

A Validated Seven-Subtest Short Form for the WAIS-IV

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This study presents a short form of the Wechsler Adult Intelligence Scale-Fourth Edition (WAIS-IV; Wechsler, 2008) using the subtests (Block Design, Similarities, Digit Span, Arithmetic, Information, Coding, and Picture Completion) suggested by Ward (1990). These seven subtests were used to predict the full WAIS-IV Full-Scale IQ, as well as the Verbal Comprehension, Perceptual Reasoning, Working Memory, and Processing Speed Index scores. Two different data sets were used: the first consisted of 70 subjects and the second consisted of 32 subjects. The first data set was used to create a linear regression and the second data set was used to validate the results and compare to the prorated score method from the WAIS-IV manual. The prorated estimated scores correlated significantly with their counterparts and proved to be a better method of estimating the Full-Scale IQ and most of the index scores, but the regression equation was better at predicting the Processing Speed Index. The current study is consistent with the Ward (1990) and Pilgrim, Meyers, Bayless, & Whetstone (1999) studies and represents a reliable and valid way of assessing intellectual functioning in an abbreviated format.

Key words: intelligence tests, neuropsychological tests, psychological tests, psychometrics, Wechsler Adult Intelligence Scale

INTRODUCTION

As the field of neuropsychology becomes more sophisticated, the number and complexity of available tests have expanded exponentially. This trend is diametrically

opposed to the trends for reimbursement, which require increasing efficiency in test selection, administration, and reporting. Although an understanding of the patient's intellectual ability is helpful for interpreting their performance across a battery of neuropsychological tests, efforts have been made over the years to shorten the intelligence measures so that the limited testing time and patient energy could be spent on tests that are more relevant to diagnosing and measuring

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cognitive functions related to central nervous system disorders.

Strauss, Sherman, and Spreen (2006, p. 286) indicate that the seven-subtest short form (Ryan & Ward, 1999) is popular in clinical use. Some limitations to the use of any short-form IQ scores have been explored in other publications, such as Kaufman and Kaufman (2001); they do not recommend the use of short-form IQ in psychoeducational evaluations, and Pierson, Kilmer, Rothlisberg and McIntosh (2012) do not recommend short-form IQs be used in assessing talented and gifted individuals. In neuropsychological assessment, Lezak, Howieson, and Loring (2004) indicate that, "In sum, 'IQ' as a score is inherently meaningless and not infrequently misleading as well" (p. 22). Thus, an IQ score in some cases may be helpful, and in other cases, it may not be useful; this determination is up to the clinician to decide. The use of short-form measures, as Strauss et al. point out, is popular in neuropsychology, where an IQ score is less important but can be informative in a clinical setting. IQ is considered to be generally a measure of academic potential (Neisser et al., 1996).

In recognition of this need to occasionally use a short-form IQ, Ward (1990) developed a seven-subtest short form for the Wechsler Adult Intelligence Scale-Revised (WAIS-R), which had correlations of .97, .96, and .98 with the Verbal IQ (VIQ), Performance IQ (PIQ), and Full-Scale IQ (FSIQ), respectively, of their full-length WAIS-R counterparts. The seven-subtest form consists of the Block Design, Similarities, Digit Span, Arithmetic, Information, Coding, and Picture Completion subtests administered under standard instructions. The scaled scores were then weighted: $VIQ_{raw} = 2 \times (\text{Information} + \text{Similarities}) + (\text{Digit Span} + \text{Arithmetic})$. $PIQ_{raw} = 2 \times (\text{Picture Completion} + \text{Block Design}) + (\text{Coding})$. FSIQ raw was the sum of the VIQ raw and the PIQ raw. Scores were then looked up in the manual as usual to obtain the IQ scores. Pilgrim, Meyers, Bayless, and Whetstone (1999) mirrored Ward's research by validating the seven-subtest form with the WAIS-Third Edition (WAIS-III; Wechsler, 1997), showing nearly identical correlations of .97, .95, and .98 with the VIQ, PIQ, and FSIQ, respectively, with their full-length WAIS-III counterparts. The validity of the use of the weighted algorithm for the short-form WAIS-R and WAIS-III has fared well when compared with other methods used to estimate IQ scores from the shortened Wechsler tests with both normal standardization samples and a variety of clinical samples (Hilsabeck, Schrage, & Gouvier, 1999; Iverson, Myers, & Adams, 1997; Kulas & Axelrod, 2002). Other research (e.g., Axelrod, Ryan, & Ward, 2001) employed a prorated score to estimate IQ and index scores. The Ward seven-subtest short form has been studied by other researchers, who found it to be particularly useful in

the assessment of brain injury (Callahan, Schopp, & Johnstone, 1997) and in psychiatric evaluations (Benedict, Schretlen, & Bobholz, 1992). Due to the popularity of the Ward seven-subtest model (Strauss et al., 2006), it was decided to focus this study on the seven subtests identified by Ward.

