The Neuropsychological Similarities of Mild and More Severe Head Injury

Ralph M. Reitan and Deborah Wolfson
Reitan Neuropsychology Laboratory

Reports in the literature have suggested that the neuropsychological effects of mild head injury are selective, represented by impairment of attention, information processing, and memory, and that evaluations with comprehensive and standard test batteries are likely to miss such deficits. The present study compared groups of individuals with mild head injuries, more severe head injuries, and non-brain-damaged controls using 19 tests from the Halstead-Reitan Battery. The results indicated that the group with mild head injuries performed significantly poorer than the controls, and that the group with more severe head injuries scored significantly more poorly than either of the other groups. Comparisons of the pattern of test scores for the two head-injured groups were remarkably similar across the 19 tests, yielding a rank difference correlation of 0.87. The findings yielded no evidence of selective or delimited impairment in the group with mild head injuries, but instead, showed them to have test results that were very similar, though showing less neuropsychological impairment, to the group of subjects with more severe head injuries. These findings suggest that a comprehensive neuropsychological test battery is necessary to detect the broad range of deficits that may result from mild head injury. © 2000 National Academy of Neuropsychology. Published by Elsevier Science Ltd

Keywords: mild head injury, severe head injury, neuropsychological deficits, intergroup similarities

Beginning with the work of Gronwall and her colleagues (Gronwall, 1976, 1977; Gronwall & Sampson, 1974; Gronwall & Wrightson, 1974, 1981) and fostered by the findings of a number of additional investigators (Gentilini, Nichelli, & Schoenhuber, 1989; Newcombe, Rabbitt, & Briggs, 1994; Ruff, Levin, Mattis, High, Marshall, Eisenberg, & Tabaddor, 1989; Van Zomeren, 1981), a belief seems to have emerged that the neuropsychological consequences of mild head injury are selective, and, when they occur, are primarily represented by deficits of memory, verbal learning, and efficiency of information processing. The investigations supporting this belief, however, have only used testing methods that are, in the main, thought to measure abilities that fall in these areas. Gronwall and her colleagues, for example, have primarily used the Paced Auditory Serial Addition Test (PASAT), which Gronwall (1989) describes as sampling information processing capacity. Gentilini et al. (1989) reviewed studies of closed head injury and concluded that the findings, based largely on tests of reaction time, the Stroop Color
Test, a card-sorting task with distracting stimuli, and the PASAT, show deficits of attention that, in turn, bring about limitations in information processing skills. In choosing tests to use in their study, they pointed out the importance of selecting appropriate test procedures rather than performing a “general survey of neuropsychological abilities, as in test batteries aimed at examining different cognitive functions (which) may well be inefficient in isolating specific impairments” (p. 165).

The editors of the volume in which Gentilini et al.’s (1989) study was published stated that the measures of attention used by these investigators “appear to be highly sensitive to sequelae of mild head injury as compared with conventional neuropsychological assessment techniques” (p. vii).

In their brief review of the literature regarding mild head injury, Ruff et al. (1989) concluded that “memory systems are frequently disturbed secondary to minor head injury” (p. 178), and therefore selected for their study the Galveston Orientation and Amnesia Test (GOAT), the Mattis-Kovner Verbal Learning and Memory Test, the Benton Visual Retention Test, and the Digit Span subtest of the Wechsler Adult Intelligence Scale, a group of tests that the editors of the volume described as tests to detect “impairment of memory for verbal information and geometric designs” (p. vii).

Newcombe et al. (1994) studied patients described as having minor head injuries, stating that their aim was “to measure abilities often compromised after significant head injury, namely memory and attention” (p. 709). They found no deficits among their head-injured subjects, as compared to the control subjects, when tested within 48 hours of the injury, concluding that “had there been any substantial cognitive impairment, we would have expected to have elicited it with the tasks selected” (p. 714).

The general conclusion based on reports such as those cited above is that a degree of impairment of attention, information processing, and memory may occur following a mild head injury, but that full recovery is usually attained within 1 to 3 months (although some patients may report residual problems for a longer period of time). It must also be noted that these research studies influence clinical approaches of practitioners in the field. In his review of the pathophysiology, natural history, initial symptoms and recovery, and clinical management of mild head injury, Alexander (1995) takes a bleak view of the prospect for remediating any residual neuropsychological deficits, stating that “there is no role for most such therapies in the mild head injury. Programs that allege to treat attention and memory problems are not acceptable” (p. 1258).

