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Application of the Wilson Rapid Approximate Intelligence Test in a Vocational Rehabilitation Sample

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Abstract

The purpose of this study is to report data on the *Wilson Rapid Approximate Intelligence Test*. Adults (N=115) undergoing a vocational assessment had scores on the test that ranged from a low of 2 to a maximum of 12 with a mean of 6.56 (SD=4.9, 95% CI [6.13, 6.98]). The split-half reliability of the results treated as a Guttman scale is.913. Of the socio-demographic factors, sex had a moderate effect on scores with males scoring higher. There was no effect of age, schooling, education or language background. Performance was unrelated to scores on a memory malingering task or reading achievement. WRAIT scores were statistically significantly correlated with general knowledge and information processing speed.

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I. Introduction

In 1983, Ables, Brandsma and Henry outlined what they described as the “Empirical mental Status Exam” and included as one of its components the *Wilson Rapid Approximate Intelligence Test* (Wilson, 1967). They supported its use “…because of its ease of administration” and added, “It provides a gross measure of that most important clinical concept, intelligence, a notion of which should be included in all cognitive and behavioral assessment” (p. 236).

Despite its advantages, the *Wilson Rapid Approximate Intelligence Test* is not well-known like proprietary giants such as the Wechsler or Stanford-Binet scales of intelligence and hardly ever referenced. It has become obscure and with few

exceptions (Carlat, 2017; Catherine, 2018) assigned largely to history. In 2018, however, Catherine *et al.* studied 100 patients with schizophrenia in Indonesia and reported a correlation of.876 between the *Wilson Rapid Approximate Intelligence Test* and the *Mini-Mental State Examination* (Folstein et al., 1975). On closer inspection, the WRAIT may warrant attention as a free, brief and practical assessment of cognitive processing capacity.

The *Wilson Rapid Approximate Intelligence Test* is a straightforward indicator of mental reasoning. It comprises a series of multiplications by two, starting with 2 x 3 =? then 2 x 6 =?, 2 x 12 =? and so forth until an error is made or the subject reaches 2 x 6144. Wilson cites its brevity and the fact that no equipment is required as two advantages. Moreover, in its development, it had been standardised against the *Wechsler Adult Intelligence Scale*. An approximate IQ has been derived and is outlined in Table 1.

Table 1. Framework for determining IQ from the Wilson Rapid Approximate Intelligence Test (Adapted from Carlat 2017, p. 226)

Best effort	IQ (approximate)
2 x 3 2 x 6	<70
2 x 12 2 x 24	70-80
2 x 48 2 x 96 2 x 192	80-90
2 x 384 2 x 768	90-110
2 x 1,536	110-120
2 x 3072 2 x 6144	120-130

The *Wilson Rapid Approximate Intelligence Test* - which I shall abbreviate as WRAIT - is focused solely on the ability to perform mental calculations which are elements of fluid intelligence. It requires acquired knowledge at the outset (e.g., 2 x 3 = 6) then working memory in a somewhat novel situation as the numbers increase. No claim is made that it is a perfect measure of intelligence but it has been used in psychiatric settings(Carlat, 2017) as part of a mental status assessment and I believe it has potential for use in a vocational rehabilitation assessment to evaluate cognitive potential quickly and efficiently. The purpose of this report is to document results on the use of the WRAIT in a practice that deals with vocational rehabilitation cases. In particular the report addresses the following issues and questions:

a. What is the average performance on the WRAIT?
b. What is the item difficulty of the questions on the WRAIT?
c. Does the total score on the WRAIT correlate with demographic variables, such as age, sex, years of schooling, post-

school qualifications or English-speaking background as well as cognitive factors such as reading level, information processing speed, general knowledge or memory malingering?

The results will enable the WRAIT to be better used for assessment in a vocational rehabilitation context.

