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Suppressed Working Memory on the WMS-III as a Marker for Poor Effort

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ABSTRACT

The purpose of this study was to examine the clinical utility of memory minus Working Memory Index (memory-WMI) discrepancy scores on the WMS-III for detecting poor effort in 145 personal injury litigants (19 poor effort, 126 adequate effort). On average, participants in the poor effort group performed significantly lower on all WMS-III memory indexes and demonstrated larger memory-WMI discrepancy scores compared to participants in the adequate effort group. Discriminant function analyses using memory-WMI discrepancy scores as independent variables revealed poor overall classification rates (60.0% to 63.4%). Based on the prevalence of unusually suppressed attention-concentration ability relative to memory functioning using unidirectional memory-WMI discrepancy scores, high specificity and negative predictive power values were found. However, there was unacceptably low sensitivity and positive predictive power. These results suggest that memory-WMI discrepancy scores on the WMS-III do not provide clinically useful information regarding response set and should be used cautiously as an indicator of poor effort.
INTRODUCTION

Determining whether a patient is exaggerating symptoms or problems, providing poor effort during testing, or malingering is a complex clinical process (Slick, Sherman, & Iverson, 1999). Over the past 10 years, the relation between attention-concentration and memory ability has received considerable attention in the literature as a potential marker for poor effort during a neuropsychological evaluation. In the original study, Mittenberg and colleagues examined the Wechsler Memory Scale-Revised (WMS-R; Wechsler, 1987) performance of 39 head injured patients and 39 analog malingerers. The analog malingerers performed more poorly on the Attention/Concentration Index ($M = 71$) than on the General Memory Index ($M = 85$), while individuals with genuine brain injuries showed the reverse pattern (i.e., Attention/Concentration Index, $M = 96 >$ General Memory Index, $M = 85$). Individuals with genuine brain injuries showed relatively intact attention-concentration abilities and relatively declined immediate memory functioning, while individuals who were instructed to feign cognitive impairment tended to suppress their attention-concentration ability relative to immediate memory functioning. Using discriminant function analysis, General Memory-Attention/Concentration (GM-A/C) discrepancy scores correctly classified 83.3% of cases, with 10.3% false positives and 23.1% false negatives. The authors presented GM-A/C discrepancy cutoff scores to evaluate the probability of poor effort (Mittenberg, Azrin, Millsaps, & Heilbronner, 1993).

The notion that suppressed attention relative to memory might be a meaningful predictor of poor effort has theoretical support in the literature. For example, patients with traumatic brain injuries (Bernard, McGrath, & Houston, 1993; Boyer, 1991; Crossen & Weins, 1988; Reid & Kelly, 1991) or severe memory problems (Butters et al., 1988) show relatively preserved Attention-Concentration Index scores, relative to memory scores, on the WMS-R. Preserved
attention-concentration, contrasted with relative or definite declines in memory functioning, has also been seen on the Wechsler Memory Scale-Third Edition (WMS-III; Wechsler, 1997) in patients with traumatic brain injuries, Korsakoff’s syndrome, and in patients who are post temporal lobectomy for intractable epilepsy (The Psychological Corporation, 1997). Given the relatively discrete impact of certain neurological conditions on learning and memory functioning (relative to attention), it stands to reason that an unusual pattern of functioning on tests that measure attention/concentration, learning, and memory may reflect an individual’s response style rather than their true underlying ability.

