Convergent Validity of a Quick Online Self-Administered Measure of Verbal IQ for
Psychology Researchers

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Abstract

Verbal intelligence—which relates to memory performance, abstract reasoning, and *g*—is often important to account for within psychological research. However, the time demands and financial costs associated with researcher-administered testing using valid measures of intelligence limit researchers' ability to include such measures within their research. To address this issue, we examined the convergent validity of two tests of verbal intelligence that could be self-administered online with the well-validated Wechsler Abbreviated Scale of Intelligence–Second Edition (WASI-II). An undergraduate sample of participants ($N = 104$) completed the Self-Administered Verbal IQ Test (SA-VIQT), with a subsection ($n = 64$) completing the Self-Administered Full Scale IQ Test (SA-FSIQT), both made available online by Open-Source Psychometrics Project. Additionally, all participants were administered the Verbal Comprehension Index (VCI) of WASI-II by a trained researcher, with a subsection administered the full WASI-II including the Perceptual Reasoning Index (PRI) ($n = 72$). Both online tests demonstrated convergent validity with the WASI-II. While the online tests may only deliver a crude indicator of verbal intelligence, they provide researchers the opportunity for statistical control or screening of participants across large samples in an efficient manner not possible when using researcher-administered testing methods.

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Verbal intelligence refers to an individual's linguistic comprehension and reasoning abilities. Standardized intelligence quotient (IQ) assessments provide insight into verbal abilities, with performance on measures of verbal intelligence linked to memory performance, abstract reasoning, and *g* (Wechsler, 1958). Johnson, Bouchard, Krueger, McGue, and Gottesman (2004) compared *g* loadings across three different mental ability batteries and found the highest loadings were for the Vocabulary subtests (between .81 - .82). Given the range of cognitive abilities associated with verbal intelligence, examining and accounting for differences therein is an important consideration in many areas of psychological research. The Wechsler Intelligence Scales are the most commonly administered instruments for assessing cognitive ability—including verbal intelligence—in children and adults (Wechsler, 2008; 2014).

Administration of the full Wechsler scales takes considerable time. However, the Wechsler Abbreviated Scale of Intelligence–Second Edition (WASI-II) provides a validated shortened assessment which includes a verbal component, referred to as the Verbal Comprehension Index (VCI; Wechsler, 2011). Although the abridged version is more convenient than the expanded version for researchers interested in screening for or controlling for verbal ability, the scale must still be administered by a researcher—typically in-person, but also with the option for virtual administration. Such testing takes time, is costly and requires careful training in test administration and scoring. For many psychological studies the time demands and financial costs are prohibitive and may be unnecessary given the researcher may only require a relatively crude index of verbal ability. For example, a brief vocabulary test consisting of 10 multiple-choice questions called WORDSUM—originally developed by Robert Thorndike (Thorndike & Gallup, 1944) based on the Vocabulary subtest

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of the original WAIS (Meisenberg, 2015)—has been widely used as a measure of IQ and verbal ability (see Malhotra, Krosnick, & Haertel, 2007 for a review), although question marks exist about its appropriateness as a measure of IQ (Huang & Hauser, 1998).

Researchers in many areas of psychological research often require a quick and approximate estimate of participants' verbal ability. For example, they may wish to screen participants to ensure they are likely of at least average verbal ability or they may wish to use a proxy for a full-scale verbal IQ measure as a covariate in statistical analyses. Moreover, researchers may need to gauge the verbal ability of participants they have sampled online, where administration of individualized testing is difficult.

Given the outlined disadvantages of individual researcher administered testing, we examined the convergent validity of an online self-administered measure of verbal IQ to determine if, for some research purposes (e.g., quick screening of participants, a covariate measure), it would be suitable to substitute for the VCI of the WASI-II. Specifically, we examined the convergent validity of the self-administered Vocabulary IQ Test (SA-VIQT), made available online by the Open-Source Psychometrics Project for measuring verbal abilities (Vocabulary IQ Test, n.d.), as well as their self-administered Full Scale IQ Test (SA-FSIQT) which includes a verbal component (Full Scale IQ Test, n.d.), with the WASI-II. We used an undergraduate sample given that a significant proportion of psychological studies that might be likely to incorporate a crude indication of verbal ability rely on such samples.

Method

Participants and Procedure

Individuals ($N = 104$; 69 female) recruited from the university undergraduate population participated for a cash honorarium or course credit. Ages ranged from 17 to 53 ($M = 24.71$, $SD = 7.82$). All participants were Caucasian and native English speakers.