The fourth edition of the Wechsler Adult Intelligence Scale (WAIS-IV) was published in 2008. There are no longer VIQ or PIQ scores, but the Verbal Comprehension Index (VCI), Perceptual Reasoning Index (PRI; previously Perceptual Organization Index), Working Memory Index (WMI), and Processing Speed Index (PSI) from the WAIS-III were carried forward to the WAIS-IV. The WAIS-IV technical manual (Wechsler, Coalson, & Raiford, 2008, p. 75) indicates that the various index scores correlate $r = .84-.91$ with their WAIS-III counterparts, thus indicating good similarity between the WAIS-III and WAIS-IV. The core WAIS-IV subtests are: Block Design, Similarities, Digit Span, Matrix Reasoning, Vocabulary, Arithmetic, Symbol Search, Visual Puzzles, Information, and Coding. The manual indicates that the testing time is 60 to 90 min for the core battery administration. There are also five supplemental subtests: Letter-Number Sequencing, Figure Weights, Comprehension, Cancellation, and Picture Completion.

With the introduction of the WAIS-IV and the popularity of the seven-subtest short form in the previous versions of the WAIS-R and WAIS-III, it is a natural extension of the previous research to assess this previously established short-form version with the new WAIS-IV. The current study involved comparison of a regression-based method and a prorated scores method for estimating full WAIS-IV scores from the Ward (1990) seven-subtest short form. Because the WAIS-IV does not contain a VIQ and PIQ, but instead uses the factor scales (VCI, PRI, WMI, and PSI), prediction of the VIQ and PIQ scores is not possible. However, the factor scales and the FSIQ could be predicted. To date, there have been no published studies regarding any short-form version of the WAIS-IV.

The advantage of using a seven-subtest short form is a simple matter of time allocation. In this time of limited insurance payment, time that would have been used to complete the full WAIS-IV could be used to directly assess other cognitive concerns. The core WAIS-IV takes 60 to 90 min to complete, whereas the seven-subtest short form takes 30 to 45 min to complete, thus saving half the time. The time savings of 30 to 45 min can then be put to use in more specific neuropsychological assessment without adding additional time and fatigue to the assessment. This may be particularly useful for individuals with more severe injuries who may not have the stamina for a lengthy assessment. The seven-subtest short form has already been shown to be effective in assessing brain injury (Callahan

et al., 1997) and in assessing psychiatric populations (Benedict et al., 1992). By establishing the usefulness of the seven-subtest method, this would pave the way for replication of the Callahan et al. and Benedict et al. studies. Thus, the development of a seven-subtest form of the WAIS-IV has many potential advantages.

Several models have been used to assess “goodness of fit” for various prediction methods used with the WAIS-III seven-subtest short form: (1) the correlation between the full-test score and the short-form score; (2) the discrepancy between the scores (measured in standard errors of measurement [SEM]); and (3) whether the original score and the short-form score are in the same diagnostic classification range. Iverson et al. (1997) commented that if the predicted score was not within 2 SEM of the full-test score and if the estimated score was in a different performance classification from the full-test score, the estimated score would be considered clinically inaccurate. Therefore, the combination of SEM and diagnostic classification change was used to determine the best model in this study.

METHODS

Participants/Procedures

Consecutive cases meeting the following criteria were collected from the authors: Individuals had completed the core WAIS-IV subtests plus the Picture Completion subtest as part of a full neuropsychological assessment using the Meyers Neuropsychological Battery (MNB); and there were no missing data on the WAIS-IV subtests. One case was dropped due to cultural considerations (foreign-born, English as a second language, artificially lowering WAIS-IV). The data were collected from the general clinical practices of the authors between January 2009 and February 2012, across the United States, until 102 eligible cases were obtained.