There has been analog malingering research and clinical group specificity studies that have supported the usefulness of the WMS-R discrepancy score as a marker for poor effort. Johnson and Lesniak-Karpiak (1997) reported that individuals who were instructed to simulate cognitive impairment obtained lower A/C Index scores relative to GM Index scores when compared to individuals who were instructed to try their best. Although no analyses were reported examining the role of GM-A/C discrepancy scores to differentiate these two groups, these results provide some support for the validity of GM-A/C difference scores as a marker for poor effort. Iverson, Slick, and Franzen (2000) examined the base rate of GM-A/C discrepancy scores in 332 inpatients from a substance abuse program. Only a small percentage of patients had large GM-A/C discrepancy scores, with only 5% to 8% presumed false positives. Low false positive rates have also been demonstrated in other clinical base rate studies, with 6.5% to 9.0% false positives in 186 patients with acute traumatic brain injury (Iverson & Slick, 2001), 7% false positives in 55 patients who were HIV positive (Slick, Hinkin, van Gorp, & Satz, 2001), and 8.5% presumed false positives in 200 patients with mixed diagnoses (Hilsabeck et al., 2003). It is essential to note, however, that large discrepancy scores are much more likely to occur in patients...
who are high functioning (Iverson et al., 2000). That is, patients with high average memory indexes are much more likely to have relatively lower A/C Index scores than patients with low average memory.

Iverson and Tulsky (under review) applied the WMS-R methodology to the WMS-III. Various discrepancy scores were calculated using the standardization sample and several of the clinical samples (The Psychological Corporation, 1997). The Working Memory Index was subtracted from the Auditory Immediate Index, Auditory Delayed Index, Immediate Memory Index, and the General Memory Index to create four discrepancy scores. The base rates of these discrepancy scores were calculated and presented. Similar to previous studies (Iverson & Slick, 2001; Iverson et al., 2000), Iverson and Tulsky found a linear relationship between an individual’s level of memory ability and the discrepancy between memory and attention-concentration measures. That is, as an individual’s level of memory functioning increased on various WMS-III memory indexes, a greater difference between memory and attention-concentration measures was required before such a pattern was considered clinically meaningful. As a result, unidirectional memory-working memory base rate cutoff scores stratified by six different memory ability levels (i.e., < 70, 70-79, 80-89, 90-109, 110-119, and 120+) were presented. This table provides valuable data for clinical reference purposes to determine the presence of unusually suppressed attention-concentration ability relative to memory functioning in the WMS-III standardization sample. If unusually suppressed attention-concentration ability relative to memory functioning is considered to reflect poor effort, then memory-working memory discrepancy scores falling at or above the cutoff scores presented in this table would potentially differentiate exaggerators from individuals with genuine injuries. However, to date, the clinical usefulness of these scores for detecting poor effort has not been examined.
The purpose of this study was to examine the clinical utility of unusually suppressed attention-concentration ability relative to memory on the WMS-III to differentiate between individuals suspected of providing poor effort versus those who appeared to be providing adequate effort within the context of personal injury litigation. Three approaches were used to discriminate between these two groups: (a) evaluation of within-group and between-group differences on WMS-III memory index scores and memory-working memory discrepancy scores, (b) discriminant function analyses using the WMS-III memory indices and discrepancy scores as independent variables, and (c) clinical outcomes analyses using unusually large memory-working memory scores as a criterion for identifying poor effort (i.e., sensitivity, specificity, and predictive power).

METHOD

Participants

Participants were 145 (61% male) individual neuropsychological cases collected from the archives of an independent practice in Queensland, Australia. All participants were involved in litigation at the time of assessment as a result of an insurance or workers compensation claim. Participants were selected from a larger data base of 399 consecutive referrals who had been administered the Wechsler Memory Scale-Third Edition (WMS-III; Wechsler, 1997) as part of a more comprehensive neuropsychological test battery. Participants were only included if they had been administered a well-validated symptom validity measure¹ and had been referred for litigation purposes. Participants were divided into two groups consisting of 19 individuals (63.2% male) suspected of providing poor effort and 126 individuals (60.3% male) presumed to be providing adequate effort. The mean age of the poor effort group was 37.4 years (SD = 10.0) and their mean years of formal education was 11.6 (SD = 2.1). The mean age of the adequate effort

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group was 35.1 years (SD = 13.3) and their mean years of formal education was 11.3 (SD = 2.1). The groups did not differ on age [t(143) = .739, p = .461] or education [t(143) = .456, p = .649].