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Participants completed both the WASI-II and the online SA-VIQT, with over half of the sample also completing the SA-FSIQT (Figure 1). The order of administration was counterbalanced across participants. The majority of participants participated in a laboratory setting, with one of two researchers administering the WASI-II and setting participants up on the computer to complete the SA-VIQT (and SA-FSIQT if applicable). However, when in-person testing could not be carried out ($n = 16$), the researcher provided an online link for participants to complete the SA-VIQT and only the VCI subtests of the WASI-II were administered as these could be administered online. Total numbers varied across those who completed the full WASI-II including the Perceptual Reasoning Index (PRI) ($n = 72$), or only the VCI component, ($n = 32$).

Figure 1. Flowchart for the number of participants who completed each test across settings

Measures

Wechsler Abbreviated Scale of Intelligence–Second Edition (WASI-II). The WASI-II is made up of four subtests, each approximately 15-minutes in duration. The Vocabulary and Similarities subtests, which require word definition and description of similarities between concepts within two words, combine to form the Verbal Comprehension

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Index (VCI). The Block Design and Matrix Reasoning subtests, which involve reproducing abstract designs under time-pressure and identifying and completing patterns, combine to form the Perceptual Reasoning Index (PRI). The VCI measures acquired word knowledge and verbal reasoning, while the PRI is a measure of nonverbal fluid intelligence (Maccow, 2011). The orthogonalized pattern coefficients for each subtest indicate strong *g* loadings across the Vocabulary (.75), Similarities (.75), Block Design (.64), and Matrix Reasoning (.69) subtests in an adult sample (McGeehan, Ndip, & McGill, 2017). Raw scores from each subtest are normed for age to compute a t-score, ranging from 20 to 80, which is then transformed to a scaled score ranging from 1 to 19—with higher scores indicating better performance. Additionally, the t-scores are summed and transformed to create a composite score for the VCI and PRI, as well as a Full-Scale IQ (FSIQ) score that represents a measure of general intelligence. The FSIQ may be categorized as the FSIQ-2 (pro-rated based on the Vocabulary and Matrix Reasoning subtests), or the FSIQ-4 (based on all four subtests). Each composite score may range from 40 to 160.

Self-administered Vocabulary IQ Test (SA-VIQT). The Open-Source Psychometrics Project has made a number of psychological assessment instruments freely available through their website. The SA-VIQT involves 45 questions which require participants to select two out of five words that possess the same meaning. Correct answers receive one-point, incorrect answers subtract one-point, while respondents can select ‘Don’t Know’ for zero-points. There is currently no information on the website regarding the selection or validation of items for the SA-VIQT. The website provides respondents with the number of correct, incorrect and unanswered items; it also produces a raw score and a transformed Vocabulary IQ score (VIQ). The raw score is calculated by subtracting the number of incorrect responses, multiplied by 0.35, from the total number of correct responses. The website does not provide detail as to how the transformed IQ scores are

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created. Like the WASI-II composite scores, the VIQ may range from 40 to 160. However, unlike the WASI-II, the VIQ score is not based on age-related norms. Presumably, the IQ scores are based on the test developer's own algorithm(s) to determine how items are weighted to produce the final score.

Self-administered Full Scale IQ Test (SA-FSIQT).¹ The SA-FSIQT uses six subtests to assess three domains of intelligence—based on findings by Hampshire et al. (2012) that suggest, for an online sample, intelligence may be best represented by measuring verbal, reasoning, and short-term memory components. The verbal domain included Vocabulary (scored 0-34) and Anagrams (scored 0-27) subtests—with these measuring word comprehension and problem solving. The reasoning domain included Mental Rotations (scored 0-17) and Central Point (scored 0-18) subtests, with these assessing spatial cognition; the short-term memory domain included Visual Memory (scored 0-85) and Exposure Memory (scored 0-26) subtests. There appears to be no information provided regarding the creation of each specific subtest. For each subtest, one point is awarded for a correct answer and one point subtracted for an incorrect answer, with higher scores indicating greater performance. The overall FSIQ, and the IQ score provided by the website for each domain, can range from 50-150, but again there was no specification regarding the weighting of subtests and the determination of overall scores.

Results and Discussion

Table 1 provides (i) a comprehensive summary of the correlations between the WASI-II subtest raw, scaled and composite scores and the online self-administered Vocabulary IQ Test (SA-VIQT) raw and verbal IQ scores, and (ii) the corresponding mean

¹ See Appendix for full description of SA-FSIQT testing

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(and *SD*) scores. Mean WASI-II VCI and FSIQ scores were approximately 111 ($SD \approx 12$); the corresponding values for the SA-VIQT were around 100 ($SD \approx 11$).

Key significant correlations to highlight are those between the SA-VIQT and the (i) WASI-II VCI ($r = .48$), (ii) WASI-II FSIQ-2 ($r = .54$), and (iii) WASI-II FSIQ-4 ($r = .53$). Note that the correlations between the online measures and the WASI-II FSIQ-4 were substantially weaker than the correlations between the WASI-II FSIQ-4 and its VCI ($r = .88$) and PRI ($r = .90$) composites. Nevertheless, the correlations suggest convergent validity for the SA-VIQT that might render it suitable as a quick and crude screening measure for research purposes such as those outlined earlier.