In this study, the core WAIS-IV subtests plus the Picture Completion subtest were given as part of a full neuropsychological assessment using the MNB (Meyers & Rohling, 2004; Volbrecht, Meyers, & Kaster-Bundgaard, 2000). The MNB has built-in performance validity measures (PVMs, Meyers, 2011). Failure on two or more of these PVMs is considered an invalid data set (Meyers, Miller, Rohling, & Axelrod, 2011; Meyers & Volbrecht, 2003; Meyers, Volbrecht, Axelrod, & Reinsch-Boothby, 2011). The Meyers Validity Index (MVI) is the total number of failed PVMs. Only valid cases were included in the sample. A case was excluded if the MVI was 2 or more.

Data sets that met the above criteria were contributed by the authors until a total of 102 data sets were achieved. Data were contributed as deidentified, preexisting clinical case data. Author 1 contributed 14 data sets from the

Central to Midwest region; Author 2 contributed 64 from the East coast; Author 3 contributed 18 from the Western region; and Author 4 contributed 6 from the Eastern United States. The data from Author 2 and Author 4 were combined as Group 1, and the remaining subjects from Authors 1 and 3 were combined as Group 2.

Group 1. Seventy participants were included in Group 1 ($M_{\text{age}} = 39.2$ years, $SD = 19.1$; $M_{\text{education}} = 13.5$ years, $SD = 3.3$). Fifty-four (77.1%) of the individuals were right-handed, and 16 (22.9%) were left-handed; 66 (94.3%) were Caucasian and 4 (5.7%) were not; 39 (55.7%) were female and 31 (44.3%) were male. Twelve individuals lived in a rural setting and 58 in an urban setting. The diagnostic makeup of this group included 24 with cognitive disorder-not otherwise specified (NOS), 10 with a learning disability, 3 with pervasive developmental disorder, 8 with attention-deficit disorder/attention-deficit hyperactivity disorder (ADD/ADHD), 7 with a vascular/cerebrovascular accident (CVA), 1 with Lewy body dementia, 2 with posttraumatic stress disorder, 1 with mild retardation, 1 with autoimmune disorder, 1 with sleep disorder, 1 with Char syndrome, 1 with polysubstance abuse, 1 with a nonverbal learning disability, 1 with antiphospholipid antibody syndrome, 1 with vasovagal syncope, and 7 with primary mental health diagnosis.

Group 2. Thirty-two participants were included in Group 2 ($M_{\text{age}} = 31.5$ years, $SD = 16.8$; $M_{\text{education}} = 12.0$ years, $SD = 2.3$). Twenty-seven (84.4%) individuals were right-handed and 5 (15.6%) were left-handed. Twenty-eight (87.5%) were Caucasian and 4 (12.5%) were not; 15 (46.9%) were female and 17 (53.1%) were male. Five lived in a rural setting and 27 in an urban setting. The diagnostic makeup of this group was 9 with cognitive disorder-NOS, 7 with a learning disorder, 4 with ADD/ADHD, 3 with CVA, 3 with posttraumatic stress disorder, 2 with pervasive developmental disorder, and 4 with primary behavior health diagnoses.

The diagnostic makeup of these groups included common neuropsychological clinical cases that were referred for clinical evaluation. All had been administered the WAIS-IV core subtests (Block Design, Similarities, Digit Span, Matrix Reasoning, Vocabulary, Arithmetic, Symbol Search, Visual Puzzles, Information, and Coding). One additional subtest was also given, Picture Completion. It was necessary to give Picture Completion so that all the original Ward (1990) seven-subtest short-form subtests could be given. All subtests were administered and scored as indicated in the test manual, by doctoral-level clinicians or technicians trained and supervised by the neuropsychologist. The FSIQ, VCI, PRI, WMI, and PSI scores were calculated as per manual

instructions. Data were then entered into Predictive Analytics Software (PASW) Statistics 18 (Statistical Package for the Social Sciences), which was used for all analyses.

Data Analysis

The demographic makeup of each group was calculated; the results of this demographic description were presented in the “Participants/Procedure” section. An χ^2 comparison of the urban and rural status of the participants was conducted and showed no significant difference between the two study groups, $\chi^2(1) = 0.04, p = .85$.

Next, Group 1 was selected; with this data set, a linear regression was calculated using the age-scaled scores from the Ward (1990) seven subtests to predict the FSIQ and the other index scores with 70 cases selected to help achieve stable regression beta weights for the seven variables (Hill & Lewicki, 2007). Then, using the regression equations developed for Group 1, the regression scores were calculated using Group 2 data.