Participants in the poor effort group (n = 19) were selected based on their performance on the Test of Memory Malingering (TOMM; Tombaugh, 1996) and/or the word trial of the Warrington Recognition Memory Test (WRMT; Warrington, 1984). Participants were included if they obtained (a) a score less than 45 on Trial 2 of the TOMM, (b) a score less than 38 on the word trial of the WRMT as recommended by Iverson and Franzen (1998), or (c) a score on both the TOMM and WRMT below the recommended cutoff. Of the sample, 52.6% had been administered the TOMM, 21.1% the WRMT, and 36.3% both the TOMM and WRMT. Scores on Trial 2 of the TOMM ranged from 23 to 42 (M = 35.7, SD = 5.9) and 16 to 36 on the WRMT (M = 27.3, SD = 5.9). The majority of the sample had been referred following very mild to mild head injury (n = 15), with a smaller portion referred for alleged cognitive difficulties resulting from electric shock (n = 2), decompression accident (n = 1), and subarachnoid hemorrhage (n = 1). All participants met criteria for probable malingered neurocognitive dysfunction as proposed by Slick et al. (1999).

Participants in the adequate effort group were 126 personal injury litigants referred for neuropsychological assessment for alleged cognitive difficulties resulting from head injury (HI). Individuals were selected for inclusion if they achieved a score of (a) 45 or higher on Trial 2 of the TOMM or (b) 38 or higher on the word trial of the WRMT. Of the sample, 75.4% had been administered the TOMM and 24.6% the WRMT. Scores on Trial 1 of the TOMM ranged from 35 to 50 (M = 46.3, SD = 3.6), 45 to 50 on Trial 2 (M = 49.4, SD = 1.2), and 38 to 50 on the WRMT (M = 47.2, SD = 3.3). Head injury severity ranged from very mild to severe, with 14.3% having sustained a severe head injury, 15.1% moderate head injury, 42.8% mild head injury, and 27.8%
very mild head injury. Mechanism of injury included motor vehicle (76.2%), motorcycle (5.5%),
fall (5.5%), assault (3.2%), workplace related (3.2%), bicycle (2.4%), and pedestrian involved in
a motor vehicle accident (2.4%).

**Measures & Procedure**

The primary measures included five of the eight memory indexes derived from the
standard administration of the WMS-III. Indexes included: Auditory Immediate Index (AII),
Immediate Memory Index (IMI), Auditory Delayed Index (ADI), General Memory Index (GMI),
and Working Memory Index (WMI). Only these five memory indexes were used as they
 correspond to those indexes used by Iverson and Tulsky (under review). The WMI was
subtracted from each of the four memory indexes (i.e., AII, IMI, ADI, GMI) to create four
memory-WMI discrepancy scores: (a) AII-WMI, (b) IMI-WMI, (c) ADI-WMI, and (d) GMI-
WMI. Only scores reflecting positive values were of interest for this study as these scores reflect
suppressed attention-concentration ability relative to memory functioning. The WMS-III was
administered in the standardized manner as part of a larger neuropsychological test battery by a
number of experienced technicians and clinicians.

**RESULTS**

Descriptive statistics and t-test results for the five WMS-III memory indexes (ADI, AII,
IMI, GMI, WMI) and four memory-WMI discrepancy scores (AII-WMI, IMI-WMI, ADI-WMI,
and GMI-WMI) for the poor effort and adequate effort groups are presented in Table 1. Between-
group differences were found on all five WMS-III memory indexes (AII \( t(143) = -5.47, p <
.001 \), ADI \( t(143) = -6.25, p < .001 \), IMI \( t(143) = -6.58, p < .001 \), GMI \( t(143) = -6.25, p <
.001 \), WMI \( t(143) = -4.16, p < .001 \)). On average, the adequate effort group performed
consistently higher (range = 90.5 to 96.9) than the poor effort group (range = 64.1 to 83.8).

