelae which have been found to artificially elevate the MMPI-2 clinical scales, thus leaving the clinician with a more accurate portrayal of the patient's psychological functioning. Although the three studies have not yielded completely identical items, their results are quite similar and there is noticeable overlap in the items they propose for the correction approach (see Appendix A for comparison of the correction factors). On the surface, a number of the items comprising the correction factors show good face validity in that they reflect symptoms which one would expect to see following head injury. However, as pointed out by Anastasi (1988), with personality measures, face validity is not as important as construct validity.

Underlying the correction approaches proposed by Alfano and colleagues (1993), Artzy (1994), and Gass (1991b) is the assumption that certain items from the MMPI-2 inventory are sensitive to head injury; in other words, that certain items describe common sequelae of head trauma and will thus be endorsed readily by individuals who have sustained a head injury. But what are the consequences of head trauma? Head injury results in numerous problematic symptoms on physical, cognitive and emotional levels that elicit varying degrees of distress.

Head Injury Sequelae

Research has consistently demonstrated that moderate to severe head injury causes wide-spread damage. Strich (1956) reported that head injury results in axonal lesions in both the brain stem and cerebral hemispheres as a result of the shearing and rotational forces of the injury. In addition, there is typically some grey matter damage, especially in the frontal and temporal lobes. This occurs as a result of compression or impact with the hard bony prominences of the skull. Although lesions may be restricted to one hemisphere, the neurobehavioural effects are generally more widespread and involve other cerebral regions (Cullum & Bigler, 1988). Initially, it was thought that mild head injuries were not associated with any neurological damage. However, there is increasing evidence suggesting that even head trauma not associated with an alteration in consciousness can result in neuropathological changes (Jenkins, Teasdale, Hadley, Macpherson, & Rowan, 1986; Levin, Amparo, Eisenberg, Williams, High, McArdle, & Weiner, 1987). Consequently, personality changes and physical and cognitive deficits have been reported with all degrees of severity of head injury.

There are a number of physical after-effects experienced across the range of head trauma severities. Typically some degree of spasticity, fatigue, dizziness, headaches, and insomnia is experienced by the head injured patient (Binder, 1986; Evans, 1992; McMillan & Glucksman, 1987). These symptoms last anywhere from days to months and are reported to usually improve over time (McLelland, 1988). However, the cognitive deficits reported often tend to persist, especially with increasing severity of the injury. Problems with attention, concentration, and memory are the most common complaints following head trauma (see Binder 1986 for review; Gentilini, Nichelli, Schoenhuber, Bortolotti, Tonelli, Falsca, & Merli, 1985; Gronwall, 1991). Even patients who suffer head injuries without loss of consciousness may suffer from some cognitive sequelae (see Bohnen & Jolles, 1992 for review; O'Hara, 1988; Sagle,1990). It is readily accepted that the cognitive deficits resulting from head injury can be assessed through neuropsychological testing, and that performance is related to both the severity of the head trauma and the time elapsed since the injury (Gronwall, 1987; Lezak, 1995; Spear-Bassett & Slater, 1990). A number of researchers have found that cognitive deficits following minor head injury often resolve themselves within three months of the trauma (Dikmen, Temkin, & Armsden, 1989; Levin, Gary, High, Mattis, Ruff, Eisenberg, Marshall, & Tabaddor, 1987; Levin, Mattis, Ruff, Eisenberg, Marshall, & Tabaddor, 1987; McLean, Temkin, Dikmen, & Wyler, 1983; O'Hara, 1988), while the cognitive deficits associated with more severe CHI tend to persist.

Although all severities of head injury are associated with emotional sequelae, few objective measures of emotional adjustment exist (O'Hara, 1988; Dikmen, Reitan, Temkin, & Machamer, 1992), and affective disturbances associated with head trauma have not been readily studied (Dikmen & Reitan, 1974; Fedoroff, Starkstein, Forrester, Geisler, Jorge, Ardnt, & Robinson, 1992; Prigatano, 1987). Depression, anxiety and irritability are frequently observed following head traumas of all types (Cripe, 1989; Lezak, 1995), and are often considered one of the most distressing problems for both the patient and the family (Brooks, Campsie, Symington, Beattie, & McKinlay, 1987; Lishman, 1973;

McClelland, 1988). Emotional difficulties can often persist for years following the head trauma (Burton & Volpe, 1988 in Burton & Volpe 1994).

Personality changes observed following head injury may include emotional changes, indifference, inflexibility, tendency towards perseveration, behavioural disinhibition and aggression. A number of researchers have found that head injury induced personality changes may not always be accompanied by other intellectual impairments (Burton & Volpe, 1994; Lishman 1973). However, Burton and Volpe (1994) suggest that it would not be surprising to find that the cognitive consequences of head trauma impacts the post-trauma emotional state of an individual.

Emotional or personality changes have also been found to outlast other complaints, especially after minor head trauma. It has been noted that emotional distress may in fact be aggravated with time (Cullum & Bigler, 1988; Fordyce, Roueche, & Prigatano, 1983). Gronwall (1991) points out that recovery, as defined by return of neuropsychological tests scores to normal, does not necessarily coincide with return to normal functioning. Some argue that the degree of emotional disturbance observed is related to the severity of the head injury (Cullum & Bigler, 1988; Goethe & Levin, 1984), while others have not found such correlations (Fedoroff et al., 1992). In short, there are numerous personality or emotional transformations which can occur following head injury. These appear to last longer than some of the other sequelae (e.g. physical) and may even reflect permanent changes which necessitate adjustment on both the patient's and family's part.

Establishing Validity of the Correction Factors

The underlying assumption of the correction factors is that certain items from the MMPI-2 are sensitive to head injury. Given that use of this inventory with head injured persons is aimed at gaining insight into their psychological functioning, it would be logical to assume that the items comprising the correction factors are selectively tapping only the physical and cognitive sequelae of head trauma. Thus, items sensitive to the emotional or personality changes often experienced following head trauma remain included in the profile to provide an accurate representation of the head injured person's psychological functioning. However, this may not be the case. Deletion of MMPI-2 items as proposed for the correction factors poses an interesting dilemma. Although the items may relate to and therefore account for some of the physical and cognitive consequences of head injury, they may also tap some of the emotional or psychiatric problems which are often observed following head trauma. Thus, removal of these items may correct the unwanted effects of the cognitive and physical sequelae, but may simultaneously lead to a tendency to minimize the emotional or psychiatric difficulties experienced by head injured individuals. For the correction factors to be applied justifiably, discriminant validation must be established by showing that they have little or no correlation to depression, such that deletion of correction factor items does not affect the accuracy of the psychological profile.

Interestingly, no research to date has explored this relation nor the convergent validity of the factors as determined by the extent to which scores, on the correction factors proposed, correlate with common measures of head injury such as loss of consciousness, post-traumatic amnesia, or even performance on standard neuropsychological tests. Such information would help establish the construct validity of the factors and justify the necessity and desirability of using correction factors when interpreting MMPI-2 profiles of head injured patients.