II. Method

Participants. The participants in the study comprised 116 persons (79 makes, 36 females) undergoing a vocational assessment. The mean age was 45.3 years (SD=13.09). The level of schooling in the sample was 19 persons with less than Year 10, 31 persons with Year 10, 14 had reached Year 11 and 52 had achieved a Year 12 standard. In terms of post-school qualifications, 54 had no formal post-school qualification, 34 had a certificate or trade qualification and 28 had a degree or diploma. The occupational background of the sample was 9 clerical, 3 sales, 20 service occupations, 8 intermediate transport, 45 labourers, 5 professionals, 10 trades and 16 not in the labour force (including students at the time of injury). There were 49 persons of non-English speaking background and 67 persons with an English-speaking background in the group. The WRAIT was not administered to three patients mainly due to time restraints or because it was not required for the vocational purpose.

Instruments. In addition to the WRAIT, the participants were also administered (a) the*Wide-Range Achievement Test-5* Reading (Wilkinson & Robertson, 2017), (b) the *Rey 15-item* test (Lezak, 1995; Podell, 2011) as an assessment of memory malingering, (c) Information sub-test of the *Naylor-Harwood Adult Intelligence Scale* (Naylor & Harwood, 1972), and (d) the *Basic Information Parameter* (Lehrl & Fischer, 1988, 1990) as a measure of information processing speed.

Procedure. Participants underwent a vocational assessment of around two hour's duration. It comprised a structured interview covering education and work history. Assessments included vocational interests, aptitudes, functional abilities and cognitive skills such as information, processing speed, reasoning and literacy. The only difference in administration from the procedure specified in the WRAIT was that testing was discontinued after the first failure whereas Wilson discontinued after two consecutive failures. Discontinuing after the first failure converts the test into a *de facto* Guttman (1944) scale, that is, a single ordinal scale in which the score automatically reproduces the entire set of responses to all items.

Analysis. Traditional item analysis and descriptive statistics are reported. Further details are provided in the results section. Effect sizes were converted to Cohen's d (Cohen, 1988). Effect sizes were interpreted according to Cohen as low (d=.2), medium (d=0.5) and large as (d=0.8). In addition, a Rasch analysis based on dichotomous scoring was used (The jamovi project, 2021).

III. Results

What is the average performance on the WRAIT?

The scores on the WRAIT ranged from a low of 2 to a maximum of 12 with a mean of 6.56 (SD=4.9, 95% CI [6.13, 6.98]). The distribution of scores shown in Figure 1 is fairly normally distributed other than for a spike at the end for persons scoring 12.