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Significant differences between groups were also found on all memory-WMI discrepancy scores (ADI-WMI \( t(143) = -2.18, p < .031 \), IMI-WMI \( t(143) = -3.06, p < .003 \), GMI-WMI \( t(143) = -3.28, p < .001 \)) with the exception of AII-WMI \( t(143) = -1.84, p = .068 \).

Comparison of within-group differences (i.e., paired samples t-tests) between WMI and the four memory indexes in each group separately revealed that WMI was significantly higher than IMI \( t(19) = -6.63, p < .021 \), ADI \( t(19) = -3.85, p < .034 \), and GMI \( t(19) = -6.77, p < .005 \) in the poor effort group, but not for AII \( t(19) = -3.51, p = .058 \). Significant differences between WMI and memory scores were also found in the adequate effort group, with WMI higher than all four memory indexes (AII \( t(126) = -2.24, p < .001 \), IMI \( t(126) = -4.01, p < .001 \), ADI \( t(126) = -1.44, p < .001 \), GMI \( t(126) = -3.42, p < .001 \). On average, the poor effort group had larger memory-WMI discrepancy scores (range = -10.7 to -19.4) compared to the adequate effort group (range = -2.2 to -6.4). Because the primary focus of this study was on the relation between the WMI and the four memory indexes, no within-group comparisons were undertaken that did not include the WMI.

To determine whether a mathematically-optimal solution could accurately classify individuals providing poor effort versus adequate effort into their respective groups, a stepwise discriminant function analysis was undertaken using the five WMS-III memory indexes (i.e., GMI, IMI, ADI, AII, WMI). One discriminant function was identified that included only one of the variables (i.e., GMI). This function was significantly associated with group membership \( \chi^2 (1) = 43.20, p < .001 \). The canonical correlation coefficient related to this function was \( r = .51 \). Approximately 82% of the cases were classified correctly overall, with 89.5% of the poor effort group and 81.0% of the adequate effort group classified correctly by this function. However,
discriminant function analyses using each of the four memory-WMI discrepancy scores as independent variables separately revealed that while all functions were significantly associated with group membership (range: \( p < .001 \) to \( p = .048 \)) all memory-WMI discrepancy scores demonstrated low classification rates (GMI-WMI = 61.4% [68.4% true positives, 60.3% true negatives]; IMI-WMI = 63.4% [57.9% true positives, 64.3% true negatives]; ADI-WMI = 60.0% [57.9% true positives, 60.3% true negatives]; All-WMI = 62.1% [57.9% true positives, 62.7% true negatives].