Loss of consciousness (LOC) and post-traumatic amnesia (PTA) are commonly considered the two most useful clinical measures of head injury severity (McClelland, 1988). Although there are some variations in the definitions employed by various researchers, severity of head injury has typically been considered: A) Mild: LOC and/or PTA < 1 hour; B) Moderate: LOC and/or PTA 1h- 24h and; C) Severe: LOC and/or PTA >24h (Russell & Smith, 1961). Post traumatic amnesia is most frequently defined retrospectively as the period from the time of injury to full awareness and the ability to retain a stable record of occurring events (McClelland, 1988). Although some researchers have not found PTA helpful in estimating the severity of deficit, rate of recovery or personality changes (e.g. O'Shaughnessy, Fowler, & Reid., 1984), Gronwall (1987), in a review of the literature, suggests that lack of significant association between severity of injury and frequency of complaints is typically due to the homogeneity of the sample. She found significant relations between severity measures and complaints when the head injury samples included a wider range of injuries. Oddy and colleagues (1978) found that the severity of the head injury was related to difficulties experienced as evidenced by the observation that many patients with prolonged periods of PTA or LOC failed to return to work. If the MMPI-2 correction factors are comprised of items sensitive to head injury, a relation between these factors and PTA and/or LOC should be expected, if a broad range of head trauma patients are sampled.

Standardized neuropsychological tests have also been devised to determine the severity of dysfunction and to help assess the localization of the head injury (O'Hara, 1988). Neuropsychological tests have been found to distinguish brain injured individuals from both normal controls and psychiatrically impaired persons (Gass, 1991a). And as mentioned previously, performance on these tests appears to be inversely related to the severity of the head injury (Gronwall, 1991). Therefore, if the correction factors are sensitive to head injury, a correlation would be expected between these factors and neuropsychological test performance.

The purpose of this study is to address a number of the above mentioned validation issues. It is hoped that a better understanding of the relation between the correction factors and other aspects of head injury will clarify the nature and value of these factors and their use in interpreting MMPI-2 profiles of head injured individuals. Items comprising the Alfano, Artzy and Gass correction factors were extracted from the MMPI-2 data collected from the sample. An additional scale (termed the Composite scale) was derived by extracting all items which were included in at least two of the three proposed correction factors. Thus all analyses involving the correction factors included the following four scales treated independently: Alfano (maximum of 13 items endorsed), Artzy (maximum of 18 items endorsed), Gass (maximum of 14 items endorsed), and Composite (maximum of 8 items endorsed). See Appendix A for a summary of the items comprising the scales.

PURPOSE OF THIS STUDY

1) The study aimed to assess the extent to which the correction factors relate to common measures of closed head injury severity, in particular- loss of consciousness (LOC) and post-traumatic amnesia (PTA). Since most of the patients were assessed more than three months after their injury, it was assumed that many of the minor head injury complaints would have abated and that endorsement of correction factor items reflected the persisting symptoms of head injury. Therefore, it was hypothesized that there would be a positive correlation between PTA and/or LOC and persisting complaints following head injury as measured by item endorsement of the factors.

2) The study aimed to assess the relation between item endorsement on the correction factors and performance on standardized neuropsychological tests: As higher factor scores were expected to reflect persisting symptoms and thus greater severity of head trauma, it was hypothesized that there would be an inverse relation between item endorsement on the factors and performance on attention and memory tests, since these measures tap functions typically affected by closed head injury (CHI). Memory and attention deficits have been repeatedly observed following head injuries of all severities (Brooks, 1984; Gentilini et al., 1985, 1989; Gronwall, 1987, 1991; See Spear-Bassett & Slater for review, 1990). Impaired performance on a variety of attention and memory tests was observed at various times post-trauma in studies conducted by Fordyce et al., 1983; Gentilini et al., 1985; McLean et al., 1983; McMillan & Glucksman, 1987; O'Shaughnessy et al., 1984; Spear-Bassett & Slater, 1990.

Other neuropsychological measures were thought to be relatively less affected by head injury and were thus not expected to be significantly related to the correction factors. These tests included: Dynamometer (preferred hand (PH) & nonpreferred hand (NPH)); Finger Tapping (PH & NPH); Hooper Visual Organization Test; North American Adult Reading Test; Purdue Pegboard (PH, NPH, Both Hands, Assemblies); Wechsler Adult Intelligence Test- Revised, Vocabulary and Block Design Subtests; and the Wide Range Achievement Test. Performance on one or a combination of the above mentioned tests was found to be relatively spared in studies conducted by Fordyce et al., 1983; Gentilini et al., 1985; and Spear-Bassett & Slater, 1990.

3) The study aimed to assess the relation between the correction factors and depression: Since the proposed purpose of correcting MMPI-2 profiles is to gain more accurate insight into the psychological functioning of head injured persons, it was hypothesized that items comprising the factors would not be related to depression. This hypothesis was based on the notion that if the items included in the factors were related to emotional functioning, then their deletion from the profiles would mean that the corrected profiles would not be an accurate reflection of personality characteristics of CHI patients - thus defeating the purpose of the corrected inventory.

METHOD

Subjects

MMPI-2 protocols of 191 adults were obtained as part of neuropsychological assessments requested for litigating purposes. Subjects were assessed between 1990 and 1995, following a suspected head injury.

Exclusion Criteria

A) Only subjects with valid MMPI-2 profiles were included in this study. The profiles were considered invalid if: **1)** more than 10 items were omitted (CNS>10) as conservatively proposed by Graham (1993); **2)** the Variable Response Inconsistency scale (VRIN) score exceeded 12, thus indicating that the patient had not responded consistently throughout the test (Graham 1993); **3)** the Infrequency-Psychopathology scale (Fp T) exceeded 100, suggesting that the patient had endorsed items infrequently selected by normal controls or psychiatric populations and may have thus been exaggerating their difficulties (Arbisi & Ben-Porath, 1995).

B) Subjects were not included if they scored below 9 overall hard correct items of the VR-II malingering test. Scores in this range were considered to indicate possible malingering.

C) The MMPI-2 was only administered to individuals with a minimum of a grade 8 education. This exclusion criterion was employed in an attempt to ensure that the subjects had at least a grade six reading level which has been reported to be necessary for accurate comprehension and response (Pope et al., 1993 in Artzy, 1994).

Description of the Sample

The above mentioned criteria led to the exclusion of 36 subjects. The resulting sample of 155 subjects was comprised of protocols from 88 males (56.8%) and 67 females (43.2%). The subjects ranged in age from 18 to 77 years (mean 34 years 2 months; standard deviation 12 years 8 months). Table 1 presents the distribution of ages in the sample.

Table 1
Age distribution of the sample at time of testing

Age Group	N	Percent
18-27	62	40.0 %
28-37	38	24.5%
38-47	33	21.3%
48-57	13	8.4%
58-67	6	3.9%
68-77	3	1.9%
	155	100%

The sample's level of education at the time of the assessment ranged from 8-20 years, with the mean level of education of 12 years and 3 months (SD = 2 years 6 months). Table 2 presents the distribution of education level in the sample.