Two sources of evidence suggest that caution should be exercised in accepting the contention that the neuropsychological effects of mild head injury are selective and delimited to particular functional areas. First, the neuropsychological consequences of traumatic brain injury, when studied with a broad range of neuropsychological tests, have been found to be very extensive, quite diversified, and variable among individual patients (Dikmen, Reitan, & Temkin, 1983; Reitan & Wolfson, 1986, 1988). Secondly, neuropathological studies have shown that even in cases with relatively mild trauma, damage of tissue, including blood vessels as well as neurons and supporting cells, is widespread throughout the brain (Adams & Graham, 1984; Alves & Jane, 1979, 1985; Gade, Becker, Miller, & Dwan, 1990; Oppenheimer, 1968; Povlishock & Coburn, 1989). Since any damage to the brain is generalized rather than delimited, one might well expect the neuropsychological impairment to be generalized rather than delimited. Alves and Jane (1985) make it clear that mild brain injury must be considered within the framework of brain injury more generally, saying that “mild brain injury does not form a distinct class of injury, but rather represents the end point of a continuum ranging from the most mild concussive blow to impacts which cause instant death” (p. 255).

Another major concern regarding mild head injury is that the presumption of selec-
Neuropsychological Similarities 435

tive and delimited neuropsychological effects may be premature. We know of only one study (Rojas & Bennett, 1995) that has used an extensive and comprehensive test battery, and this obviously would be necessary to support a conclusion that deficits occur in some areas of functioning but not in others. In addition, direct comparisons of the type and degree of deficits in mild versus more severe brain injury would be necessary before a conclusion could be drawn that deficits were selective in mild head injury. In fact, Williams, Levin, and Eisenberg (1990) evaluated outcome among patients with mild head injuries, comparing subgroups with and without complications of the type that indicated possible damage of the brain parenchyma. Neurobehavioral functioning was significantly more impaired among the patients with complications, and the variability among patients initially classified as having a mild brain injury was so great that the authors suggested that a revision of the mild head injury classification should be considered.

In contrast to the contention that impairment is selective and delimited in mild head injury, Rojas and Bennett (1995) found that a summary measure, the General Neuropsychological Deficit Scale (GNDS), was remarkably sensitive in identifying persons who had sustained mild head injuries. The GNDS, first described in 1988 (Reitan & Wolfson, 1988), is a summary measure based on 42 variables from the Halstead-Reitan Neuropsychological Test Battery (HRB). Inasmuch as the HRB was developed case-by-case to reflect impairment over the entire range of brain pathology, it is obvious that the GNDS reflects neuropsychological functions generally rather than selectively. Further, research studies have shown (Reitan & Wolfson, 1988; Sherer & Adams, 1993), with cross-validation (Wolfson & Reitan, 1995), that the GNDS is very sensitive to cerebral damage. Rojas and Bennett (1995) found that the GNDS correctly identified 92% of 25 persons who had sustained a mild head injury and 25 volunteer subjects who were comparable in age, gender, and education, while the Stroop Neuropsychological Screening Test did not differentiate the two groups. Individual variables from the HRB and the Impairment Index demonstrated significant deficits in the group with mild head injuries, but none was as sensitive as the GNDS. Rojas and Bennett concluded that patients with a mild head injury “do not show a consistent pattern across the tests of the HRB, but are impaired on a significant number of scores when all measures are taken into account” (p. 109).

It is apparent that the question of specificity of impairment versus more generalized impairment in mild head injury needs further investigation. On the basis of neuropathological findings, one would expect neuropsychological deficits, when they occur, to be generalized and diversified, in contrast to the prevailing conclusion supported by reports from the majority of head injury researchers.

METHOD

Three groups of subjects were composed and compared in order to study the significance of intergroup differences and the extent to which performances across tests were similar in groups with mild and more severe traumatic head injuries. None of the intergroup differences in mean age and education were statistically significant.