Table 1

Correlation coefficients (r) comparing WASI-II and SA-VIQT scores

WASI-II scores		SA-VIQT scores					<i>M (SD)</i>
		VIQ	Raw	# Correct	# Incorrect	# DK	
Raw							
	BD	.42***	.42***	.35**	-.41***	-.11	52.10 (10.22)
	95% CI	.21, .59	.21, .59				
	VC	.66***	.67***	.66***	-.21*	-.48***	42.03 (3.50)
	95% CI	.54, .76	.54, .76				
	MR	.35**	.35**	.33**	-.23*	-.15	22.71 (2.89)
	95% CI	.13, .54	.13, .54				
	SI	.37***	.37***	.35***	-.20*	-.21*	35.06 (4.09)
	95% CI	.20, .53	.20, .53				
Scaled							
	BD	.41***	.41***	.36**	-.33**	-.17	11.74 (2.70)
	95% CI	.20, .59	.20, .59				
	VC	.59***	.60***	.59***	-.19	-.42***	12.31 (1.90)
	95% CI	.45, .70	.46, .71				
	MR	.38**	.38***	.35**	-.26*	-.15	11.69 (2.45)
	95% CI	.16, .56	.16, .56				
	SI	.30**	.31**	.29**	-.17	-.17	12.07 (2.56)
	95% CI	.11, .47	.13, .47				
Composite							
	VCI	.48***	.49***	.47***	-.20*	-.32***	111.06 (10.16)
	95% CI	.32, .62	.33, .62				
	PRI	.49***	.49***	.44***	-.36**	-.20	109.60 (11.95)
	95% CI	.29, .65	.29, .65				
	FSIQ-2	.54***	.55***	.51***	-.32**	-.26*	111.42 (10.51)
	95% CI	.36, .69	.37, .69				
	FSIQ-4	.53***	.54***	.49***	-.38**	-.24*	111.90 (11.15)
	95% CI	.34, .68	.36, .69				
<i>M (SD)</i>		99.51 (11.91)	24.11 (7.04)	26.81 (6.49)	7.78 (4.81)	10.56 (7.22)	

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

$df = 102$ (and 70 for those including perceptual reasoning subtests)

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Table 2

Correlation coefficients (r) comparing WASI-II and SA-FSIQT scores

WASI-II scores		SA-FSIQ scores									<i>M (SD)</i>	
		FSIQ	Memory IQ	Memory visual	Memory exposure	Verbal IQ	Verbal vocab	Verbal anagram	Spatial IQ	Spatial rotation		Spatial central
Raw												
	BD	.56***	.44***	.51***	-.11	.36**	.27*	.30*	.56***	.53***	.38**	52.10 (10.22)
	95% CI	.36, .71				.13, .56						
	VC	.41**	.21	.25*	.05	.49***	.51***	.29*	.48***	.41**	.42**	42.03 (3.50)
	95% CI	.18, .60				.28, .66						
	MR	.49***	.40**	.42**	.13	.35**	.39**	.19	.40**	.37**	.30*	22.71 (2.89)
	95% CI	.28, .66				.11, .55						
	SI	.32*	.23	.27*	-.11	.25*	.21	.19	.34**	.32*	.24	35.06 (4.09)
	95% CI	.08, .53				.00, .47						
Scaled												
	BD	.49***	.36**	.43***	-.09	.30*	.25*	.24	.55***	.54***	.33**	11.74 (2.70)
	95% CI	.28, .66				.06, .51						
	VC	.42**	.25**	.26*	.00	.46***	.40**	.33**	.47***	.42**	.37**	12.31 (1.90)
	95% CI	.19, .60				.24, .63						
	MR	.44***	.34**	.33**	.12	.35**	.39**	.20	.36**	.35**	.23	11.69 (2.45)
	95% CI	.22, .62				.11, .55						
	SI	.30*	.21	.25*	-.14	.22	.14	.19	.33**	.32**	.19	12.07 (2.56)
	95% CI	.06, .51				-.03, .44						
Composite												
	VCI	.41***	.27*	.30*	-.07	.37**	.31*	.28*	.43***	.41**	.30*	111.06 (10.16)
	95% CI	.18, .60				.14, .56						
	PRI	.58***	.43***	.45***	.00	.42**	.38**	.30*	.57***	.55***	.36**	109.60 (11.95)
	95% CI	.39, .72				.19, .60						
	FSIQ-2	.49***	.34**	.35**	.08	.44***	.47***	.26*	.48***	.44***	.34**	111.42 (10.51)
	95% CI	.28, .66				.22, .62						
	FSIQ-4	.57***	.40**	.43***	-.04	.45***	.40**	.33**	.58***	.55***	.37**	111.90 (11.15)
	95% CI	.37, .71				.23, .63						
<i>M (SD)</i>		107.22 (13.81)	112.22 (14.45)	56.98 (13.09)	16.20 (13.44)	109.81 (11.47)	18.94 (3.38)	13.02 (4.83)	117.73 (15.23)	10.19 (4.91)	11.33 (2.32)	

