Clinical and Psychometric Properties of the new WMS-IV Design Memory Subtest

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Introduction

The Wechsler Memory Scale 4th edition (Wechsler, 2009) is the most recent revision of the Wechsler Memory Scales. One of the primary goals of the revision from the WMS-III (Wechlser, 1997) was to improve the assessment of visual memory. Visual memory functions in the third edition were assessed by the Faces and Family Pictures subtests.

The Faces subtest measures immediate and delayed recognition of faces. While previous research has identified face memory as differentiating right from left temporal lobe functioning (Milner, 1968), these findings are not always replicated (Glogau, Ellring, Elger, & Helmstaedter, 2004). The Faces subtest exhibited some psychometric issues including floor problems (Holdnack & Delis, 2004), a high guess rate (Levy, 2006), and low communality with other visual memory measures (Millis, Malina, Bowers, & Ricker, 1999). The Faces subtest appears to have a very specific application in neuropsychological assessment but may not work optimally as a general indicator of visual memory functioning.

Few studies have utilized the Family Pictures subtest of the WMS-III. This subtest requires the examinee to respond verbally to visually presented images. The test measures visual-verbal associative memory (e.g., picture-name, object-activity) as well as spatial memory (e.g., location of characters in the picture). In order to purify the visual memory domain, efforts were made to reduce the impact of verbalization on visual memory tasks in the WMS-IV.

The Designs subtest was developed to limit confounding cognitive processes (e.g., verbalization, motor control, and visual-spatial processing); however, these factors can never be fully eliminated (Heilbronner, 1992). The Designs subtest assesses memory for visual images within a grid, requiring the examinee to recall both visual and spatial information. However, visual objects and location are processed though different visual systems (Ungerleider, Courtney & Haxby, 1998) and may be processed differentially in clinical disorders such as temporal lobe epilepsy (Chiaravalloti & Glosser, 2004; Hermann, Seidenberg, Wyler, & Haltiner, 1993), object and spatial memory are both measured and separate scores are provided for each visual memory type. Finally, recognition trials were added to each visual memory subtest.

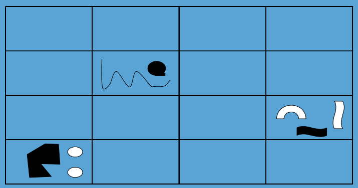
Methods

Procedures

The examinee is shown a page in the stimulus book containing a 4 x 4 grid with designs placed in different blocks on the grid. There are 4 items having 4, 6, 6, and 8 designs for the examinee to remember, respectively. The examinee is told to remember the designs and the location of the designs. After seeing the stimulus page for 10 seconds, the examinee is given a 4 X 4 puzzle grid and cards with designs on them. The examinee must select the cards with the correct designs and place them in the puzzle grid in their correct location.

After a 20-30 minute delay, the examinee is given the cards to place in the grid. Following the delayed recall task, a delayed recognition condition is administered. Scores are computed for Total Immediate, Immediate Content, Immediate Spatial, Total Delayed, Delayed Content, and Delayed Spatial.

Example of a Designs Item



Participants

Controls

The sample was comprised of 900 examinees ages 16-69 years of age. Exclusionary criteria included any history of neurological, psychiatric, developmental or medical condition affecting cognitive functioning. Subjects were screened for general cognitive impairment and poor effort. The demographic characteristics of the sample were matched to 2005 census data for ethnicity and education level. Examinees above the age of 70 were excluded based on research with previous editions of this subtest that showed declining visual and spatial discrimination skills interfered with older examinees performance on this subtest.

Clinical Groups

The clinical samples were collected as part of the WMS-IV standardization. These groups included but were not limited to Moderate to Severe Traumatic Brain Injury (n=30), Right Temporal Lobectomy (n=15), Math Disorder (n=22), Schizophrenia (n=55), and Autism (n=22). Diagnostic criteria for each groups are presented in the WMS-IV Technical and Interpretive Manual (Wechsler, 2009). An age, education, and ethnicity matched normal control sample was derived for each clinical group from the standardization sample.

Results

Reliability

In the normative sample, obtained internal consistency measures were: Immediate Total (.83-.90), Immediate Content (.66-.88), Immediate Spatial (.70-.83), Delayed Total (.80-.90), Delayed Content (.70-.84) and Delayed Spatial (.67-.82). Test-Retest correlations for designs were: Immediate Total (.73), Immediate Content (.64), Immediate Spatial (.50), Delayed Total (.72), Delayed Content (.64) and Delayed Spatial (.50).