Next, using the usual prorated scores method from the WAIS-IV manual, the FSIQ and index scores were calculated. The formulas for the regression equations and the prorated scores are presented in Table 1. The scores were then calculated for the Group 2 data for both the regression equations and the prorated scores methods. Using the SEM from page 45, Table 4.3 of the WAIS-IV technical manual (Wechsler et al., 2008), the band of error was calculated for each individual in Group 2, using both the regression and prorated score methods. The results of the band-of-error calculation are presented in Table 2. The band of error was then visually inspected to determine which methods produced the best “hit rate” for correct estimation of the FSIQ and index scores. The “best methods” were identified

TABLE 2
Frequency Count of the Band of Error Actual – Estimated, Group 2 Data

	> +2 SEM	+2 SEM	±1 SEM	-2 SEM	> -2 SEM
R_Full-Scale IQ (FSIQ)	0	3	20	6	3
R_Verbal Comprehension (VCI)	1	5	13	5	8
R_Perceptual Reasoning (PRI)	1	8	13	3	7
R_Working Memory (WMI)	0	0	32	0	0
R_Processing Speed (PSI)	2	9	16	5	0
P_Full-Scale IQ (FSIQ)	1	6	23	2	0
P_Verbal Comprehension (VCI)	4	3	13	9	3
P_Perceptual Reasoning (PRI)	3	5	13	7	4
P_Working Memory (WMI)	0	0	32	0	0
P_Processing Speed (PSI)	5	14	7	5	1

Note. SEM from page 45, Table 4.3 of Wechsler et al. (2008) for FSIQ = 2.16, VCI = 2.85, PRI = 3.48, WMI = 3.67, PSI = 4.78. R_ = Estimate based on the regression equation; P_ = Estimate based on prorated score equation.

as having the highest number of cases within +2 SEM of the full WAIS-IV score.

The best-methods estimates were then compared to the original scores to determine the significance of the difference between the actual and estimated scores, and the correlations of the actual and estimated scores. Finally, the clinical accuracy of these scores was evaluated by determining the percent of cases where the diagnostic classification of the score would change based on the full WAIS-IV versus the estimated score, the percent of cases where the short-form estimate was more than 2 SEM different from the full-test score, and the percent of cases where there was both a change in diagnostic classification and the predicted and actual scores differed by more than 2 SEM (i.e., the short-form score was “clinically inaccurate”).

TABLE 1
Regression Beta Weights and Constants for the FSIQ and Index Scores (Derived From Group 1)

Subtest	FSIQ*	VCI*	PRI*	WMI*	PSI*
Similarities (SI)	0.941	2.937			
Block Design (BD)	1.144		2.794		0.921
Information (IN)	1.148	2.835			
Digit Span (DS)	0.859			2.835	
Coding (CD)	0.997				4.063
Arithmetic (AR)	0.877		0.778	2.783	
Picture Completion (PC)	0.868		1.913		
Constant	32.148	43.530	45.279	43.700	49.402
R	0.987	0.981	0.930	1.000	0.936
Prorated Formulas:					
Prorated, using scale scores, and applying usual computation of index scores per the WAIS-IV Manual	$((IN + SI + BD + PC + DS + AR + CD) \times 10) / 7$	$((IN + SI) \times 3) / 2$	$((BD + PC) \times 3) / 2$	DS + AR	CD × 2
R	.986	.980	.915	1.000	.921

FSIQ = Full-Scale IQ; VCI = Verbal Comprehension; PRI = Perceptual Reasoning; WMI = Working Memory; PSI = Processing Speed.
*All $p < .001$.

RESULTS

The equations and the regression beta weights resulting from the stepwise linear regression with Group 1 data, using the age-scaled scores from the Ward (1990) seven subtests to predict the FSIQ and the other index scores are presented in the top half of Table 1. The final model using seven subtests showed a correlation of .99 between the FSIQ and the regression FSIQ; the correlations between the index scores and their respective prorated versions were also quite strong (.93 for PRI to 1.0 for WMI). The results of the initial regression analysis (Group 1 data) show that the Ward seven subtests are able to predict fairly accurately the FSIQ and the various index scores of the WAIS-IV.

The bottom of Table 1 shows the formulas and results of the prorated score method, which also produced a correlation of .99 between the FSIQ and the prorated FS IQ; the correlations between the index scores and their respective prorated versions were also quite strong (.92-.98; the WMI correlation was of course 1.0 because both subtests comprising the WMI are included in the Ward [1990] seven-subtest short form. The WMI is not included in further discussion).