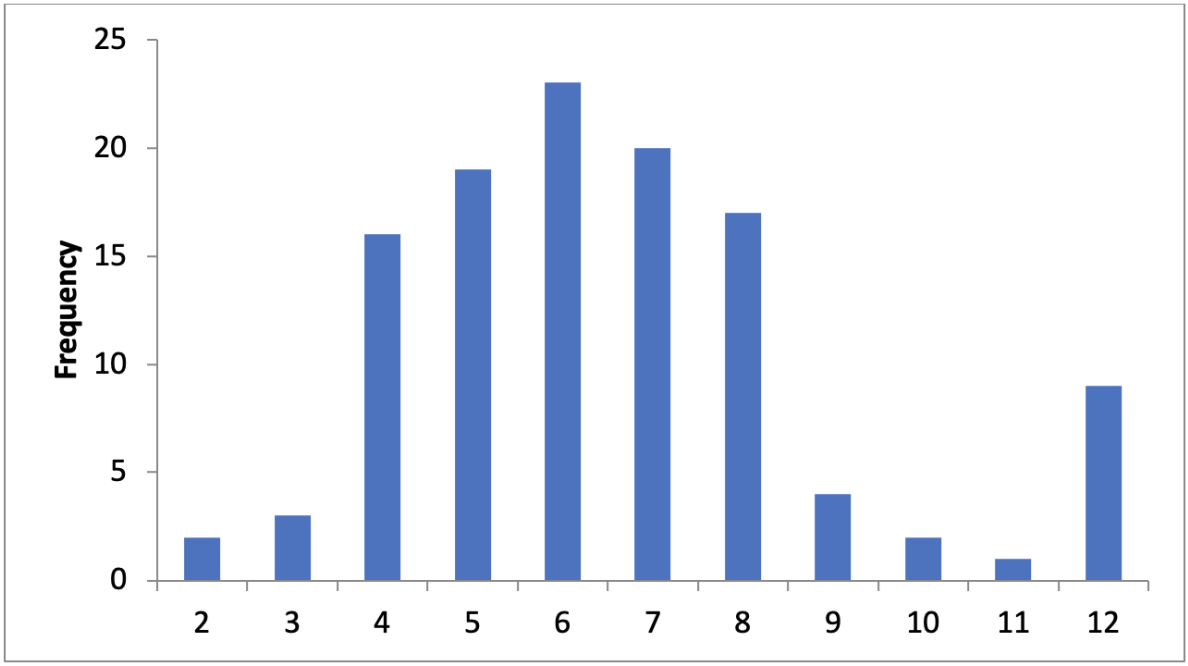

Figure 1. Distribution of scores on the WRAIT

What is the item difficulty of the questions on the WRAIT?

Table 2 provides a list of the questions and their item difficulty (i.e., the proportion of subjects passing that question). It is also illustrated in Figure 2. There is a good spread of difficulty in the items from completely easy items (2 x 3 =? and 2 x 6 =?) to the most difficult item (2 x 6144 =?). The split-half reliability of the results treated as a Guttman scale is artificially high at.913 and even higher at.954 when corrected by the Spearman-Brown formula.