Table 2
Years of education

	N	Percent
<12y (part high-school)	58	37.4%
12y (high-school grad.)	55	35.5%
≤ 16y	34	21.9%
≥ 17y	8	5.2%
	155	100%

Head Injury Related Information

The assessments were conducted anywhere from one month to seven years following the suspected head injury (mean 2 years; standard deviation 1 year 5 months). Table 3 presents the distribution of time elapsed since injury in the sample, at the time of the assessment. Note that this information was not available for 10 of the cases.

Table 3
Time since injury

	N	Percent
≤ 3 mo	6	4.1 %
> 3 mo- ≤ 12 mo	34	23.5 %
> 1 yr - ≤ 2 yrs	43	29.6 %
> 2 yrs - ≤ 3 yrs	31	21.4 %
> 3 yrs - ≤ 4 yrs	18	12.4 %
> 4 yrs - ≤ 5 yrs	10	6.9 %
> 5 yrs - ≤ 6 yrs	0	0.0 %
> 6 yrs - ≤ 7 yrs	3	2.1 %
	145	100%

Information regarding the client's age at the time of their injury was available for 145 of the clients. Subjects ranged from 13 to 76 years old at the time of their head trauma. The mean age at injury was 31 years 10 months (SD = 12 years 7 months). Table 4 presents the subjects' ages at time of their injury.

Table 4
Age at time of injury

Age Group	N	Percent
≤20 y	37	25.5%
21-30y	37	25.5%
31-40y	40	27.6%
41-50y	20	13.8%
51-60y	8	5.5%
61-70y	1	.7%
71-80y	2	1.4%
	145	100%

Loss of consciousness (LOC) and post traumatic amnesia (PTA) were used as measures of the severity of head injury. Information regarding LOC and PTA was obtained for 80 subjects and 61 subjects respectively from medical records when available, and from retrospective patient reports when documentation was lacking. No or less than 60 minutes LOC was observed in 82% of the sample and 47% of the sample had PTA less than 60 minutes. That is, the majority of patients had mild head injuries. Table 5 presents information on the sample's experience of LOC and Table 6 presents similar information for PTA.

Table 5
Length of LOC in sample

	N	Percent
Nil	27	33.6%
< 5 min	26	32.5%
5- 60 min	13	16.3%
1-24 hours	5	6.3%
1-7 days	5	6.3%
> 7 days	4	5.0%
	80	100%

Table 6
Length of PTA in sample

	N	Percent
Nil	18	29.5%
< 5 min	6	9.8%
5- 60 min	5	8.2%
1-24 hours	10	16.4%
1-7 days	9	14.8%
> 7 days	13	21.3%
	61	100%

Table 7 presents a summary of the demographic and head injury characteristics of the whole sample. And Tables 8 and 9 present the similar information for the LOC and PTA subsamples. Note the similarity in demographics and HI characteristics.

Table 7

Summary of Demographic and Head Injury Characteristics

VARIABLE			
Sex:	N		
-Males	88 (56.8%)		
-Females	67 (43.2%)		
	Range	Mean	Standard Deviation
Age at testing	18-77y	34y 2mo	12y 8mo
Education	8-20y	12y 3mo	2y 6mo
Time since injury	1mo-7y	2y	1y 5mo
Age at injury	13-76y	31y 10mo	12y 7mo
LOC		< 5 min	
PTA		5-60 min	

Table 8

Summary of Demographic and Head Injury Characteristics for LOC Subgroup

VARIABLE			
Sex:	N		
-Males	44 (55%)		
-Females	36 (45%)		
	Range	Mean	Standard Deviation
Age at testing	18-73y	34y 9mo	12y 11mo
Education	9-20y	12y 4mo	2y 3mo
Time since injury	1mo-7y	1y 10mo	1y 3mo
Age at injury	15-72y	32y 11mo	13y

Table 9

Summary of Demographic and Head Injury Characteristics for PTA Subgroup

VARIABLE

Sex:	N		
-Males	32 (52.5%)		
-Females	29 (47.5%)		

	Range	Mean	Standard Deviation
Age at testing	18-73y	34y 2mo	12y 7mo
Education	9-19y	12y 4mo	2y 3mo
Time since injury	1mo-7y	1y 9mo	1y 4mo
Age at injury	15-72y	32y 4mo	12y 9mo

PROCEDURE, STATISTICAL ANALYSIS, AND RESULTS

The following section will investigate the hypotheses proposed previously. This will entail a reiteration of the hypothesis, a description of the statistical procedure utilized, and the subsequent findings.

Throughout the statistical analysis, correlations of $p < .05$ were interpreted only if the correlation was of .30 magnitude or larger. Correlation magnitude was defined according to Cohen's (1988) criteria for correlation effect size (small: $r = .1$; medium: $r = .3$; large: $r = .5$).

HYPOTHESIS A: *The first hypothesis predicted that there would be a correlation between PTA and LOC and persisting complaints following head injury as measured by endorsement of items on the correction factors*

Statistical Analysis and Results:

Spearman Rank correlations were obtained between the Alfano et al. (1993), Artzy (1994), Gass (1991b), and Composite correction factors and the LOC and PTA severity measures. No significant correlations were found between any of the MMPI-2 head injury correction factors and LOC or PTA. See Table 10 for correlations.

Table 10

Correlations Between the Correction Factors and Common Measures of Head Injury Severity: Post Traumatic Amnesia (PTA) and Loss of Consciousness (LOC)

(* if P<.05- one tailed)

	Alfano	Artzy	Gass	Composite
LOC	-.013	-.082	-.023	-.054
PTA	.012	-.046	-.008	-.023

The data was then broken down into two groups based on the severity of the head injury (mild (N=65): LOC $\leq$ 60 min; moderate to severe (N=15): LOC > 60 min). An ANOVA revealed found no significant differences in the number of correction factor items endorsed by each group (Alfano: F (1, 78) = .794, p = .376; Artzy: F (1, 78) = 3.27, p = .074; Gass: F (1, 78) = .44, p = .509; Composite: F (1, 78) = 1.33, p = .253). Similarly, no significant differences were obtained when subjects were categorized into mild and moderate to severe groups based on PTA (mild (N=29) PTA $\leq$ 60 min; moderate to severe (N=33) PTA > 60 min). Alfano: F (1, 59) = .044, p = .834; Artzy: F (1, 59) = 000, p = .987; Gass: F (1, 59) = .054, p = .817; Composite: F (1, 59) = .013, p = .909). The power associated with these analyses was low, as discernible from Table 11.

Table 11

Power of ANOVA's Between the Correction Factors and Common Measures of Head Injury Severity: Post Traumatic Amnesia (PTA) and Loss of Consciousness (LOC)

	Alfano	Artzy	Gass	Composite
LOC	.170	.430	.084	.204
PTA	.042	.035	.044	.037

HYPOTHESIS B: *The second hypothesis predicted that there would be an inverse relation between correction factor item endorsement and performance on tests of attention and memory, while performance on other neuropsychological tests would be relatively spared.*

A number of neuropsychological tests were thought to be sensitive to the effects of head injury:

A) ATTENTION: Digit Symbol; D2 (Total & Errors); Pasat (2.4 sec & 1.6 sec); Stroop (Color, Words, Color-Words, Errors); Symbol Digit, and Trails A & B.