Subjects

Group 1: Non-Brain-Damaged Controls (n = 41). No subject in this group had any past or present evidence of cerebral disease or damage as documented by history and neurological examination. The group had a mean age of 30.10 years (SD = 13.04) and a mean education of 11.68 years (SD = 3.11). Only 5 of these 41 subjects were normal controls...
who did not have significant medical or psychiatric conditions. The remaining 36 subjects had a variety of difficulties. The group was composed deliberately in this manner, recognizing that brain-damaged subjects frequently have many stresses and problems to which they must adjust as a result of illness and injury. Thus, in order to provide at least rough equivalence between the controls and the brain-damaged subjects, we selected controls who also had significant problems. It must be emphasized, however, that each of the controls was examined very thoroughly for any past or present evidence of brain damage, and none of the control subjects had any such evidence. Thus, they were controls in the sense that they did not have brain damage, but clearly were not normal with regard to many other difficulties. Twelve of the 36 controls had recent spinal cord injuries and were paraplegic. The reader is no doubt aware of the extreme emotional trauma and adjustment problems faced by persons who have recently learned that they probably will never be able to walk again. Sixteen of the other control subjects had severe emotional disturbances that required hospitalization. Many studies have shown that persons with brain damage experience various types of emotional disorders. In this study, however, we deliberately avoided including any subjects who were psychotic. The types of emotional difficulties and the number of subjects involved were as follows: Anxiety reactions, 7; paranoid reactions, 3; conversion reactions, 3; depressive reactions, 2; and sociopathic personality, 1. The remaining 8 non-brain-damaged subjects all had been hospitalized for various medical conditions (congenital heart defect, 1; peripheral nerve injury, 1; facial injury, 2; herniated intravertebral disk, 1; rheumatoid arthritis, 1; cancer, 1; and headache, 1). It is apparent that, in the main, this group of non-brain-damaged controls had many problems that they were currently facing.

Groups 2 and 3: Head-Injured Subjects Who Were Formally Enrolled in a Research Project. Groups 2 and 3 were drawn from cases enrolled in a formal study of the effects of traumatic brain injury (Reitan & Wolfson, 1988). Subjects included in Group 2 all had definite evidence of brain tissue damage resulting from the head injury. No subject in Group 3 had any such evidence of brain tissue damage and met criteria for mild head injury. It should be noted, however, that every subject in Groups 2 and 3 was enrolled in a research study, and that the neuropsychological testing was done for research purposes. (Of course, all available findings, including written reports of the test results, were available to professionals for clinical use in providing care to these subjects.) Since these groups were composed of consecutive cases, every subject was enrolled in the study regardless of whether brain damage was identified, and regardless of the clinical problems that might have co-existed.

The specific criteria for admitting subjects to either Group 2 or Group 3 were as follows: (a) The subject must have sustained a head injury; (b) the subject must have been hospitalized because of the head injury; (c) the subject must not have had any prior history of traumatic brain injury, other cerebral disease, alcoholism, mental retardation, or significant psychiatric disorder; and (d) The subject must be between the ages of 18 and 45.

Group 2: Traumatic Brain Injury—Structural Tissue Damage (n = 18). These subjects were 14 men and 4 women who had a mean age of 31.22 years (SD = 13.09) and a mean education of 12.28 years (SD = 2.30). The mean duration between time of injury and neuropsychological testing was 53.58 days (SD = 64.68 days). The large standard deviation was due to a relatively long delay in testing two persons with severe injuries. Sixteen of
the 18 subjects had evidence of cerebral contusions and 2 subjects had penetrating head injuries. Nine of the subjects had contusions that involved only the cerebral tissue, 7 subjects had contusions that were multiple and widespread, and 2 subjects sustained cerebral tissue damage due to a penetrating missile injury. Neurological examination of these subjects revealed hemiparesis, hemiplegia, and dysphasia as the most common focal signs, with 7 subjects demonstrating motor deficits and 7 subjects exhibiting dysphasia. In total, 11 of the 18 subjects showed focal signs, and 7 subjects did not show any focal signs on clinical examination. None of these patients had seizures during hospitalization. Fifteen of the 18 patients sustained a loss of consciousness (LOC) from the head blow. The durations of LOC were quite variable, ranging from 15 minutes or less to 120 days. More specifically, the duration of LOC experienced by this group was as follows: 15 minutes or less, 2; from 1 to 5 hours, 6; from 20 hours to 2 days, 2; from 20 to 30 days, 3; for 60 days, 1; and for 120 days, 1. It is apparent from these findings that all subjects in this group sustained traumatic injury of the brain tissue and that their injuries were relatively severe.