Correlations with Other Memory Measures

WMS-III

The WMS-IV Designs Immediate Total correlated r=.35 with WMS-III Immediate Faces. Designs Total Delayed correlated r=.38 with Delayed Faces. Designs Immediate correlated r=.41 with Immediate Family Pictures and Designs Delayed correlated r=.43 with Delayed Family Pictures.

RBANS

The Designs Total Immediate correlated (r=.38) with RBANS Immediate Memory and Designs Delayed (r=.44) with RBANS Delayed Memory.

Clinical Data

Performance on the Designs subtests (expressed in scaled score units) by various clinical groups is presented in Tables 1 and 2. Patients diagnosed with Autism, Schizophrenia, and TBI performed in the low average range with scores between 6 and 8 on immediate and delayed Designs scores. The Right TLE and Math Disorder groups performed mostly in the low average range but some scores, especially on delayed recall, were in the average range.

Table 1: Immediate Designs by Clinical Group

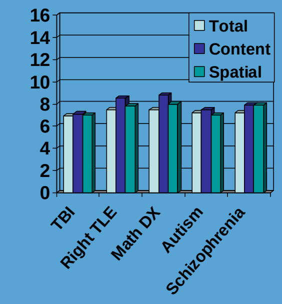
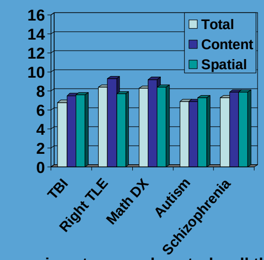


Table 2: Delayed Designs by Clinical Group



In comparison to normal controls, all the scores in the clinical samples were significantly lower except for Designs Immediate Content for Schizophrenia patients and Delayed Content for Schizophrenia, Right TLE and Math Disorder. Effect sizes for TBI ranged from .72 to 1.36 and for the Right TLE .16 to 1.66 with most above 1.0 for both samples.

Additionally, performance in patients with TBI on Delayed Content was significantly correlated with caretaker ratings of General Adaptive Functioning (.63), Community Use (.63), Health and Safety (.63) and Self-Care (.57) as measured on the ABAS-II (Harrison & Oakland, 2003).

Conclusion

The WMS-IV Designs subtest provides a reliable assessment of memory for visual details and spatial location. It correlates low to moderate with other visual memory measures. Designs scores are sensitive to brain injury and right temporal lobe damage with large effect sizes between controls and clinical groups. In patients with brain injury, Design memory performance is associated with deficits in adaptive functioning providing useful treatment planning information.

Clinical and Psychometric Properties of the New WMS-IV Visual Working Memory Subtests

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Introduction

The Wechsler Memory Scale 4th edition (Wechsler, 2009) is the most recent revision of the Wechsler Memory Scale. One of the primary goals of the revision from the WMS-III (Wechsler, 1997) was to improve the assessment of working memory. In the WMS-III, working memory was assessed primarily with Spatial Span and Letter-Number Sequencing. The WMS-III Working Memory Index was composed of these two tests, one auditory and one visual. Additionally, Letter-Number Sequencing appeared in both the WMS-III and WAIS-III Working Memory Indexes, a redundant use of this subtest. For the revision, it was decided to have no shared subtests between WAIS-IV/WMS-IV. The WAIS-IV has auditory working memory subtests and the WMS-IV has visual working memory tests. The co-norming and separation allows the auditory and visual working memory indexes to be statistically compared in a common normative sample.

Another goal for the WMS-IV working memory subtests was to increase the amount of mental manipulation required to complete the tasks. The Spatial Span subtest of the WMS-III is primarily an indicator of visual storage, subsequently Spatial Addition was developed for the WMS-IV. A second visual working memory subtest, Symbol Span, was developed as a visual analog to WAIS-IV Digit Span. Symbol Span uses novel visual stimuli which are difficult to verbalize and taps storage and manipulation functions.

The WMS-IV visual working memory subtests were designed based on the work of Baddeley (2000) and Gathercole (2208). These tests measure storage components of the visual-spatial sketchpad. Both tests require mental manipulation of visually-presented information relating to the functions of the central executive. Additionally, Spatial Addition requires the examinee to ignore irrelevant information, another function of the Central Executive (Baddeley, 2000; Gathercole, 2008).

Methods

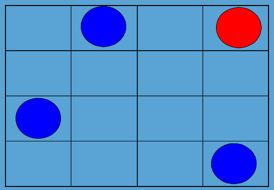
Procedures

Spatial Addition

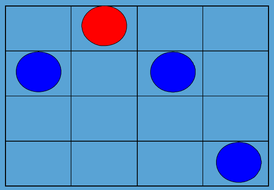
The Spatial Addition subtest assess visual-spatial storage and manipulation in working memory. The subtest is based on a modified n-back paradigm.