B) MEMORY: Brown-Peterson Consonant Trigrams; Buschke SelectiveReminding Test (Recall 1, STR,LTS,CLTR,RLTR,Trial LT, Trial CL, Intrusions, Cued Recall, 30min Delay); Rey Auditory Verbal Learning Test (Trial 1,2,3,4,5,& Total, Interference Trial,

Trial 6,7, & Recognition); Rey Visual Design Learning Test (Trial 1, Total, and Recognition); Rey- Osterrieth Complex figure Test-Delayed Recall; and Sentence Repetition.

Statistical Analysis and Results:

While controlling for age at time of testing, partial correlations were obtained between the head injury correction factors and the above mentioned neuropsychological tests. As expected, no correlations were found between the head injury correction factors and the above mentioned neuropsychological tests thought to be relatively spared of the effects of head injury. Surprisingly, no significant correlations were found between the proposed correction factors and performance on tests of memory and attention. See Appendices B and C for tables of the correlations.

HYPOTHESIS C: *The third hypothesis predicted that since the purpose of correcting MMPI-2 profiles is to gain more accurate insight into the psychological functioning of head injured persons, the items comprising the factors would not be related to depression.*

<u>Depression</u>

The MMPI-2 depression content scale was used as an index of the subject's depression. The Depression content scale is intended to assess cognitive, affective, and behavioural symptoms of clinical depression The literature suggests that this scale is not only effective in detecting clinical depression (Ben-Porath et al., 1993; Boone, 1994) but may also have incremental validity, containing more information than available from the clinical Scale 2- Depression (Ben-Porath, Butcher, & Graham, 1991). The depression content scale has also been found to have both good internal consistency and test-retest reliability (Graham, 1993). The use of this content scale had an added advantage in that of the 33 items comprising this scale, only two overlapped with items from the proposed correction factors (Alfano: #38, #146; Artzy, none; Gass, none; Composite: none).

Statistical Analysis and Results

Pearson Product Moment correlations revealed strong correlations between the MMPI-2 correction factors and depression as measured by the MMPI-2 depression content scale. See Table 12 for correlations.

Table 12

Correlations Between the Correction Factors and the Depression Content Scale of the MMPI-2 (* if P<.05- one tailed)

Alfano	Artzy	Gass	Composite
r = .523	r = .523	r = .535	r = .507
p <.001	p <.001	p <.001	p <.001

EXPLORATORY ANALYSES

ANALYSIS A: *The first analysis explored the relation between depression and performance on standardized neuropsychological tests.*

As Hale and colleagues (1993) note, although cognitive functioning of depressed individuals has been extensively studied, the findings are inconsistent. While some researchers have found depression to have a potentially detrimental impact on cognitive functioning (Brumack 1985; Glass, Uhlenhuth, & Weinreb, 1978; Hart & Kwentus, 1987; Pernicano 1986; Williams 1978), others have found neuropsychological tests of cognitive functioning to be quite resilient to the effects of depression (Burton & Volpe, 1994; Donnelly, Murphy, Goodwin, & Waldman, 1982; Fedoroff et al., 1992; Gass 1991a; Gass & Daniel, 1990; Gass & Russell, 1985, 1986; Hale, Dingemans, Wekking, & Cornelissen, 1993).

Statistical Analysis and Results

Partial correlations with test age controlled for, revealed no significant relations between most of the standardized neuropsychological tests and depression as measured by the MMPI-2 depression content scale. See Appendices D and E for the tables of correlations.

The sample was then broken down into 'depressed' (Content scale $T \geq 70$) and 'non-depressed' (Content scale $T < 70$) groups. ANOVA's were performed and found significant differences between the groups on the RAVLT (Total: F (1, 30) = 5.16, p = .03, Trial 4: F (1, 30) = 6.06, p, .02, Trial B: F (1, 30) = 10.54, p = .003; Trial 6: F (1, 29) = 5.42, p = .027; Delay: F (1, 30) = 7.14, p = .012, Recognition: F (1, 27) = 8.09, p = .008), Symbol Digit (F (1, 110) = 7.74, p = .011), Trigrams (F (1, 127) = 4.69, p = .032), and Vocabulary (F (1, 117) = 5.85, p = .017).

ANALYSIS B: *The second analysis explored the relation between the amount of time since the head injury and endorsement of correction factor items.*

Results from Gass and Russell's study (1991) found that there may be a positive correlation between time since the injury and the number of symptom complaints made.

Statistical Analysis and Results

Pearson Product Moment correlations revealed no significant relations between endorsement of factor items and time elapsed since the head injury. See Table 13 for correlations.

Table 13

Correlations Between the Correction Factors and Time Elapsed Since the Injury

(* if P<.05- two-tailed)

	Alfano	Artzy	Gass	Composite
Time since injury	.004	-.024	-.009	.037

ANALYSIS C: *The third analysis explored the relation between the age at which the injury occurred and the present performance on neuropsychological test.*

According to Binder (1986), older patients may be at risk for prolonged disability. Russell and Smith (1961) found that when all grades of severity of head injury are considered, age is clearly related to outcome. In a review of the literature Bohnen and Jolles (1992) conclude that although the evidence is not strong, the elderly may be more vulnerable to protracted symptoms after mild head injury. However, Brooks (1984) in a review of his previous studies and that of other researchers, reports that no significant differences are found between patients under 30 and those over 30 years old.

Statistical Analysis and Results

Partial correlations controlling for age at testing revealed significant correlations of medium to large magnitude between age at injury and performance on a number of neuropsychological tests. See Appendices F and G for tables of the correlations.

DISCUSSION

Discussion of Main Results

The MMPI-2 is the most widely used self-report measure of psychopathology employed by psychologists (Butcher & Pope, 1992). The appropriateness of its use in neuropsychological settings has, however, been an issue of contention. In particular, it has been noted that artificial elevations of the clinical scales may result from bona fide medical problems, thus resulting in unreliable or inaccurate representations of the psychological functioning of individuals with conditions such as head injuries (Alfano et al., 1993; Artzy, 1994; Gass, 1991b). Consequently, psychiatric difficulties may be unjustifiably detected and inappropriate psychotherapeutic or pharmacological interventions may be implemented (Gass, 1992). This has led to the development of correction factors aimed at rectifying the effects of head injury sequelae in the hopes of providing a more accurate representation of the patient's psychological functioning.

However, just as no research to date appears to have demonstrated the appropriateness of using the MMPI-2 with head injured individuals, the validity of employing the correction factors proposed by Alfano and colleagues (1993), Artzy (1994), or Gass (1991b) has yet to be established. To that end, the present study aimed to explore the validity of the correction factors proposed for the interpretation of MMPI-2 profiles of head injured persons by investigating: 1) the extent to which the correction factors correlate with commonly used measures of head injury severity; 2) the relation between endorsement of items comprising the correction factors and performance on standardized neuropsychological tests; 3) the extent to which the items comprising the factors are selectively sensitive to the physical and cognitive sequelae of head injury versus also accounting for the psychological distress often observed after head trauma. Unexpected results were obtained.