**Group 3: Mild Traumatic Head Injury (n = 18).** This group consisted of 17 men and 1 woman. The group had a mean age of 27.44 years (SD = 11.98) and a mean education of 13.06 years (SD = 2.31). The mean duration between time of injury and neuropsychological testing was 13.83 days (SD = 9.20). Seventeen of these 18 subjects had a closed head injury with a diagnosis of concussion. The remaining individual had a right frontal depressed skull fracture that was elevated surgically. The surgeon reported that the cerebral cortex underlying the minimally depressed bone appeared to be normal. Three of these 18 subjects did not lose consciousness, and 5 were unconscious for 2 minutes or less. Among the 10 remaining subjects, the duration of LOC was as follows: approximately 5 minutes, 2; 10 minutes, 2; 15 minutes, 1; approximately 20 minutes, 4; and 25 minutes, 1. Thirteen of the 18 subjects had at least a brief period of amnesia for events before or after the injury, with the following distribution: anterograde amnesia, 7; retrograde amnesia, 3; and both anterograde and retrograde amnesia, 3. Defining posttraumatic amnesia (PTA) as the interval from the time of injury until the return of consciousness with continuing memory for events in the environment, the distribution of times of PTA was as follows: no PTA, 3; no PTA beyond the period of loss of consciousness, 3; between 1 and 2 minutes, 1; between 15 and 30 minutes, 4; between 1 and 2 hours, 5; and between 6 and 7 hours, 2; None of these subjects had any evidence of focal signs on neurological examination and none had a seizure during hospitalization.

**Procedure**

Each subject was individually administered the entire HRB by a technician who had been fully trained in standard administration of each test, including methods for eliciting the best performances of each subject. Every subject included in the study was being tested for the first time. It was necessary to delay testing in a few cases of traumatic brain injury until injuries not involving the brain had healed, but the great majority of subjects were tested within 30 days postinjury. The GNDS, which is a summary value based on the HRB and represents the full range of methods of inferring impairment (including level of performance, pathognomonic signs, patterns and relationships among test results, and comparisons of performances on comparable tasks on the two sides of the body) (Reitan & Wolfson, 1993), provided an overall indication of the neuropsychological status of each subject and was used as the basic score for comparing the three groups.
The GNDS was selected for this purpose because it meets several important criteria. Prior research (Reitan & Wolfson, 1988; Rojas & Bennett, 1995; Sherer & Adams, 1993; Wolfson & Reitan, 1995) has shown that the GNDS (a) is a comprehensive score that summarizes the results of the HRB, (b) demonstrates equivalent impairment in groups with generalized, left, and right cerebral damage, thus showing broad and approximately equivalent sensitivity to brain damage across the full range of cerebral involvement, (c) is based on neuropsychological tests developed through examinations of persons with documented brain lesions of various types, locations, durations, and etiologies (i.e., a range of diversified neurological conditions), (d) differentiates between controls and brain-damaged groups at highly significant levels in categories of cerebrovascular disease and traumatic brain injury as well as in heterogenous brain damage, (e) shows no significant gender differences, (f) has been cross-validated regarding its sensitivity to brain damage, and (g) has been shown to be very sensitive to the effects of mild head injury.

Evaluation of the degree of similarity in neuropsychological abilities of the groups with mild and more serious head injuries (Groups 2 and 3) was done by comparing results on the 19 subtests in the HRB that are scored according to level of performance. Raw scores were converted to GNDS scores for individual tests. GNDS scaled scores range from 0 to 3, with corresponding raw-score ranges representing clinically significant performances. A GNDS score of 0, for example, represents a perfectly normal performance; a score of 1 is still normal, but not as good as it could possibly be; a score of 2 represents mild to moderate impairment, and a score of 3 corresponds with performances that are severely impaired (see Reitan & Wolfson, 1988). GNDS scores thus represent a type of standard score, similar in some respects to scaled scores of the Wechsler Scales, except that no age adjustments are introduced and the conversions are based on clinical rather than psychometric considerations.