Note. * $p < .05$, ** $p < .01$, *** $p < .001$
 $df = 62$

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Table 2 provides (i) the correlations between the WASI-II subtest raw, scaled and composite scores and the online self-administered Full Scale IQ Test (SA-FSIQT) subtest and FSIQ scores, and (ii) the corresponding mean (and *SD*) scores. Mean SA-FSIQT scores were approximately 107 ($SD \approx 14$). Here, the key significant correlations to highlight are those between the SA-FSIQT and the (i) WASI-II VCI ($r = .41$), (ii) WASI-II PRI ($r = .58$), (iii) WASI-II FSIQ-2 ($r = .49$), and (iv) WASI-II FSIQ-4 ($r = .57$). Again, the correlations suggest convergent validity for the SA-FSIQT that might also render it suitable as a quick and crude screening measure for non-verbal and full-scale IQ for research purposes such as those outlined earlier.

There were strong correlations between the raw scores of the online tests and the raw WASI-II scores. In particular, the strongest relationship was between the SA-VIQT raw scores and the raw WASI-II Vocabulary subtest scores ($r = .67$). Given the online measures do not account for age-related norms, as is the case for the WASI-II scaled and composite scores, correlations between the raw scores may be a more appropriate indicator of convergence. Additionally, an advantage of using the raw scores from the online measures is that the researcher has direct access to that score and its calculation, whereas the transformed IQ scores provided by the website are based on a currently unspecified algorithm.

Conclusion

In sum, both the SA-VIQT and SA-FSIQT may be used as convenient measures of verbal intelligence for research purposes, with demonstrated convergent validity with the well-validated WASI-II in a university sample. The online tests provide only a limited measurement of intelligence—primarily useful as a crude indicator of verbal intelligence for statistical control or participant screening—but affords researchers the opportunity to conduct such testing more broadly and efficiently within their research. For example, compared to the WASI-II, the online measures eliminate the need for researcher training, one-to-one test

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administration, and manual scoring, which require in-person testing that is time-consuming and costly. Instead, the SA-VIQT and SA-FSIQT are accessible online, provide clear instructions allowing for participant self-administration, and are automatically scored. Therefore, the online tests make it easier for researchers to measure verbal intelligence within studies involving large samples and across a range of external locations. Additionally, the online tests provide a quicker measure of intelligence compared to the WASI-II, which may also make these tests a suitable replacement within time-dependent laboratory-based research. The full WASI-II administration requires, on average, 30-minutes to complete and additional time for scoring, whereas average completion time of the SA-VIQT ($M = 13.57$ minutes, $SD = 3.82$) and SA-FSIQT ($M = 20.91$ minutes, $SD = 6.07$) is significantly shorter. The shorter SA-VIQT may be more convenient for measuring verbal intelligence, but the SA-FSIQT may be more appropriate where perceptual abilities are also required to be measured, given its sound convergence with the PRI of the WASI-II. For many reasons, running an IQ test in-person may not be efficient, feasible or practical. Therefore, these short online self-administered tests may fill that void for some research purposes.

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Appendix**Detail on SA-FSIQT subtests**

The verbal domain included the Vocabulary and Anagrams subtests. The Vocabulary subtest provided participants with a target word and required them to select up to 10 words from a list that matched the meaning of that target. This was repeated 7 times, and scores could range from 0 to 34. The Anagrams subtest required participants to select which of the 18 scrambled letter combinations would unscramble to create a real English word. There were three trials lasting 60 seconds, each with an increasing number of letters for each word, with scores ranging from 0 to 27.

The reasoning domain included the Mental Rotations and Central Point subtests. Mental Rotations provided a series of four different target shapes and required participants to select up to eight different shapes that represented the same target shape but at a different rotation, with scores ranging from 0 to 17. Central Point provided participants with a 15x15 cell grid, with several cells coloured green, and required the selection of a cell that reflected the mid-point of the green cells. There were 16 trials, and partial scores are provided depending on how close the selection was to the correct mid-point, with scores ranging from 0 to 18.

The short-term memory domain included Visual Memory and Exposure Memory subtests. Visual Memory required nine pattern reproductions of a shaded grid following a 5-second encoding period of the original pattern. Scores ranged from 0 to 85. Exposure Memory revealed a series of icons sequentially then provided eight icons simultaneously – requiring participants to select which of those icons appeared in the previous sequence. There were six trials with scores ranging from 0 to 26.