Relation of Correction Factors to Commonly Used Measures of Head Injury Severity

Sensitivity of certain MMPI-2 items to the effects of head injury is the basis upon which correction factors have been constructed. In other words, it is hypothesized that some MMPI-2 items tap or reflect characteristics which are often experienced by people who have sustained a head injury; their post-trauma complaints. Most of the subjects for the present study were tested more than three months after their injury. The literature suggests that symptoms of mild head injury often abate within the first three months (Dikmen et al., 1989; Levin et al., 1987b,c; McLean et al., 1983; O'Hara, 1988) and that persisting complaints are typically observed in persons who sustain more severe injuries (Brooks, 1984). Since such a positive correlation has been observed between severity of the head injury and the number of complaints voiced by head injured persons (Gronwall, 1987; Lezak, 1995), it was hypothesized that a similar relation would be noted between the endorsement of items comprising the correction factors and measures of head injury severity. Surprisingly, no such linear relationships were found between the correction factors and loss of consciousness or post traumatic amnesia. Scatter plots did not reveal the possibility of a non-linear relation between the correction factors and the measures of head injury severity.

A number of reasons may account for the lack of relation between the correction factors and common measures of head injury severity. One of the problems may be that the sample was too homogenous and therefore not representative of the general head injured population. The majority of the subjects in the present sample had sustained a mild head injury as defined by LOC of less than one hour. Gronwall (1987) points that many of the studies that were unable to find a significant correlation between PTA and/or LOC and frequency of complaints, had samples which were not representative of the spectrum of head injuries. If LOC is employed to determine severity of head injury, the lack of representativeness of the sample may have affected the results of the present study. However, no correlations were found with PTA although this severity measure suggested that the present sample was more representative of the possible range of head injury severity.

Another possible explanation for the lack of correlation may be that the differences in the reported complaints across the range of head injury severities are of a qualitative nature rather than quantitative nature. Alfano and colleagues (1991) have found support for the idea that the sequelae of head injury are non-unitary in nature. Although it is relatively well established that severely head injured persons suffer from and complain of numerous difficulties following their injury, a number of researchers have also found that individuals with mild head injuries have significant long lasting complaints (Benton, 1989; Binder, 1986; O'Shaughnessy et al., 1984). It has been suggested that the relatively intact cognitive capacities of mildly head injured individuals enables them to grasp fully the extent to which the injury has impacted their life (O'Hara, 1988). In addition, these individuals are less likely to be made aware of and receive support and/or medical attention. Thus, individuals with mild head injuries may experience and unduly focus on what they perceive as unexpected attention, memory or affective difficulties. Therefore, it may be that post-trauma complaints are experienced across the spectrum of head injury severities and that these complaints differ in a qualitative nature which was not explored in the present study. For example, it may be that numerous complaints are reported across the spectrum of severities of head trauma but whereas mild head injured individuals focus primarily on cognitive difficulties, more severely injured persons complain of cognitive, physical and personality changes. Qualitative differences in post-trauma complaints were not addressed in the present study and may warrant further investigation.

Alternatively, it may be that LOC and PTA are not accurate predictors of head injury severity and that a lack of correlation might therefore be expected. There is increasing evidence that PTA and LOC may in fact be poor predictors of the degree of brain injury (Berrol, 1989; Dikmen et al., 1992; O'Shaughnessy et al., 1984). A number of researchers have found that PTA is difficult to assess when it is of short duration

(Gronwall & Wrightson, 1980; McMillan & Glucksman, 1987), and is unreliably reported by patients after 3 months (Gronwall & Wrightson, 1980). Although patients may be considered to experience the same duration of PTA and/or LOC , there may be a qualitative difference in their experience which may be difficult to measure and control for. In other words, while one patient may have altered consciousness with some recollection in the post-trauma period, another patient may have a qualitatively different altered consciousness with less ability to recall any events.

In addition, accidents resulting in head trauma often involve the use of drugs and alcohol which may make it difficult to assess the extent of PTA and/or LOC (Berrol, 1989; Galbraith et al., 1976 in Bohnen & Jolles, 1992). As Russell (1961) points out, the assessment of PTA is difficult especially for an untrained observer. Similar difficulties are most probably encountered for the assessment of LOC. One of the limitations of this study was that due to its retrospective nature, information regarding LOC and PTA was obtained either through unreliable self-reports or when available, through medical records where assessment of the severity of the head injury was conducted by various individuals.

However, as previously mentioned, Gronwall (1987) found that many of the studies reporting LOC and PTA to be poor predictors of head injury severity were poorly designed. Although trying to relate these measures of severity across the spectrum of head injuries, their samples were often homogeneous and consequently not representative of head injury populations. Numerous researchers have found a significant correlation between LOC and/or PTA and the degree of post-trauma dysfunction (Brooks et al., 1987; Rutherford, 1989; Van Zomeren & Van den Burg, 1985), thus validating these measures as predictors of head injury severity. The lack of correlation between the correction factors and LOC and PTA then raises the possibility that the items comprising the factors may not be as sensitive to head injury as initially proposed. At the very least, our results question the validity and appropriateness of using correction factors for interpretation of MMPI-2 profiles of head injured individuals.

In short, results from the present study found no correlation between LOC and PTA and the correction factors proposed for interpretation of MMPI-2 profiles of head injured individuals. The nature of this lack of relation is unclear. The sample may not have been representative of head injured populations. Alternatively, it may be that individuals with all types of head injuries report numerous difficulties perhaps of a different qualitative nature which was not investigated in the present study. Another explanation may be that PTA and LOC are not accurate predictors of head injury severity and may be less than ideal measures with which to validate the correction factors. Yet a different way to examine the validity of these correction factors is by assessing their relation with performance on cognitive tests.

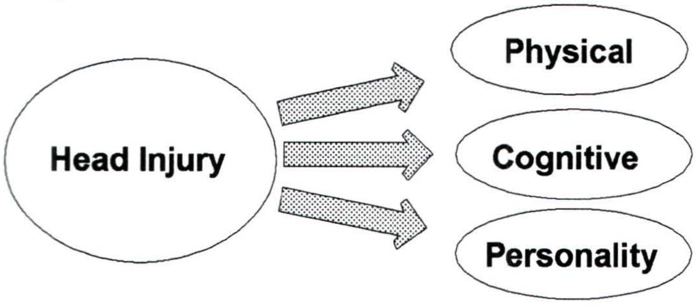
Relation of Correction Factors to Standardized Neuropsychological Test Performance

Standardized neuropsychological tests have been devised for the purpose of detecting and understanding brain dysfunction (Cripe, 1989). Even subtle deficits of attention and information processing can be detected with the use of sensitive and appropriate neuropsychological tests (Bohnen & Jolles, 1992). The literature has repeatedly shown these tests to not only be able to detect brain damage but to also be able to differentiate between brain injury and psychiatric difficulties (Gass,1991a). Therefore, unlike LOC and PTA whose relation to head injury is not considered clearly established, performance on neuropsychological tests has been found to correlate reliably with brain injury. Thus, the lack of relation between test performance and the correction factors in the present study further raises strong questions about the validity of these factors. It suggests that although the individuals sampled in the present study complained of numerous difficulties, these did not consistently correspond to actual deficits in functioning. However, it is important to note that neuropsychological tests are administered in optimal conditions where distractions are minimized. These conditions do not reflect real life day-to-day living situations, thus the degree to which the test results can be generalized is questionable. In other words, it may be that the deficits experienced by head injured individuals manifest themselves under conditions which are not assessed in the artificial environment created for neuropsychological testing. Some researchers have found that it is very difficult to assess the impact of deficits identified by psychological tests on a patient's everyday life (Boone, 1994).