The examinee is shown a 4x4 grid with blue and/or red dots on it for 5 seconds. They are told to remember the location of the blue dots and ignore any red dots that appear on the page. The examinee is then shown a second page with blue and/or red dots on it for 5 seconds. The examinee then adds the two visual images together. The examinee is given cards with blue, white, and red dots and a 4 X 4 puzzle grid. The examinee must place a blue dot on the grid in the location where they saw the blue dots on either page and a white dot in any location that blue dots appear on both pages, thus subtracting the images.

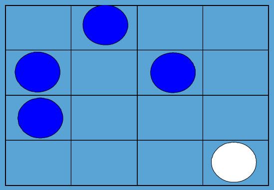
Example: Page 1



Example: Page 2



Example: Answer



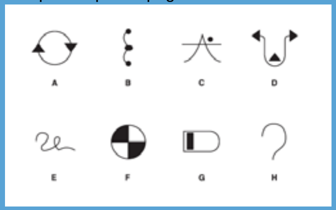
Symbol Span

Symbol Span assesses storage and manipulation of visual-details in working memory. The subtest was developed as a visual analog to Digit Span. Symbols were used instead of digits to limit the degree that the auditory working memory system is invoked during the task. Earlier versions used a visual digit span but digits are easily read from the visual representation and rehearsed verbally; while, symbols are difficult to verbalize and auditorily rehearse.

The examinee is shown a series of designs of increasing length for 5 seconds and is then shown a page with correct designs and foils. They must select the correct designs in the correct order. The examinee is awarded 2 points for getting the correct designs in the proper order and 1 point if they get the correct designs but in an incorrect order. There is only a forward condition as previous research indicated that examinees would study the stimuli from right to left during a backward condition which does not require mental reversal of order.

Example: symbols to be remembered

Example: response page



Participants

Controls

The sample was comprised of 1400 examinees ages 16-90 years for Symbol Span and 900 examinees ages 16-69 for Spatial Addition. Exclusionary criteria included any history of neurological, psychiatric, developmental or medical condition affecting cognitive functioning. Subjects were screened for general cognitive impairment and poor effort. The demographic characteristics of the sample were matched to 2005 census data for ethnicity and education level. Examinees above the age of 70 were excluded for Spatial Addition based on research with previous editions of this subtest that showed declining spatial discrimination skills interfered with older examinees ability to perform the task.

Clinical Groups

The clinical samples were collected as part of the WMS-IV standardization. These groups included but were not limited to Moderate to Severe Traumatic Brain Injury (n=30), Right Temporal Lobectomy (n=15), Math Disorder (n=22), Schizophrenia (n=55), and Autism (n=22). Diagnostic criteria for each group are presented in the WMS-IV Technical and Interpretive Manual (Wechsler, 2009). An age, education, and ethnicity matched normal control sample was derived for each clinical group from the standardization sample.

Results

Reliability

Across the normative sample age groups, Spatial Addition internal consistencies ranged from .89 to .93 and Symbol Span ranged from .76 to .92. Test-retest correlations were .77 for Spatial Addition and .72 for Symbol Span.

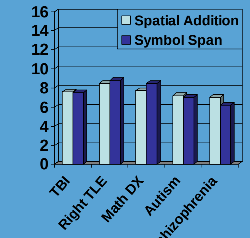
Concurrent Validity

Spatial Addition and Symbol Span correlated .58 and .52 with WMS-III Spatial Span, .46 and .47 with WAIS-IV Digit Span, and .51 and .45 with WAIS-IV Arithmetic, respectively. Spatial Addition and Symbol Span correlated .70 and .47 with WIAT-II Numerical Operations and .65 and .62 with WIAT-II Math Reasoning, respectively.

Clinical Studies

Clinical studies found large effect sizes for Spatial Addition in the TBI (d=1.23), RTLE (d=1.00), Autism (d=1.13) and Math Disorder (d=.80) groups, while, Symbol Span showed large effects in Autism (d=1.22) and Schizophrenia (d=1.01). All differences between the controls and patients were statistically significant and had moderate to large effect sizes. Table 1 provides level of performance on working memory subtests by clinical group in scaled score units. In TBI patients, performance on Spatial Addition related to daily functioning skills including Community Use (r=.53), Self-Direction (r=.49) and Social Functioning (r=.52).

Table 1: Working Memory Performance by Clinical Group



Conclusions

The new WMS-IV visual working memory subtests, Spatial Addition and Symbol Span have good reliability and concurrent validity. The subtests are clinically sensitive yielding large effect sizes in patients with known brain injury. The tests relate to academic and daily living skills, indicating ecological validity.