The effectiveness of memory-WMI discrepancy scores to differentiate individuals from the poor effort versus adequate effort group was further examined using base rate cutoff scores presented by Iverson and Tulsky (under review). Cutoff scores representing unusually large memory-WMI discrepancy scores found in less than 5% of the standardization sample are reproduced from Iverson and Tulsky in Table 2. These scores reflect unidirectional Memory > WMI discrepancy scores only. The cutoff scores were applied to the sample and test-operating characteristics were calculated. Memory-WMI discrepancy scores falling at or above the cutoff scores were considered reflective of poor effort. The sensitivity, specificity, positive predictive power, negative predictive power, and overall predictive power for each of the four memory-WMI discrepancy scores to identify individuals in the poor effort versus adequate effort group is presented in Table 3. Overall, the specificity and negative predictive power (NPP) values for all four memory-WMI discrepancy scores was consistently high (specificity: range = .95 to .98; NPP: range = .86 to .88). However, very low sensitivity and positive predictive power (PPP) values were obtained (sensitivity: range = .00 to .11; PPP: range = .00 to .40).
The memory-WMI discrepancy scores evaluated here did not appear useful for identifying poor effort in this sample of personal injury litigants. Between-group comparisons revealed that the poor effort group performed significantly lower on all WMS-III memory indexes and demonstrated larger memory-WMI discrepancy scores compared to the adequate effort group. Within-group comparisons revealed that both the adequate effort and poor effort groups demonstrated significantly higher attention-concentration ability relative to memory functioning (i.e., WMI > memory). However, the WMS-III performance of the poor effort group was characterized by a global suppression of both memory and attention-concentration ability. The presence of relatively preserved attention-concentration abilities compared to memory functioning in the adequate effort group is consistent with past research examining the performance of various clinical groups on the WMS-R (e.g., Boyer, 1991; Butters et al., 1988; Crossen & Weins, 1988; Hilsabeck et al., 2003; Iverson & Slick, 2001; Iverson et al., 2000; Johnson & Lesniak-Karpiak, 1997; Mittenberg et al., 1993; Reid & Kelly, 1991; Slick et al., 2001). However, the global suppression of attention-concentration and memory ability in the poor effort group is inconsistent with past studies using analog malingerers reporting that measures of attention-concentration are relatively preserved compared to memory functioning on the WMS-R (e.g., Bernard et al., 1993; Johnson & Lesniak-Karpiak, 1997; Mittenberg et al., 1993).

Of further interest was the ability of the WMS-III memory indexes and the memory-WMI discrepancy scores to classify patients into their respective groups using discriminant function analysis. Although all four memory-WMI discrepancy scores had low rates for classifying individuals as providing poor effort versus adequate effort (range = 60.3% to 64.3%), the WMS-III
memory indexes revealed a promising 82.1% overall classification rate. The GMI was the best predictor variable. The high classification rate of the GMI to differentiate between these two groups appears to be the result of the difference in level of performance on the memory indexes. The poor effort group performed significantly lower on all five WMS-III memory indexes, and the variable that was identified as being the best predictor of group membership by the discriminant function analysis (i.e., GMI) was the variable that demonstrated the largest mean difference between the two groups (i.e., GMI difference = 26.3). These findings are consistent with research by Van Gorp et al. (1999) who examined the role of standard cognitive tests to detect malingering in a traumatic brain injury sample. Van Gorp and colleagues concluded that the “pattern of neuropsychological performance was not a reliable indicator of malingering performance” but rather the “level of performance provided an indication of malingering as probable malingerers consistently performed worse on traditional and clinical neuropsychological measures” (p. 245).

Of primary interest for clinicians, results from clinical outcomes analyses examining the effectiveness of memory-WMI discrepancy scores to identify poor effort were disappointing. Overall, memory-WMI discrepancy scores had high specificity and negative predictive power values. However, unacceptably low sensitivity and positive predictive power values were obtained. These results suggest that those individuals who are providing adequate effort during assessment will frequently have memory-WMI scores that fall in the normal range (specificity = .95 to .98) and there is a high probability that memory-WMI discrepancies falling in the normal range (i.e., >5% abnormality) is indicative of an individual who is providing adequate effort (negative predictive power = .86 to .88). However, these results do not necessarily suggest that normal memory-WMI discrepancy scores are indicative of adequate responding, as memory-
WMI discrepancy scores falling in the normal range were also common in individuals who were identified as providing poor effort. Only a small percentage of individuals in the poor effort group had unusually large memory-WMI discrepancy scores (Sensitivity = .00 to .11), and when present, there was an extremely low probability that unusually large memory-WMI discrepancy scores will actually be indicative of poor effort (positive predictive power = .0 to .40). In order to establish the clinical utility of memory-WMI discrepancy scores as a means for evaluating poor effort, at minimum, it must be demonstrated that unusually suppressed attention-concentration ability relative to memory functioning rarely occurs in clinical samples (i.e., specificity) and is a common characteristic in individuals attempting to feign impairment (i.e., sensitivity). This study fails to support this basic tenet.