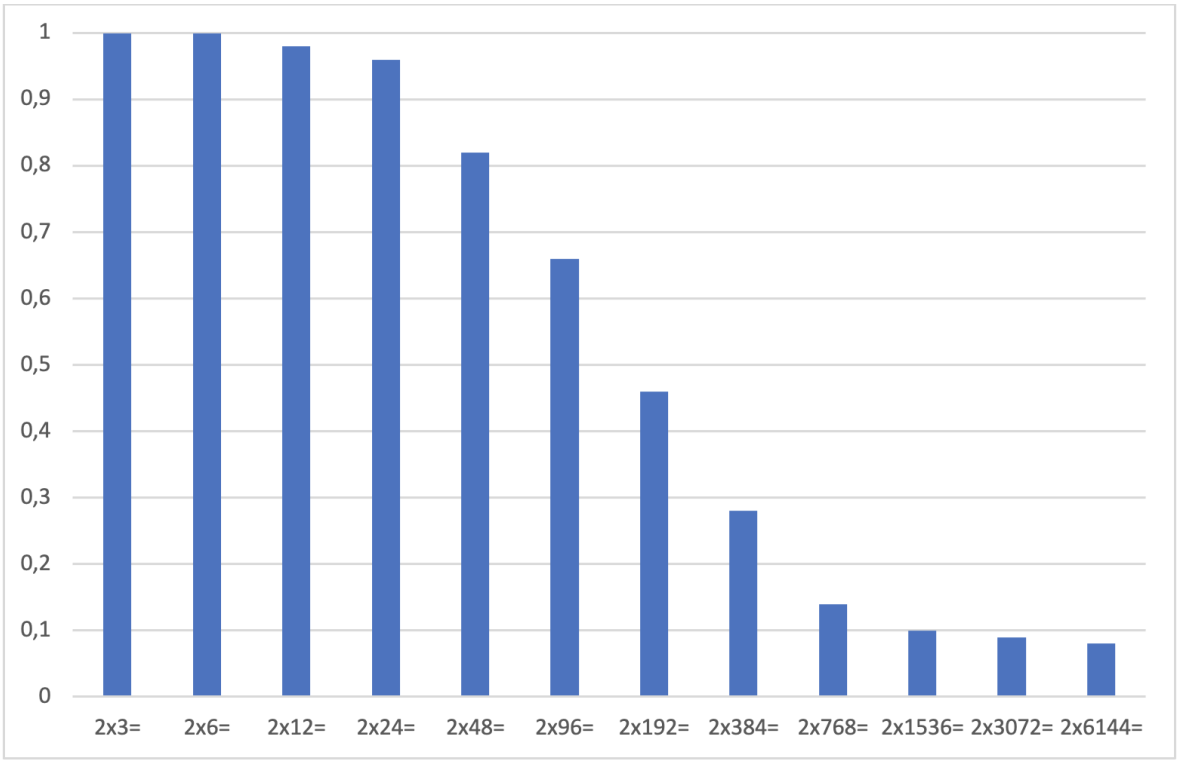

Figure 2. Item difficulties on the WRAIT

Responding on the WRAIT was tested against the dichotomous Rasch model. As expected with Guttman type items, the scale had a person reliability of.853. The item statistics are reported in Table 3. In the second column, the table indicates the proportion passing each item (the item difficulty which is similar to Figure 2). The third column provides the Rasch measure in logits (which range typically from -3 to +3). Clearly items 1 and 2 (2 x 3 =? and 2 6 =?) are far too easy for this adult vocational rehabilitation sample. Equally, the last three items are not answered by the majority of subjects. The standard error of the measure in logits is represented in column 4 of Table 3. Columns 5 and 6 provide the infit and outfit mean squares that indicate how well the data fit the model. The expected range is 0.75 to 1.3. These indicate problems with the very easy and the very difficult items in the WRAIT.

Table 2. Item Statistics for the WRAIT

Item	Proportion Item difficulty	Measure Logits	SE Measure	Infit	Outfit
2x3=	1.0000	-39.564	5.93e+6	1.51e-15	2.59e-21
2x6=	1.0000	-39.564	5.93e+6	1.51e-15	2.59e-21
2x12=	0.9828	-7.140	0.757	0.872	0.120
2x24=	0.9569	-6.004	0.522	0.797	0.182
2x48=	0.8190	-3.494	0.332	0.781	0.361
2x96=	0.6552	-1.716	0.288	0.742	0.432
2x192=	0.4569	0.108	0.280	0.758	0.464
2x384=	0.2845	1.790	0.307	0.753	0.403
2x768=	0.1379	3.767	0.389	0.598	0.222
2x1536=	0.1034	4.426	0.424	0.480	0.135
2x3072=	0.0862	4.805	0.447	0.480	0.110
2x6144=	0.0776	5.010	0.459	0.531	0.111

Note. Infit= Information-weighted mean square statistic; Outfit= Outlier-sensitive means square statistic.