Relation of Correction Factors to Depression

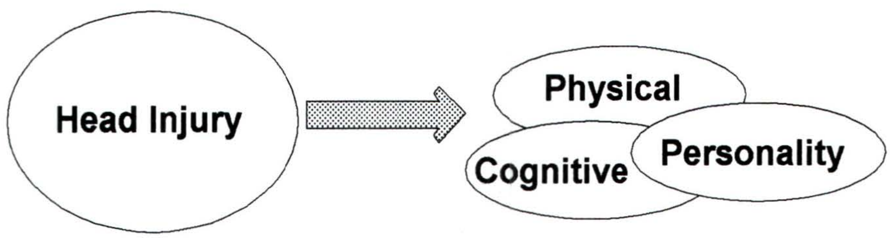
The underlying assumption of the correction approaches is that they account for the effects of head injury sequelae which may artificially inflate the clinical scales of the MMPI-2. However, head injury results in a wide range of changes on physical, personality and cognitive levels. Although not clearly specified, one could assume that if the application of a correction factor is to lead to a more accurate reflection of the person's psychological functioning, the factor must not include items which tap personality changes often seen following head injury (e.g. depression). However, results from the present study found that all of the proposed correction factors had significant correlations with depression as measured by the MMPI-2 depression content scale. This suggests that the premise under which the correction factors were made is flawed. Suggestions to remove MMPI-2 items to account for selected head injury sequelae (e.g. physical & cognitive) imply that head injury sequelae can be compartmentalized into unrelated components (see diagram 1).

Diagram 1



In this model of head injury sequelae, the various components do not influence one another. It is therefore possible to remove MMPI-2 items specific to cognitive or physical complaints observed after head injury while leaving in items that, although reflecting sequelae of head injury, are important for the understanding of the person's psychological functioning. However, results from this study suggest that it is not accurate to assume that head injury sequelae can be compartmentalized. The significant correlations found between the correction factors and depression suggest that although items comprising the factors may have face validity suggesting that they are sensitive to physical or cognitive complaints following head injury, they also tap the post-trauma distress often experienced by head injured individuals. It is perhaps more accurate to view the sequelae of head injury as intimately interrelated (see diagram 2).

Diagram 2



These findings suggest that the correction factors proposed for the interpretation of MMPI-2 profiles of head injured individuals may not be valid. It does not appear to be possible to remove items specific to physical and cognitive complaints without affecting the psychological profile. Therefore, removal of these items, while accounting for some unwanted effects, may also minimize the psychological difficulties experienced by the head injured person.

These findings raise questions regarding the appropriateness of the use of the MMPI-2 correction factors for personality assessment in head injured individuals. In their original form, MMPI-2 profiles of head injured persons are elevated. However, when attempts are made to correct for this, the psychological difficulties experienced by these individuals may be minimized. The results from the present study suggest that the scale elevations observed may be due to emotional distress experienced by the head injured person, and that items must thus not be deleted in order for the MMPI-2 profiles to best reflect the person's psychological functioning.

Given that the impact of head injury sequelae on the clinical scales of the MMPI-2 profiles remains unclear, it is important that interpretations be substantiated through the use of other sources. For example, greater emphasis of the MMPI-2 content scales may provide more accurate representation of the person's psychological functioning. The depression content scale shares only nine items with Scale 2 which has been found to be artificially elevated in head injured individuals. As mentioned previously the depression content scale has been shown to have incremental validity, containing more information than that available from Scale 2 (Ben-Porath et al., 1991). However, the face validity of the Content scales may be tapping only specific aspects of what they are trying to measure.

Discussion of Exploratory Analyses

Gass (1991a) points out that it has commonly been assumed that depression adversely affects performance on neuropsychological tests presumably due to factors such as cognitive inefficiency, lack of motivation and psychomotor retardation. A number of studies have found depression to impact cognitive functioning (Hart & Kwentus, 1987; Lodewyk & Wong, 1993).

However, results from the present study found little relation between depression and performance on standardized neuropsychological tests. These findings are in keeping with numerous studies which have found not only no relation between depression and cognitive performance (Burton & Volpe, 1994; Donnelly et al., 1982; Fedoroff et al., 1992; Gass & Russell, 1986,1991; Hale et al., 1993), but also that these neuropsychological tests can be quite resilient to the effects of a person's emotional state (Gass, 1991a; Gass & Daniel, 1990). Since the depression content scale has been found effective in detecting clinical depression (Ben-Porath et al., 1993; Boone, 1994), there is no reason to believe that these results may have been due to an inadequacy in the measure employed to assess depression. However, emotional sequelae of head injury is most probably not unitary in feature (Alfano, Neilson, Paniak, & Finlayson, 1992). The use of a single measure tapping a specific aspect of emotional distress may have therefore been too limiting. The use of additional measures of emotional functioning (e.g. Beck Anxiety Checklist, Structured Interview for the DSM-IV) would have strengthened the present results.

No significant relation was found between the amount of time elapsed since the injury and the number of complaints reported as measured by endorsement of the correction factors. This finding is not in keeping with that obtained by Gass and Russell (1991). They found a steady increase in complaints related to time since the injury. The present results may perhaps be explained by thinking in terms of qualitative differences in complaints over time. In other words, it may be that immediately following the head injury, the individual is plagued by a number of physical, cognitive and personality changes which can cause great distress. Although many of these symptoms may abate with time, awareness of the extent to which the persistent deficits impact daily functioning may give rise to a whole new series of complaints. Some researchers have found that relatives report increased levels of disturbance in severely head injured persons over a five year period. It was hypothesized that this may reflect increased frustration as he or she begins to understand the impact of his or her head trauma (Brooks et al., 1987). Therefore, although patients may consistently report difficulties, the origins of these complaints may change over time. This possibility was not explored in the present study and may warrant further investigation.

Significant correlations were found between age at time of the injury and performance on a number of standardized neuropsychological tests. The literature on age related differences in performance is often contradictory. A number of researchers have found performance to be related to the age at which the injury occurred, with older patients at greater risk of disability (Binder, 1986; Bohnen & Jolles, 1992; Dikmen et al., 1989), while others have found no such relation (Brooks, 1984; Lezak 1979). Results from the present study yielded some effects related largely to a decline in speed of processing with advancing age. Since over 75% of the present sample was under 40 years of age, it may be that the sample was too homogeneous and that more differences would have been detected with a more representative sample.

Further Considerations

Gender effects were not addressed in the present study. Results from research conducted by Artzy (1994) found no significant differences between men and women on the clinical scales of the MMPI-2. This is in keeping with the findings that both men and women have similar elevated scores on a number of clinical scales following head injury (Alfano et al., 1990). Consequently, it was not considered necessary to address gender effects in the present study.