Both methods produced strong correlations and would be considered reliable methods of calculating a Ward (1990) seven-subtest IQ or composite score with correlations within 1 point using either method. However, when examining Table 2, it can be seen that the prorated score method more consistently performed within the ±2 SEM range, with the exception of the PSI. For the PSI, the regression equation seems to perform better than the prorated score method.

To compare differences between regression and prorated methods, dependent-sample *t*-tests were run for the FSIQ, $M_{\text{prorated}} = .47$ and $M_{\text{regression}} = -0.80$, $t(31) = 4.95$, $p < .01$; VCI, $M_{\text{prorated}} = -0.56$ and $M_{\text{regression}} = -1.71$, $t(31) = 3.82$, $p < .01$; PRI, $M_{\text{prorated}} = -0.63$ and $M_{\text{regression}} = -1.02$, $t(31) = 0.53$, $p > .05$; WMI, $M_{\text{prorated}} = 0.00$ and $M_{\text{regression}} = -0.20$, $t(31) = 2.51$, $p < .05$; and PSI, $M_{\text{prorated}} = 2.97$ and $M_{\text{regression}} = -1.95$, $t(31) = 1.33$, $p > .05$.

Scores from both methods were then compared to the original full WAIS-IV scores, and a Cohen's *d* was calculated to check if the difference between the actual scores and the estimated scores was meaningful. The results of this analysis (Table 3) showed that all Cohen's *d* scores for both methods were in the negligible range, indicating that the difference between the full WAIS-IV scores and the estimated scores based on either method using the seven-subtest short form were not statistically significant nor clinically meaningful. As shown in Table 4, the estimated scores using the regression method and the prorated method showed nearly identical results.

TABLE 3
Paired-Samples Statistics Using Group 2 Data

		Mean	N	Std. Deviation	Std. Error	Cohen's <i>d</i> (Effect Size)
Pair 1	Full-Scale IQ	92.6	32	16.0	2.9	0.06
	R_Full-Scale IQ	93.6	32	16.9	3.0	
Pair 2	Verbal Comprehension	94.3	32	17.1	3.0	0.09
	R_Verbal Comprehension	96.0	32	18.2	3.2	
Pair 3	Perceptual Reasoning	95.5	32	14.0	2.5	0.07
	R_Perceptual Reasoning	96.5	32	13.8	2.4	
Pair 4	Processing Speed	92.2	32	14.2	2.5	0.14
	R_Processing Speed	90.3	32	13.5	2.4	
Pair 1	Full-Scale IQ	93.9	32	16.0	2.9	0.11
	P_Full-Scale IQ	92.1	32	16.3	2.9	
Pair 2	Verbal Comprehension	94.3	32	17.1	3.0	0.03
	P_Verbal Comprehension	94.8	32	17.1	3.0	
Pair 3	Perceptual Reasoning	95.5	32	14.0	2.5	0.04
	P_Perceptual Reasoning	96.1	32	14.5	2.6	
Pair 5	Processing Speed	92.2	32	14.2	2.5	0.19
	P_Processing Speed	89.3	32	15.7	2.8	

Note. Guidelines used in interpreting effect size: negligible ≤.19; small =.20-.49; medium =.50-.79; large =.80 (Cohen, 1988). R_ = Estimate based on the regression equation; P_ = Estimated based on prorated score equation.

Finally, considering Iverson et al.'s (1997) criteria for clinical inaccuracy, a visual inspection was made of the frequency with which the original score would be

TABLE 4
Paired-Samples Correlations Between Full WAIS-IV Score and Short-Form Estimated Score Using Group 2 Data

	Weighted Regression Estimates	N	Correlation	Sig.
Pair 1	Full-Scale IQ & R_Full-Scale IQ	32	.99	.000
Pair 2	Verbal Comprehension & R_Verbal Comprehension	32	.97	.000
Pair 3	Perceptual Reasoning & R_Perceptual Reasoning	32	.93	.000
Pair 4	Processing Speed & R_Processing Speed	32	.93	.000
	Prorated Scores Method	N	Correlation	Sig.
Pair 1	Full-Scale IQ & P_Full-Scale IQ	32	.99	.000
Pair 2	Verbal Comprehension & P_Verbal Comprehension	32	.97	.000
Pair 3	Perceptual Reasoning & P_Perceptual Reasoning	32	.95	.000
Pair 4	Processing Speed & P_Processing Speed	32	.92	.000

R_ = Estimate based on the regression equation; P_ = Estimated based on the prorated score.