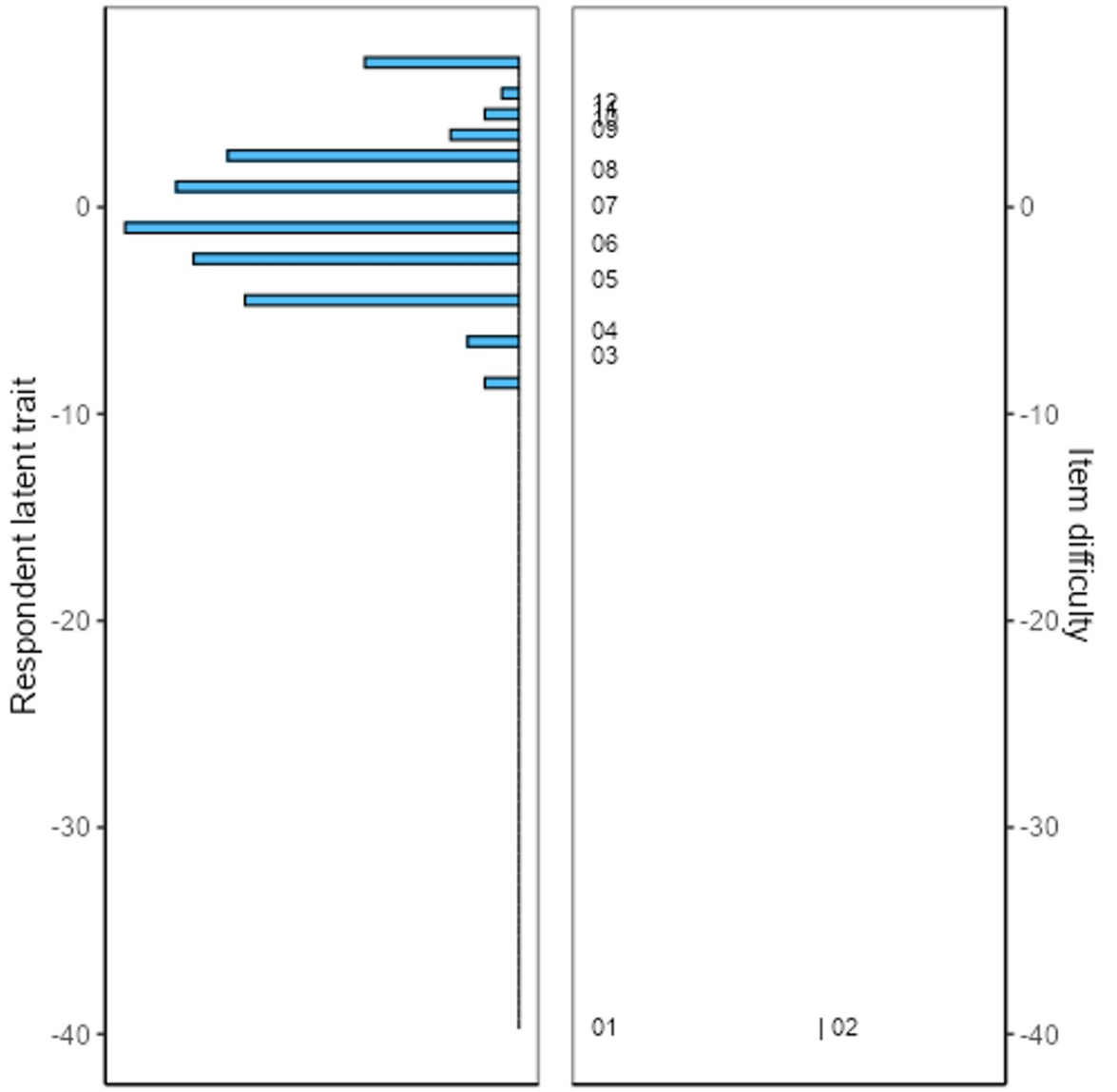

Figure 3. Wright map of persons and items (logit scale)

The results for the group are also displayed in a Wright Map which locates the items and the ability of the group on the same logit scale. As observed earlier, the first two items are well below the ability level of the group. There are also a number of people in the group whose ability is well beyond the stretch of the items.

Does the total score on the Information sub-test correlate with demographic variables, such as age, sex, years of schooling, post-school qualifications or English-speaking background as well as cognitive factors such as reading level, information processing speed, information or memory malingering?

The results indicated a statistically significant difference in the WRAIT score between (a) males and females with a moderate effect size according to Cohen (1988) (see the first section of Table 3). There was no statistically significant difference in WRAIT scores of (b) those with or without a post-school qualification (see the second section of Table 3); or (c) between those of non-English speaking background and those with an English-speaking background although there

was a low effect size (see the third section of Table 3); (d) the number of years of high school completed (see fourth section of Table 3); and (e) when age was divided around the median of 46 years (see fifth section of Table 3).