The lack of clinical utility for memory-WMI discrepancy scores to detect poor effort in this study may be due to four reasons. First, direct comparison between measures of attention-concentration and memory on the WMS-R and WMS-III is confounded by a number of changes to the subtests that contribute to these measures (see Table 4 for comparison). There have been obvious modifications to the overall configuration of memory indexes across tests. In particular, a significant modification is the exclusion of the Digit Span subtest from the WMS-III Working Memory Index. There is a large body of research suggesting that low digit span performance is associated with poor effort (e.g., Axelrod & Rawlings, 1999; Bernard, 1990; Binder & Willis, 1991; Greiffenstein, Baker, & Gola, 1994; Greve, Bianchini, Mathias, Houston, & Crouch, 2003; Iverson & Franzen, 1994, 1996; Iverson & Tulsky, 2003; Meyers, Galinsky, & Volbrecht, 1999; Meyers & Volbrecht, 1999; Millis, Ross, & Ricker, 1998; Mittenberg, Theroux-Fichera, Zielinski, & Heilbronner, 1995; Suhr, Tranel, Wefel, & Barrash, 1997; Trueblood, 1994;
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Trueblood & Schmidt, 1993). The exclusion of this subtest from the WMI may potentially reduce the usefulness of this index as a marker for poor effort.

Second, previous research using the WMS-R has employed only two samples of analog malingerers (Johnson & Lesniak-Karpiak, 1997; Mittenberg et al., 1993); no clinically-based exaggerators have been studied. Therefore, while isolated analog malingering studies have supported the notion that suppressed attention-concentration ability relative to memory functioning may be useful for detecting individuals instructed to feign cognitive impairment (e.g., Mittenberg et al., 1993), this pattern of scores has not been established in a sample of individuals suspected of providing poor effort within the context of litigation. In retrospect, virtually every study using the WMS-R has been a specificity study. That is, researchers have reported results from known clinical groups (Hilsabeck et al., 2003; Iverson & Slick, 2001; Iverson et al., 2000; Slick et al., 2001), but they have not replicated the original findings by Mittenberg et al. (1993) in analog malingering studies or in clinical studies with suspected, real-world malingerers.

Third, the base rate of symptom exaggeration in this litigant sample from Australia was 13.1%. This base rate is somewhat lower than the expected base rate of symptom exaggeration reported in North America. In a recent review, Larrabee (2003) reported a 40% base rate (range = 15% to 64%) of symptom exaggeration calculated from the combined participants of 11 North American research studies (n = 1363). In a survey of members of the American Board of Clinical Neuropsychology, Mittenberg, Patton, Canyock, and Condit (2002) reported base rates of symptom exaggeration ranging from 29% to 39% in a large sample of personal injury and head injury cases respectively. To our knowledge, similar malingering base rate studies have not been completed in Australia. However, recent research using litigant samples from Australia have

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reported similarly low base rates of 14.1% (Lange, Senior, Douglas, & Dawes, 2003) and 27% (Langeluddecke & Lucas, 2003). It is possible that the lower base rates found in an Australian population may be due to cultural factors. Nonetheless, the clinical implications of a lower base rate of symptom exaggeration in this sample relates to interpretation of positive predictive power values reported in this study. In low base rate conditions, positive predictive power values are less stable than other clinical outcome measures (e.g., specificity, sensitivity) and tend to decline as the base rate of a condition declines. Because there is a lower base rate of symptom exaggeration in this sample, the positive predictive values reported in Table 3 may underestimate the clinical utility of memory-WMI discrepancy scores.