The retrospective nature of the present study lends itself to numerous complications as information obtained was difficult to verify and was often collected by various individuals. This also made it impossible to obtain some important information which could have impacted the results of the study. In particular, no information was obtained for 66% of the sample, regarding subjects premorbid psychiatric functioning and drug and alcohol abuse. It has been noted that premorbid personality traits and psychological well being, as well as premorbid drug and alcohol abuse impact post-trauma functioning (Binder, 1986; Dikmen et al., 1989). Such difficulties may have been avoided through a prospective research format.

Information about previous head injuries was also unavailable. This information is relevant as some researchers have suggested that there may be a cumulative effect to head injuries (Gronwall & Wrightson, 1975). Therefore, someone with numerous mild head injuries may show deficits more in keeping with that observed following moderate to severe head trauma. Another limitation of the present study is that no information was available regarding the type and extent of injury as verified through magnetic resonance imaging or CT scans.

In addition, the use of a self-report measure for investigating personality has its own limitations. Some researchers have suggested that the lesion may affect a person's ability to report accurately their functioning (Prigatano, 1987). For example, it has been suggested that persons with right hemisphere lesions may minimize their difficulties, while individuals with left hemisphere lesions have 'catastrophic reaction' to their trauma and tend to exaggerate their difficulties (Bear & Fedio, 1977). The use of semi-structured interview and/or corroborative reports from family members would be valuable in this instance.

As mentioned previously, the present study addressed only a narrow aspect of emotional distress. Anxiety, fear, irritability and a number of other emotional states may have impacted the test results. In addition, although the Depression content scale has been found to be a valuable measure of depression, the face validity of this scale may have been tapping only certain aspects of this emotional state. Corroborative reports and/or findings from other depression measures may have provided a more thorough investigation of the correlation of depression to the correction factors and test results.

Lastly, Evans (1992), in a review of the literature, found that numerous studies report that litigation does not typically influence test performance or resolution of difficulties experienced by head injured individuals. Even upon settlement of their cases, these persons continue to experience deficits and research has shown that they continue to experience difficulties up to a year following settlement of the litigation. However, other researchers have found litigation to be a significant factor influencing test performance (e.g. Lees-Haley, 1990). Since most of the individuals comprising the sample of the present study were assessed for litigating purposes, it may be argued that ulterior motives impacted test performance and self-report on the MMPI-2. But precautions were taken to assess the validity of the MMPI-2 and the possibility of malingering (see methods section), thus this should not have been an issue in the present study. The possibility that the present results are not applicable to non-litigating head injured persons must be acknowledged.

Conclusion

The present study aimed to assess the validity of using correction factors to interpret the MMPI-2 profiles of individuals with head injuries. Results from this study suggest that application of correction factors is not appropriate for the following reasons:

1) Although the correction factors are based on the premise that items to be removed are sensitive to head injury, no correlation was found between the correction factors and common measures of head injury severity-LOC and PTA

2) Though items comprising the factors are thought to be sensitive to the cognitive and physical sequelae of head injury, there was no relation between endorsement of these items and performance on standardized neuropsychological tests.

3) Significant correlations were found between the correction factors and depression. This suggests that although the items comprising the factors may tap the cognitive and physical sequelae of head injury, these appear to be intimately related with emotional functioning. Given the relation of the correction items to depression, removal of these items would not lead to an accurate representation of the person's psychological functioning thereby defeating the purpose of the proposed factors.

Findings from the present study lead one to question the appropriateness of using the MMPI-2 correction factors with head injured individuals. It appears that the items proposed for the correction factors are correlated to depression and that it may therefore be more appropriate to leave these items in the profiles, in order to gain a more accurate understanding of the person's psychological functioning. Noting that the impact of head injury on MMPI-2 profiles is not fully understood and that MMPI-2 interpretations are often used to aid decisions of diagnosis and treatment programs, clinicians are encouraged to interpret MMPI-2 results cautiously.

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APPENDIX A

Comparison of correction items from Alfano et.al. (1993), Artzy (Dissertation 1994), and Gass (1991)

MMPI-2 ITEM #		ARTZY	ALFANO	GASS
10	I am about as able to work as I ever was		*	
12	My sex life is satisfactory		*	
31	I find it hard to keep my mind on a task or job	*	*	*
35	Sometimes when I was young I stole things	*		
38	I have had periods of days, weeks, or months when I couldn't take care of things because I couldn't "get going"		*	
53	Parts of my body often have had feelings like burning, tingling crawling, or like "going to sleep"	*		
69	I think I would like the kind of work a forest ranger does	*		
91	I have little or no trouble with my muscles twitching or jumping	*		
101	Often I feel as though there is a tight band around my head			*
106	My speech is the same as always (not faster or slower, no slurring or hoarseness)	*	*	*
119	I like collecting flowers or growing house plants	*		
137	I used to keep a diary	*		
146	I cry easily	*		
147	I cannot understand what I read as well as I used to	*	*	*
149	The top of my head sometimes feels tender			*
165	My memory seems to be alright			*
168	I have had periods in which I carried on activities without knowing later what I had been doing	*		
170	I am afraid of losing my mind			*
172	I frequently notice that my hand shakes when I try to do something			*
175	I feel weak all over much of the time			*
177	My hands have not become clumsy or awkward		*	
179	I have no difficulty in keeping my balance in walking		*	
180	There is something wrong with my mind	*	*	*
181	I do not have spells of hay fever or asthma			*

APPENDIX A Con't

Comparison of correction items from Alfano et.al. (1993), Artzy (Dissertation 1994), and Gass (1991)

MMPI-2 ITEM #	ARTZY	ALFANO	GASS
229 I have had blank spells in which my activities were interrupted and I did not know what was going on around me	*		
247 I have numbness in one or more places of my skin		*	*
266 I have never been in trouble with the law	*		
295 I have never been paralyzed or had any unusual weakness of any of my muscles		*	*
299 I cannot keep my mind on one thing	*	*	
308 I forget right away what people say to me	*		
309 I usually have to stop and think before I act even in small matters	*		
325 I have more trouble concentrating than others seem to have	*	*	*

Note: The derived Composite scale includes the following items: 31, 106, 147, 180, 247, 295, 299, 325

APPENDIX B

Correlations Between the Correction Factors and Performance on Neuropsychological Tests of Memory and Attention Thought to be Sensitive to the Effects of Head Injury (* if P<.05- one tailed)