TABLE 5
Percent of Estimates Considered 'Clinically Inaccurate' for
Regression-Weighted Versus Prorated Methods of Estimation

Score	Mean Diff (SD)	% Outside 2 SEM	% Changed Classification	% Outside 2 SEM AND Changed Classification*
R_FSIQ	-0.79 (2.92)	9	16	3
P_FSIQ	0.46 (2.15)	3	9	3
R_VCI	-1.70 (4.44)	28	28	22
P_VCI	-0.56 (4.46)	22	31	13
R_PRI	1.01 (5.35)	25	31	16
P_PRI	-0.62 (4.72)	22	34	19
R_PSI	1.95 (5.32)	6	38	3
P_PSI	2.96 (6.11)	19	53	19

R_ = Estimate based on the regression equation; P_ = Estimated based on the prorated score.

*Clinically inaccurate.

classified differently using the short-form methods, combined with the frequency with which the original score differed from the estimated score by more than 2 SEM (i.e., >4 points for FSIQ, >5 points for VCI, >6 points for PRI, or >9 points for PSI). As can be seen in Table 5, the FSIQ score would be clinically inaccurate just 3% of the time using either method. The VCI would be inaccurate 22% of the time using the regression model but only 13% with the prorated method, and the PRI calculations would be 16% inaccurate with the regression model compared with 19% with the prorated method. The PSI, however, had an inaccuracy rate of 3% with the weighted regression but a 19% inaccuracy rate with the prorated scores method. Neither model was consistently superior to the other for all scores and indexes. The prorated method showed similar or better performance on all but PSI. Given that the correlation between the actual PSI and the regression is .93 and the prorated method is .92, the difference between the two methods is actually small; but the prorated method is simpler, is the method presented in the WAIS-IV manual, and is well known in the field of neuropsychology.

DISCUSSION

The results of the current study showed that it is possible to use the seven subtests identified by Ward (1990) as a short form for the WAIS-IV. The original Group 1 data were used to create the regression equations that were then validated against a second set of data (Group 2). Group 2 data were also used in the prorated score method for a direct comparison with the regression equation method. There was a strong correlation (as seen in Table 4) between the original index scores and the estimated index scores using both regression weighting and the prorated scores method, comparable with

those reported for the Ward seven-subtest short form of the WAIS-III. These findings indicate that the prorated scores and regression equations do appear to be stable and are adequately predictive of their full-version counterparts. For all accuracy measures, the most accurate prediction for the short form was the prorated method of estimating the FSIQ score. The prorated FSIQ compares favorably with Iverson et al. (1997), who found 9% of FSIQ, 6% of VIQ, and 17% of PIQ scores from the WAIS-R estimates would be clinically inaccurate. Lange, Iverson, Viljoen, and Brink (2007) found 2% to 5% of VCI, 5% to 10% of POI (the WAIS-III version of PRI), and 3% to 8% of WMI scores from prorated WAIS-III data met this criteria. Given the generally higher correlations using the prorated method and the low proportion of scores meeting the clinically inaccurate criteria, there is very strong support for the continued use of this short form with the prorated scores method for the calculation of the FSIQ score. If index scores are also needed, the prorated score is both simpler and more clinically accurate for the VCI, and it is nearly as accurate for the PRI. For the PSI, the weighted regression showed clear superiority in clinical accuracy; although the correlations between the prorated PSI and the actual PSI were nearly identical, the additional variables included in the weighted regression made this method superior to the prorated model which used just one variable.

Although the group data showed very high correlations comparable to those found in previous research, there was more variability in the predictive accuracy at the individual level, especially for the VCI, PRI, and PSI. This variability at the individual-case level has also been observed in previous research using short forms with the WAIS-R (Iverson et al., 1997) and the WAIS-III (Kulas & Axelrod, 2002), especially for the component scores (VIQ, PIQ, and the index scores). In the current study, the greatest differences were observed when there was a spread of 6 or more points in the age-scaled scores for the subtests in the short form. When clinicians observe such a spread in the individual patient's data, it is recommended the remainder of the subtests in the relevant indices be administered before making conclusions based on profile analysis.