Table 3. Demographic differences in WRAIT scores

Factor	N	Mean	Statistical test and effect size
Sex			
Males	79	7.00 (2.35)	*t*(114) =-3.11, p=.002
Females	37	5.62(1.92)	Cohen's d=.-62
Post-school qualifications			
Degree-diploma	34	6.79 (2.28)	F(2, 52.8)=1.44, p=.246
Certificate-trade	28	6.97 (3.13)	Cohen's d=.174*
Nil	34	6.19 (1.58)	
Language background			
Non-English	49	6.90 (2.28)	*t*(114) =-1.35, p=.178
English	67	6.31 (2.31)	Cohen's d=-.255
Years in high school			
<9	19	6.53 (2.17)	F(2, 51.5)=.274, p=.761
10-11	45	6.38 (2.23)	Cohen's d=.071*
12	52	6.73 (2.44)	
Age			
Age <46	57	6.28 (2.27)	*t*(114) = 1.29, p=.200
Age 46+	59	6.83 (2.33)	Cohen's d=.-239

*Please note, that d equals the effec59t when comparing the groups with minimum and maximum mean (https://www.psychometrica.de/effect_size.html)

Furthermore, performance was (a) unrelated to scores on a memory malingering task (r=-.094, p=.322). and (b) reading achievement (r=.073, p=.454). WRAIT scores were statistically significantly correlated with (c) general knowledge (i.e.,

information) (r=.378, p<.001) and (d) information processing speed (r=-.321, p<.001).

IV. Conclusions

This study reported the application of the WRAIT as an assessment of complex processing in a vocational rehabilitation sample. It produced results ranging from a low of 2 to a maximum of 12 with a mean of 6.56 in this sample. As expected, the split-half reliability of the results was extremely high because it operated as a Guttman scale.

Of the socio-demographic factors, there was no statistically significant difference due to age, schooling, education or language background. Sex, on the other hand, had a moderate effect on scores with males scoring higher. The mechanism for this observed difference in the WRAIT was not clear but it is consistent with some reports of lower mathematical performance by women compared to men (Vos et al., 2023).

Performance was also compared to other cognitive variables. It was unrelated to scores on a memory malingering task or reading achievement. WRAIT scores were statistically significantly correlated with general knowledge and information processing speed. Respectively, they represent crystallised intelligence and fluid intelligence components. The results from this study suggest a tentative model of the processes involved (see Figure 4) and one which might be the subject of future research.

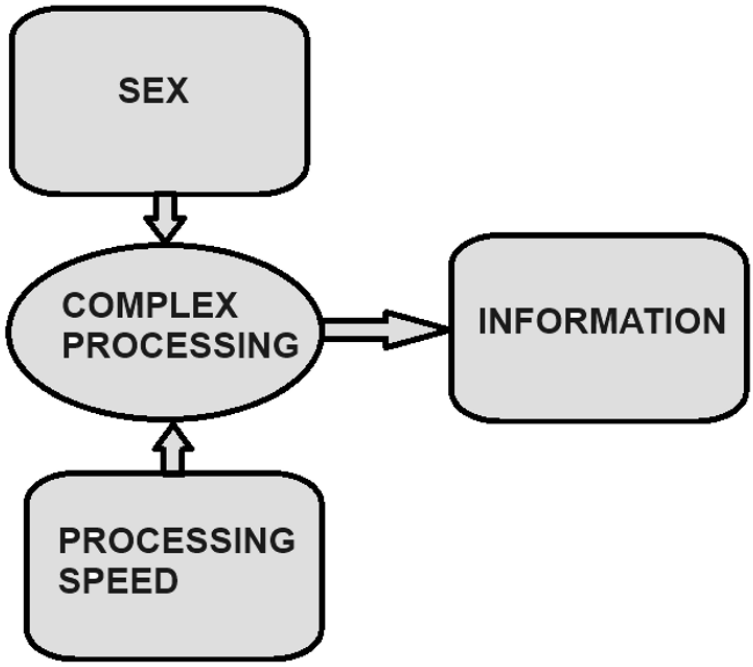

Figure 4. A simple model of the factors associated with complex processing in this study.