	Alfano	Artzy	Gass	Composite
Buschke T1	.046	.124	.009	.112
Buschke STR	.293	-.022	.102	.067
Buschke LTS	-.022	.008	-.089	-.045
Buschke CLTR	-.067	-.051	-.076	-.061
Buschke RLTR	.074	.052	.045	.049
Buschke Trl LT	.037	.032	.001	.032
Buschke Trl CL	-.066	-.101	-.117	-.049
Buschke Intrus.	-.161	-.058	-.171	-.119
Buschke Cued Rcl	.055	.106	.094	.106
Buschke 30m Del	.014	.003	.012	.006
Digit Symbol	-.134	-.144	-.159	-.125
D2 Total	-.115	-.196	-.075	-.096
D2 Errors	-.092	-.085	-.028	.006
PASAT 2.4s	-.154	-.061	-.073	-.106
PASAT 1.6s	-.172	-.132	-.137	-.131
RAVLT T1	-.256	-.042	-.113	-.174
RAVLT T2	-.173	-.107	-.110	-.133
RAVLT T3	-.021	-.079	-.031	.000
RAVLT T4	-.224	-.192	-.183	-.154
RAVLT T5	-.007	-.018	.041	.050
RAVLT Tot	-.164	-.135	-.106	-.109
RAVLT B	-.205	-.113	-.169	-.076
RAVLT T6	-.183	-.098	-.151	-.128
RAVLT T7	-.171	-.110	-.124	-.095
RAVLT Recog	-.216	-.169	-.105	-.124
RVDLT T1	.052	.029	-.032	.064
RVDLT Tot	.123	.173	-.002	.113
RVDLT Recog	-.222	-.099	-.241	-.161
Rey-O Fig Del	-.039	.048	-.047	.001
Sentence Rep.	.054	-.039	-.049	.007
Stroop C	.106	.157	.147	.115
Stroop W	.067	.117	.087	.089
Stroop C-W	.174	.209	.195	.198
Stroop Errors	.080	.200	.083	.138
Symbol Digit	-.054	.008	-.094	-.033
Trails A	.127	.133	.169	.109
Trails B	.137	.135	.176	.123
Trigrams	-.182	-.175	-.232	-.148

APPENDIX C

Correlations Between the Correction Factors and Performance on Neuropsychological Tests Thought to be Relatively Less Sensitive to the Effects of Head Injury (* if P<.05- one tailed)

	Alfano	Artzy	Gass	Composite
Block Design	-.029	-.038	-.029	-.003
Dynam. PH	-.177	-.180	-.227	-.190
Dynam. NPH	-.187	-.122	-.211	-.185
Fing. Tap. PH	-.142	-.153	-.201	-.172
Fing. Tap. NPH	-.113	-.109	-.156	-.153
Hooper	.107	.147	.060	.138
NAART	.035	.180	.199	.105
Purdue PH	.000	.044	-.027	.018
Purdue NPH	-.051	.051	-.036	.021
Purdue Both Hands	-.029	.069	-.024	.034
Purdue Assemblies	-.054	-.025	-.097	-.019
Vocabulary	-.066	-.080	-.127	-.102
WRAT-S	.081	-.033	.016	.041
WRAT-A	.107	.066	.017	.108
WRAT-R	.194	.089	.112	.112

APPENDIX D

Correlations Between the MMPI-2 Depression Content Scale and Performance on Neuropsychological Tests of Memory and Attention Thought to be Sensitive to the Effects of Head Injury
(* if P<.05- one tailed)

	Depression
Buschke T1	-.124
Buschke STR	.031
Buschke LTS	-.062
Buschke CLTR	-.075
Buschke RLTR	.048
Buschke Trl LT	.034
Buschke Trl CL	-.049
Buschke Intrus.	-.019
Buschke Cued Rcl	.028
Buschke 30m Del	-.015
Digit Symbol	-.208*
D2 Total	-.083
D2 Errors	-.020
PASAT 2.4s	-.183*
PASAT 1.6s	-.163*
RAVLT T1	-.103
RAVLT T2	-.315*
RAVLT T3	-.256
RAVLT T4	-.345*
RAVLT T5	-.381*
RAVLT Tot	-.355*
RAVLT B	-.379*
RAVLT T6	-.512*
RAVLT T7	-.415*
RAVLT Recog	-.457*
RVDLT T1	.062
RVDLT Tot	.014
RVDLT Recog	-.106
Rey-O Fig Del	-.059
Sentence Rep.	-.155
Stroop C	.044
Stroop W	.061
Stroop C-W	.148
Stroop Errors	.018
Symbol Digit	-.210*
Trails A	.043
Trails B	.095
Trigrams	-.222*

APPENDIX E

Correlations Between the MMPI-2 Depression Content Scale and Performance on Neuropsychological Tests Thought to be Relatively Less Sensitive to the Effects of Head Injury (* if P<.05- one tailed)

	Depression
Block Design	-.146
Dynam. PH	.047
Dynam. NPH	.025
Fing. Tap. PH	-.036
Fing. Tap. NPH	-.035
Hooper	-.043
NAART	.123
Purdue PH	-.018
Purdue NPH	-.077
Purdue Both Hands	-.075
Purdue Assemblies	-.032
Vocabulary	-.179*
WRAT-S	-.245*
WRAT-A	-.173
WRAT-R	-.169

APPENDIX F

Correlations Between the Age at Time of Injury and Performance on Neuropsychological Tests of Memory and Attention Thought to be Sensitive to the Effects of Head Injury (* if P<.05- two tailed)

	Age at Injury
Buschke T1	-.178
Buschke STR	-.055
Buschke LTS	-.058
Buschke CLTR	.205
Buschke RLTR	-.551*
Buschke Trl LT	.012
Buschke Trl CL	-.184
Buschke Intrus.	-.189
Buschke Cued Rcl	.093
Buschke 30m Del	.269*
Digit Symbol	-.729*
D2 Total	-.429*
D2 Errors	-.545*
PASAT 2.4s	.332*
PASAT 1.6s	.369*
RAVLT T1	.362*
RAVLT T2	.099
RAVLT T3	.124
RAVLT T4	.307
RAVLT T5	.204
RAVLT Tot	.265
RAVLT B	.369*
RAVLT T6	-.036
RAVLT T7	.193
RAVLT Recog	.349
RVDLT T1	.271*
RVDLT Tot	.369*
RVDLT Recog	.487*
Rey-O Fig Del	.505*
Sentence Rep.	-.123
Stroop C	.342*
Stroop W	.280
Stroop C-W	.225*
Stroop Errors	-.356*
Symbol Digit	-.503*
Trails A	.245*
Trails B	.217*
Trigrams	.133

APPENDIX G

Correlations Between the Age at Time of Injury and Performance on Neuropsychological Tests Thought to be Relatively Less Sensitive to the Effects of Head Injury (* if P<.05- two tailed)

	Age at Injury
Block Design	-.327*
Dynam. PH	.167
Dynam. NPH	.213*
Fing. Tap. PH	-.154
Fing. Tap. NPH	-.879*
Hooper	-.004
NAART	.266
Purdue PH	-.339*
Purdue NPH	-.548*
Purdue Both Hands	-.267*
Purdue Assemblies	-.555*
Vocabulary	-.507*
WRAT-S	-.523*
WRAT-A	-.604*
WRAT-R	-.523*

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Word and Design List Learning Deficits Related to Side of Hippocampal Atrophy as Assessed by Volumetric MRI Measurements. M. Jones-Gotman, M. Brulot, D. McMackin, F. Cendes, F. Andermann, A. Olivier, A. Evans, & T. Peters. EPILEPSIA 34. 6, 71, 1993.

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Title of Thesis: The Validity of the Minnesota Multiphasic Personailty Inventory-2 Head Injury Correction Factors.

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