Using a short form of the WAIS-IV provides many advantages for a clinician to consider. First, abbreviated testing is both efficient and less strenuous on the examinee. In situations where the referral is not related to qualification for educational services or documentation of mental retardation, the authors find the abbreviated form to be an acceptable method to use when there are more pressing clinical questions to answer. Moreover, the Ward (1990) seven-subtest scales are often part of other testing batteries, such as the MNB. The MNB uses the short form as its preferred form over the long form of

the WAIS-III/WAIS-IV. The use of a short form provides a reliable estimate of IQ and, in most cases, index performance; although the potential information from some subtests is lost, the time savings allows the clinician to include a variety of more specific neuropsychological assessment instruments, thus focusing the assessment more on neuropsychological factors. In cases where there is atypical variability in the short-form subtest scores, administration of additional WAIS-IV subtests may be clinically justified. Another obvious advantage is the time savings: The seven-subtest form takes 30 to 45 min to administer, which provides a 50% time savings (using the WAIS-IV manual's estimate of 60 to 90 min to complete the core WAIS-IV tests).

In the current study, the seven-subtest form was administered in the same order as in the full WAIS-IV, skipping only the unused subtests and administering the Picture Completion as the final subtest. By using this order, the Block Design subtest is administered first, in both the short form and the regular form. Thus, the problem with order effect as postulated by Thompson, Howard, and Anderson (1986) is not applicable to the study findings and to enhancing the generalizability of the study results. There obviously are other short-form versions possible (Donnell, Pliskin, Holdnack, Axelrod, & Randolph, 2007; Reid-Arndt, Allen, & Schopp, 2011; Thompson et al.), and although these may be interesting to pursue in future studies, they are not the purpose of the current study.

In this study, we used a clinical sample, although this sample was not the same as the standardization sample for the WAIS-IV; however, it is a sample consistent with the types of cases with which this short form could be used. Another limitation is that the sample was mostly Caucasian. However, "demographically adjusted norms are not intended for use in psychoeducational assessment, determination of intellectual disability, vocational assessment, or any other context in which the assessment goal is to determine absolute functional level (IQ or memory)" (*Overview of Advanced Clinical Solutions for WAIS-IV and WMS-IV*, 2009, p. 7). Thus, any demographic difference is likely not of clinical significance.

Another limitation of the use of any short form is the loss of some information from the original full form. However, in neuropsychology specifically, and in other situations where a short form is used, the loss of information is minimal given the strong correlations with the original long form. The clinician must weigh the loss of information and the gain of time that can be more productively spent assessing specific referral questions. Further research is needed to replicate the work of Callahan et al. (1997) in a brain injury sample and the work of Benedict et al. (1992) in a psychiatric population, to see if the seven-subtest short form retains sufficient diagnostic strength as it did with the previous versions of the WAIS. This should be the subject of

future research. Although the authors believe the sample size for both the creation and validation samples was sufficient for their purpose in this study, certainly replication with a larger sample size would be appropriate. Additionally, clinical validation of this short form with different population and clinical groups should be made. The results of this study indicate that the Ward (1990) seven-subtest short form of the WAIS-IV, whether applied with the regression-derived scoring algorithm presented here or a simpler prorated score method, appears to retain psychometric properties similar to the full version of the WAIS-IV.

REFERENCES

- Axelrod, B. N., Ryan, J. J., & Ward, L. C. (2001). Evaluation of seven-subtest short forms of the Wechsler Adult Intelligence Scale-III in a referred sample. *Archives of Clinical Neuropsychology*, *16*, 1-8.
- Benedict, R. H., Schretlen, D., & Bobholz, J. H. (1992). Concurrent validity of three WAIS-R short forms in psychiatric inpatients. *Psychological Assessment*, *4*, 322-328.
- Callahan, C. D., Schopp, L., & Johnstone, B. (1997). Clinical utility of the seven subtest WAIS-R short form in neuropsychological assessment of traumatic brain injury. *Archives of Clinical Neuropsychology*, *12*, 133-138.
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.
- Donnell, A. J., Pliskin, N., Holdnack, J., Axelrod, B., & Randolph, C. (2007). Rapidly-administered short forms of the Wechsler Adult Intelligence Scale-3rd edition. *Archives of Clinical Neuropsychology*, *22*(8), 917-924.
- Hill, T., & Lewicki, P. (2007). *STATISTICS: Methods and applications*. Tulsa, OK: StatSoft.
- Hilsabeck, R. C., Schrage, D. A., & Gouvier, W. D. (1999). External validation of the equivalence of two computational formulas for a WAIS-R seven subtest short form. *Applied Neuropsychology*, *6*(4), 239-242.
- Iverson, G. A., Myers, B., & Adams, R. L. (1997). Comparison of two computational formulas for a WAIS-R seven-subtest short form. *Journal of Clinical Psychology*, *53*, 465-470.
- Kaufman, J. C., & Kaufman, A. S. (2001). Time for the changing of the guard: A farewell to short forms of intelligence tests. *Journal of Psychoeducational Assessment*, *19*, 245-267.
- Kulas, S. F., & Axelrod, B. N. (2002). Comparison of seven-subtest and Satz-Mogel short forms of the WAIS-III. *Journal of Clinical Psychology*, *58*, 773-782.
- Lange, R. T., Iverson, G. L., Viljoen, H., & Brink, J. (2007). Clinical validation of Canadian WAIS-III index short forms in inpatient neuropsychiatry and forensic psychiatry. *The Clinical Neuropsychologist*, *21*, 434-441.
- Lezak, M. D., Howieson, D. B., & Loring, D. W. (2004). *Neuropsychological assessment* (4th ed.). New York, NY: Oxford University Press.
- Meyers, J. E. (2011). *Electronic manual for the Meyers Neuropsychological Battery (MNB)*. Retrieved from <http://www.meyersneuropsychological.com>
- Meyers, J. E., Miller, R. M., Rohling, M. L., & Axelrod, B. N. (2011). Does the source of a forensic referral affect neuropsychological test performance on a standardized battery of tests? *The Clinical Neuropsychologist*, *25*, 477-487.