Mean GNDS scores, which represent an invariant and straightforward transformation of raw scores, were computed for each of the 19 tests in the groups with mild and more severe head injuries. Rank-differences correlations were computed between the rank of each test (from the poorest to the best mean) in the two groups.

RESULTS

Prior comparisons of brain-damaged and control groups have shown that a GNDS cutting score of 25/26 differentiates the groups with only about a 10% overall error rate (Reitan & Wolfson, 1988). Brain-damaged groups generally have a mean GNDS score of about 50, whereas control groups average about 17 or 18. GNDS score ranges represent the following categories: 0–25, normal; 26–40, mild impairment; 41–67, moderate impairment; and 68 and higher, severe impairment (Reitan & Wolfson, 1988).

In this study, Group 1 (Non-Brain-Damaged Controls) had a mean GNDS score of 17.20 (√SD = 8.14), with 90% scoring 25 or less (normal range) and 10% having scores of 26 or more (impaired range). None of the controls had a GNDS score higher than 34. Group 2 (Traumatic Brain Injury with Brain Tissue Damage) had a GNDS mean score of 52.11 (√SD = 19.39), with 89% having scores of 26 or more and 11% falling in the normal range (scores of 25 or less). Group 3 (Mild Head Injury with No Definite Neurological Evidence of Brain Tissue Damage) had a mean GNDS score of 26.56 (√SD = 13.34), with 61% falling in the normal range and 39% having scores that fell in the impaired range.
Neuropsychological Similarities 439

Statistical comparisons of mean GNDS scores for the paired groups yielded the following results: Controls vs. Mild Head Injury, $t = 2.10$ ($p < .02$); Controls vs. Definite Traumatic Brain Injury, $t = 7.63$ ($p < .001$); and Mild Head Injury vs. Definite Traumatic Brain Injury, $t = 4.60$ ($p < .001$).

These results indicate that subjects with definite brain tissue damage clearly differed from the other two groups. In addition, the subjects with a mild head injury were significantly more impaired than the controls. However, the control group and the mild head injury group were more similar to each other than to the group with established evidence of brain tissue damage.

Our principal purpose in this study was not to provide detailed comparisons of these groups, but rather to compare the patterns of impairment shown by the two head-injured groups (mild and more severe), as presented below. However, some readers may wish to review raw-score means and standard deviations for these groups, and these are provided in Table 1. Table 1 shows that both the controls and the group with mild head injury had better means scores than the group with brain tissue damage on all 19 variables, and most of the mean differences were statistically significant. The controls had better mean scores than the group with mild head injuries on 14 variables (with four differences reaching statistical significance), the groups had an identical mean on one variable, and the group with mild head injuries had the higher raw-score means on four variables.

The major question in this study concerns whether the pattern of test results was similar in the two head-injured groups. Figure 1 presents graphically the mean GNDS scores for each of the 19 tests that constitute the level-of-performance variables that contribute to the total GNDS score.

It is apparent that the group with cerebral tissue damage consistently performed more poorly than the group with mild head injuries. However, the pattern of scores in the two groups was remarkably similar. The rank-difference correlation between scores for the two groups, shown in Figure 1, was 0.87 ($p < .001$).

**DISCUSSION**

The subjects with a mild head injury performed significantly more poorly than the non-brain-damaged controls, indicating that the HRB is sensitive to the effects of mild head injury (as previously shown by Rojas & Bennett, 1995). Nevertheless, these two groups were more similar in their GNDS scores than they were to the group with definite traumatic injury of brain tissue, a finding that is not surprising, considering the fact that the results of neurological evaluation of the mild head-injured subjects and the controls were essentially similar (normal). In fact, considering the criteria used to compose the group with mild head injuries, it is entirely possible that many of the subjects, even though sustaining a blow to the head with temporary adverse physiological effects, may not have experienced any structural damage of brain tissue. Thus, the comparisons of mean GNDS scores for the three groups yielded results that were not surprising, but which did show the value of a sumerial measure in reflecting impairment in individuals with a mild head injury. Obtaining this result with the GNDS is also an indication of the general rather the selective nature of the mild neuropsychological impairment in mild head injury.