The distribution of scores in Figure 1 merits some comment, especially the spike in scores on item 12. It may be due to

the fact that the final calculation (2 x 6144 =?) is actually somewhat easier and does not require carrying forward more than once compared with the sums, 2 x 96 =? or 2 x 768 =?. The first two items are excessively easy for this sample but it is considered that they should be retained as a helpful orientation to the task and also for use with a broader population. The Wright map of persons and items (Figure 3) indicates that the items (other than the first two) are spread evenly across ability levels but it may also suggest that the addition of say two more questions (2 x 12,288 =? and 2 x 24,576 =?) might not go astray in assessing the highest levels.

The issue of whether one should adopt the original criterion of two consecutive failures versus the criterion of a single failure as in this study is important. In all likelihood a return to two consecutive failures would enhance the results for some subjects who through anxiety or other factors might otherwise stumble at an early stage but otherwise be quite competent. Of course, it would reduce the Guttman properties of the WRAIT results but this might be a small price to pay.

Some limitations of this study include the specific nature of the sample. No claim is made that the sample is representative. It reflects a rehabilitation context in which the population of persons have suffered a personal injury (work injury, motor vehicle accident, general injury). The sample, however, was diverse in terms of age and schooling. The dominance of males and the high proportion of those from a non-English speaking background is indicative of the clinical vocational rehabilitation population.

In the absence of formal, full-scale measures, IQ has historically been determined through indicators such as education or reading achievement or vocabulary as a brief indicator of IQ. Vocabulary is a shortcut and has provided the basis for commercially available short forms of intellectual assessment (e.g., *Wechsler Abbreviated Scale of Intelligence*) for many years. A two sub-test form with verbal as well as non-verbal still requires a good 15 minutes whereas the WRAIT can be completed in much shorter time and is useful where a general mental status rather than a comprehensive high-stakes assessment is being undertaken.

In Table 4, I have listed the z-score equivalents for each score converted them to a Wechsler IQ and also a Wechsler sub-test scales score with a means of 10 and standard deviation of 3. The results from this group can be compared with the framework provided in Table 1 (Carlat, 2017) and also to Wilson's (1967) analysis of "300 consecutive referrals for intelligence testing by the psychiatric staff at Broughton Hospital" (p. 1290). Wilson, for instance, classified scores of 3 or less as suggestive of intellectual deficit, scores of 4-5 as dull normal, scores of 6-10 within the normal range and scores of 11-12 as superior intelligence. It appears that for some reason the ability level of the rehabilitation subjects in this study varied from Wilson (1967) and Carlat (2017). Possibly the addition of two items may provide a higher ceiling for scores and alleviate the concentration of groups.

Table 4. Z-score, WAIS IQ and WAIS scale score equivalents

Item	Score	Z-score	WAIS IQ*	Wechsler Scale Score*
2x3=	1	-1.13	83	7
2x6=	2	-.93	86	7
2x12=	3	-.72	89	8
2x24=	4	-.52	92	8
2x48=	5	-.31	95	9
2x96=	6	-.11	98	10
2x192=	7	.08	101	10
2x384=	8	.29	104	11
2x768=	9	.49	107	12
2x1536=	10	.70	111	12
2x3072=	11	.90	114	13
2x6144=	12	1.11	117	13

*rounded

The general observation is that the WRAIT has psychometric validity and clinical utility in combination with other measures. When combined with the Information sub-test of the *Naylor-Harwood Adult Intelligence Scale* (see Athanasou, 2024) and the *Basic Information Parameter* (see Athanasou, 2023) as an indicator of processing speed, it provides a useful clinical overview of the cognitive functioning of a person in a brief and economical manner. Incorporating complex processing through the WRAIT with information processing speed offers a valuable insight into fluid intellectual processes.

Statements and Declaration

Funding: None.

Declaration of competing interest: There is no competing interest and the author has no financial disclosure.

Ethics: This research was conducted in accordance with the Privacy Act 1988 and the Australian Code for the Responsible Conduct of Research (2018).

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