- Meyers, J. E., & Rohling, M. L. (2004). Validation of the Meyers Short Battery on mild TBI patients. *Archives of Clinical Neuropsychology, 19*, 637–651.
- Meyers, J. E., & Volbrecht, M. E. (2003). A validation of multiple malingering detection methods in a large clinical sample. *Archives of Clinical Neuropsychology, 18*, 261–276.
- Meyers, J. E., Volbrecht, M. E., Axelrod, B. N., & Reinsch-Boothby, L. (2011). Embedded symptom validity tests and overall neuropsychological test performance. *Archives of Clinical Neuropsychology, 26*, 8–15.
- Neisser, U., Boodoo, G., Bouchard, T. J., Boykin, A. W., Brody, N., Ceci, S. J., . . . Urbina, S. (1996). Intelligence: Knowns and unknowns. *American Psychologist, 51*, 77–101.
- Overview of Advanced Clinical Solutions for WAIS-IV and WMS-IV. (2009). Retrieved from http://www.pearsonassessments.com/NR/rdonlyres/D4ACCA90-D61F-4C24-BA37-61F6AC068C38/0/Overview_WAISIV_WMSIV.pdf
- Pierson, E. E., Kilmer, L. M., Rothlisberg, B. A., & McIntosh, D. E. (2012). Use of brief intelligence tests in the identification of giftedness. *Journal of Psychoeducational Assessment, 30*, 10–24.
- Pilgrim, B. M., Meyers, J. E., Bayless, J., & Whetstone, M. M. (1999). Validation of the Ward seven-subtest WAIS-III short form in a neuropsychological population. *Applied Neuropsychology, 6*, 243–246.
- Reid-Arndt, S. A., Allen, B. J., & Schopp, L. (2011). Validation of WAIS-III four-subtest short forms in patients with traumatic brain injury. *Applied Neuropsychology, 18*(4), 291–297.
- Ryan, J. J., & Ward, L. C. (1999). Validity, reliability, and standard errors of measurement for two seven-subtest short forms of the Wechsler Adult Intelligence Scale III. *Psychological Assessment, 11*, 207–211.
- Strauss, E., Sherman, E. M., & Spreen, O. (2006). *A compendium of neuropsychological tests: Administration, norms, and commentary* (3rd ed.). New York, NY: Oxford University Press.
- Thompson, A. P., Howard, D., & Anderson, J. (1986). Two- and four-subtest short forms of the WAIS-R: Validity in a psychiatric sample. *Canadian Journal of Behavioral Science, 18*, 287–293.
- Volbrecht, M., Meyers, J., & Kaster-Bundgaard, J. (2000). Neuropsychological outcome of head injury using a short battery. *Archives of Clinical Neuropsychology, 15*, 251–265.
- Ward, L. C. (1990). Prediction of Verbal, Performance and Full Scale IQs from seven subtests of the WAIS-R. *Journal of Clinical Psychology, 46*, 436–440.
- Wechsler, D. (1997). *WAIS-III: Administration and scoring manual*. San Antonio, TX: Pearson.
- Wechsler, D. (2008). *WAIS-IV administration and scoring manual*. San Antonio, TX: Pearson.
- Wechsler, D., Coalson, D. L., & Raiford, S. E. (2008). *WAIS-IV technical and interpretive manual*. San Antonio, TX: Pearson.

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