The principal purpose of this study was to obtain empirical information about the possibility of selective and delimited effects of mild head injury as contrasted with the
**TABLE 1**
Means, Standard Deviations, \( T \) Ratios, and Probability Levels for Control Group (Group 1), Traumatic Brain Injury with Brain Tissue Damage Group (Group 2), and Mild Traumatic Head Injury Group (Group 3)

<table>
<thead>
<tr>
<th>Halstead-Reitan Battery Subtests</th>
<th>VIQ</th>
<th>PIQ</th>
<th>II</th>
<th>CT</th>
<th>TPT-TT</th>
<th>TPT-M</th>
<th>TPT-L</th>
<th>RT</th>
<th>S-S</th>
<th>T-D</th>
<th>T-ND</th>
<th>Trails A</th>
<th>Trails B</th>
<th>TFR-TT</th>
<th>BTS-TE</th>
<th>BAS-TE</th>
<th>BVS-T</th>
<th>FA-T</th>
<th>FT W</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( M )</td>
<td>109.17</td>
<td>112.15</td>
<td>0.28</td>
<td>33.10</td>
<td>7.02</td>
<td>4.24</td>
<td>25.22</td>
<td>6.9</td>
<td>52.15</td>
<td>47.76</td>
<td>33.73</td>
<td>64.15</td>
<td>16.37</td>
<td>0.07</td>
<td>0.05</td>
<td>0.07</td>
<td>0.68</td>
<td>0.68</td>
<td>1.22</td>
</tr>
<tr>
<td>( SD )</td>
<td>13.80</td>
<td>10.43</td>
<td>0.21</td>
<td>9.98</td>
<td>3.95</td>
<td>1.44</td>
<td>1.84</td>
<td>4.26</td>
<td>5.60</td>
<td>12.81</td>
<td>28.93</td>
<td>1.70</td>
<td>0.26</td>
<td>0.22</td>
<td>0.26</td>
<td>1.06</td>
<td>1.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Group 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( M )</td>
<td>96.72</td>
<td>95.33</td>
<td>0.73</td>
<td>62.33</td>
<td>26.58</td>
<td>5.22</td>
<td>2.05</td>
<td>22.50</td>
<td>15.17</td>
<td>41.44</td>
<td>32.44</td>
<td>155.67</td>
<td>30.22</td>
<td>1.00</td>
<td>0.89</td>
<td>0.50</td>
<td>5.17</td>
<td>8.28</td>
<td></td>
</tr>
<tr>
<td>( SD )</td>
<td>15.58</td>
<td>15.64</td>
<td>0.28</td>
<td>24.06</td>
<td>10.63</td>
<td>2.84</td>
<td>1.39</td>
<td>4.40</td>
<td>9.04</td>
<td>7.34</td>
<td>12.95</td>
<td>92.07</td>
<td>8.97</td>
<td>4.36</td>
<td>1.28</td>
<td>1.47</td>
<td>4.12</td>
<td>6.60</td>
<td></td>
</tr>
<tr>
<td><strong>Group 3</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( M )</td>
<td>109.17</td>
<td>116.83</td>
<td>0.29</td>
<td>29.61</td>
<td>12.55</td>
<td>7.61</td>
<td>4.11</td>
<td>26.33</td>
<td>8.11</td>
<td>49.28</td>
<td>43.78</td>
<td>30.33</td>
<td>76.50</td>
<td>19.22</td>
<td>0.28</td>
<td>0.72</td>
<td>0.00</td>
<td>1.28</td>
<td>1.67</td>
</tr>
<tr>
<td>( SD )</td>
<td>16.94</td>
<td>11.50</td>
<td>0.28</td>
<td>18.25</td>
<td>5.14</td>
<td>0.99</td>
<td>1.32</td>
<td>2.03</td>
<td>7.43</td>
<td>7.03</td>
<td>5.00</td>
<td>13.49</td>
<td>32.92</td>
<td>4.52</td>
<td>0.57</td>
<td>0.96</td>
<td>0.00</td>
<td>1.64</td>
<td>1.61</td>
</tr>
</tbody>
</table>