Fourth, the selection of subjects might have reduced the likelihood of finding positive results with the WMS-III discrepancy scores. Specifically, subjects were classified as providing poor effort on the basis of very low scores on the TOMM or the Recognition Memory Test. Suppressing performance on these measures might be a marker for globally suppressed performance, thus decreasing the likelihood of showing unusual memory-working memory discrepancies. The TOMM, for example, has excellent sensitivity in analog malingerers (Powell, Gfeller, Hendricks, & Sharland, 2004) and excellent specificity in multiple healthy and clinical groups (Ashendorf, Constantinou, & McCaffrey, 2004; Constantinou & McCaffrey, 2003; Hill, Ryan, Kennedy, & Malamut, 2003; Rees, Tombaugh, & Boulay, 2001; Rees, Tombaugh, Gansler, & Moczynski, 1998; Tombaugh, 1997). However, some researchers have reported more modest sensitivity in some patient and analog malingering groups (Gervais, Rohling, Green, & Ford, 2004; Tan, Slick, Strauss, & Hultsch, 2002; van Hout, Schmand, Wekking, Hageman, & Deelman, 2003). This means that some of the patients in the presumed adequate effort group
might have been providing poor effort, but they were not detected by the TOMM or the
Recognition Memory Test. Additional research is needed to clarify these issues.

In conclusion, the results of this study do not support the use of memory-WMI
discrepancy scores on the WMS-III as a reliable predictor of poor effort. Memory-WMI
discrepancy scores will fail to identify the vast majority of cases, and when detected, these
measures provide little to no confidence that an identified pattern of unusually suppressed
attention-concentration ability relative to memory functioning is reflective of poor effort.
Additional research is needed to determine if there are subgroups of patients who are providing
poor effort during testing who can be reliably identified using one or more of these score patterns
(e.g., those who do not globally suppress their performance across a battery of tests).
FOOTNOTE:

1 The data collected for this investigation was obtained from referrals during 1998 to 2003. In earlier years, the standard practice of the clinician was to refrain from administering well-validated symptom validity tests (e.g., TOMM) unless concerns were raised during testing regarding motivation. On many occasions the Rey 15 item test was administered. However, given the demonstrated limitations of this test, individuals who were administered the Rey 15 Item test were not included. It is acknowledged that this criteria for exclusion may ultimately produce a selection bias towards the inclusion of individuals who are more likely to be exaggerating. However, analysis of the data using the entire sample did not change the results or conclusions of this study. Data pertaining to the entire sample can be obtained from the authors on request.
ACKNOWLEDGEMENTS

Portions of these data were presented at the International Neuropsychological Society annual conference, February 2004, Baltimore, MD, USA.

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Table 1. Descriptive statistics and t-test results for WMS-III memory minus Working Memory Index discrepancy scores

<table>
<thead>
<tr>
<th>Cognitive Measure/Score</th>
<th>Poor Effort</th>
<th>Adequate Effort</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Auditory Delayed Index</td>
<td>73.0*</td>
<td>8.3</td>
</tr>
<tr>
<td>Auditory Immediate Index</td>
<td>73.1</td>
<td>10.9</td>
</tr>
<tr>
<td>Immediate Memory Index</td>
<td>65.1*</td>
<td>10.9</td>
</tr>
<tr>
<td>General Memory Index</td>
<td>65.6*</td>
<td>9.9</td>
</tr>
<tr>
<td>Working Memory Index</td>
<td>83.8</td>
<td>14.1</td>
</tr>
<tr>
<td>AII - WMI</td>
<td>-10.7</td>
<td>13.6</td>
</tr>
<tr>
<td>IMI - WMI</td>
<td>-19.4</td>
<td>12.8</td>
</tr>
<tr>
<td>ADI - WMI</td>
<td>-10.8</td>
<td>12.5</td>
</tr>
<tr>
<td>GMI - WMI</td>
<td>-17.9</td>
<td>11.5</td>
</tr>
</tbody>
</table>

Note: N = 145; Poor Effort, n = 19; Adequate Effort, n = 126. Within-group differences between WMI and memory indexes, * p < .05, ** p < .001; AII = Auditory Immediate Index, IMI = Immediate Memory Index, ADI = Auditory Delayed Index, GMI = General Memory Index, WMI = Working Memory Index.
Table 2. WMS-III memory minus Working Memory Index cut-off values for unusually large discrepancy scores occurring in less than 5% of the standardisation sample.