Group 2 vs. Group 3

\( t \) & 1.99 & 4.68 & 4.88 & 3.59 & 5.05 & 3.37 & 4.48 & 3.33 & 2.55 & 3.27 & 3.46 & 3.70 & 3.43 & 4.62 & 1.50 & 0.45 & 1.45 & 3.74 & 4.13 |

\( p \) \( <.10 <.001 <.001 <.005 <.001 <.005 <.001 <.005 <.02 <.005 <.005 <.001 <.005 <.001 <.20 <.70 <.20 <.001 <.001 |

Group 1 vs. Group 2

\( t \) & 2.96 & 5.28 & 7.65 & 7.20 & 8.91 & 3.49 & 4.87 & 2.43 & 5.44 & 5.92 & 6.93 & 5.05 & 4.39 & 10.41 & 3.21 & 4.49 & 1.98 & 7.13 & 7.04 |

\( p \) \( <.01 <.001 <.001 <.001 <.001 <.001 <.001 <.001 <.001 <.001 <.001 <.001 <.005 <.001 <.10 <.001 <.001 |

Group 1 vs. Group 3

\( t \) & 0.00 & 1.67 & 0.17 & 1.03 & 1.30 & 1.69 & 0.29 & 1.14 & 0.75 & 1.61 & 2.82 & 0.99 & 0.73 & 3.85 & 2.10 & 4.79 & 1.21 & 1.82 & 1.08 |

\( p \) \( <1.00 <.10 <.90 <.40 <.25 <.10 <.80 <.25 <.50 <.20 <.01 <.40 <.50 <.05 <.05 <.001 <.25 <.10 <.20 |

VIQ = Verbal IQ; PIQ = Performance IQ; II = Impairment Index; CT = Category Test; TPT-TT = Tactual Performance Test-Total Time; TPT-M = Tactual Performance Test-Memory; TPT-L = Tactual Performance Test - Localization; RT = Rhythm Test; S-S = Speech-Sounds Perception Test; T-D = Tapping-Dominant; T-ND = Tapping-Nondominant; Trails A = Trail Making Test-Part A; Trails B = Trail Making Test-Part B; TFR-TT = Tactile Form Recognition-Total Time; BTS-TE = Bilateral Tactile Stimulation-Total Errors; BAS-TE = Bilateral Auditory Stimulation-Total Errors; BVS-T = Bilateral Visual Stimulation-Total; FA-T = Finger Agnosia-Total; FT W = Finger-Tip Number Writing.
more general and widespread deficits found with more severe traumatic brain injury. The reader will recall that Alves and Jane (1985) had proposed that mild brain injury was essentially similar to more severe brain injury, representing only a different range on a continuum of brain involvement. Secondly, studies of brain pathology would suggest that brain injury, when it occurs in cases of mild head injury, would be similar to brain injury that occurs with more severe head injury. Nevertheless, neuropsychological reports have concluded that the effects of mild head injuries are essentially limited to the areas of attention, information processing and memory, and that comprehensive neuropsychological test batteries may well fail to reveal the existing impairment insomuch as the battery does not focus on the “pertinent” areas of impairment.

Because an extensive range of neuropsychological tests (as included in the HRB) was administered, it was possible to address the question of similarities and differences in the pattern of neuropsychological findings. The correlation of ranks for the mild and more severely head-injured groups indicated that the overall patterns were extremely similar, even though the severely injured group, as expected, consistently scored more poorly. There appeared to be no particular pattern of selective impairment in either group. The two tests among the 19 measures that are generally recognized as being heavily dependent on close and continued attention and continuous information processing (the Rhythm Test and the Speech-Sounds Perception Test) generally followed the trend of impairment shown by other measures. If there was any trend with respect to areas of function, it might be that both groups tended to perform relatively well on verbal and performance IQ measurements and on sensory-perceptual tests.

The results of this study have definite clinical implications. Since deficits, when they occur in mild head injury, appear to be variable and diversified, it is clinically important that a comprehensive battery of neuropsychological tests be used in order to avoid miss-
ing relevant areas of impairment and thereby failing to identify the full extent of the individual’s problems.

REFERENCES