<table>
<thead>
<tr>
<th>Ability Level</th>
<th>Auditory Immediate Index</th>
<th>Auditory Immediate Memory Index</th>
<th>Auditory Delayed Memory Index</th>
<th>General Memory Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 70</td>
<td>5</td>
<td>7</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>70-79</td>
<td>5</td>
<td>15</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>80-89</td>
<td>17</td>
<td>13</td>
<td>18</td>
<td>17</td>
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<tr>
<td>90-109</td>
<td>24</td>
<td>24</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>110-119</td>
<td>28</td>
<td>33</td>
<td>34</td>
<td>31</td>
</tr>
<tr>
<td>&gt; 120</td>
<td>37</td>
<td>36</td>
<td>39</td>
<td>38</td>
</tr>
</tbody>
</table>

_Note:_ Cutoff values reproduced with permission from Iverson & Tulsky (in press)
Table 3. Test operating characteristics of WMS-III memory minus Working Memory Index discrepancy scores for identifying cognitive exaggeration.

<table>
<thead>
<tr>
<th></th>
<th>AII-WMI</th>
<th>IMI-WMI</th>
<th>ADI-WMI</th>
<th>GMI-WMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>.11</td>
<td>.00</td>
<td>.11</td>
<td>.00</td>
</tr>
<tr>
<td>Specificity</td>
<td>.98</td>
<td>.98</td>
<td>.96</td>
<td>.95</td>
</tr>
<tr>
<td>Positive PP</td>
<td>.40</td>
<td>.00</td>
<td>.29</td>
<td>.00</td>
</tr>
<tr>
<td>Negative PP</td>
<td>.88</td>
<td>.87</td>
<td>.88</td>
<td>.86</td>
</tr>
<tr>
<td>Overall PP</td>
<td>.86</td>
<td>.85</td>
<td>.85</td>
<td>.83</td>
</tr>
</tbody>
</table>

Note: Prevalence = .13; N = 145; Poor Effort, n = 19; Adequate Effort, n = 126; PP = Predictive Power; AII = Auditory Immediate Index, IMI = Immediate Memory Index, ADI = Auditory Delayed Index, GMI = General Memory Index, WMI = Working Memory Index.
Table 4. Comparison of subtests between conceptually similar memory indexes from the WMS-R and WMS-III.

<table>
<thead>
<tr>
<th>WMS-R</th>
<th>WMS-III</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Attention/Concentration (A/C)</strong></td>
<td><strong>Working Memory Index (WMI)</strong></td>
</tr>
<tr>
<td>Visual Memory Span*</td>
<td>Spatial Span*</td>
</tr>
<tr>
<td>Digit Span</td>
<td>--</td>
</tr>
<tr>
<td>Mental Control</td>
<td>--</td>
</tr>
<tr>
<td>--</td>
<td>Letter-Number Sequencing</td>
</tr>
<tr>
<td><strong>General Memory (GM)</strong></td>
<td><strong>Immediate Memory Index (IMI)</strong></td>
</tr>
<tr>
<td>Logical Memory I*</td>
<td>Logical Memory I*</td>
</tr>
<tr>
<td>Verbal Paired Associates I*</td>
<td>Verbal Paired Associates I*</td>
</tr>
<tr>
<td>Visual Paired Associates I</td>
<td>--</td>
</tr>
<tr>
<td>Visual Reproduction I</td>
<td>--</td>
</tr>
<tr>
<td>--</td>
<td>Faces I</td>
</tr>
<tr>
<td>--</td>
<td>Family Pictures I</td>
</tr>
</tbody>
</table>

Note: *conceptually similar subtests; WMS-R = Wechsler Memory Scale-Revised; WMS-III = Wechsler Memory Scale-Third Edition