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Investigating the structure and invariance of the *Wechsler Adult Intelligence Scales*, *Fourth Edition* in a sample of adults with intellectual disabilities☆

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ABSTRACT

Recent research has questioned whether the Wechsler Adult Intelligence Scales (WAIS) measure the same constructs for adults with intellectual disabilities as they do for the general population (MacLean et al., 2011). Using the special validity sample of the WAIS-IV (Wechsler, 2008b), the structure of the WAIS-IV was investigated using confirmatory factor analysis and tested for measurement invariance across a sample with intellectual disabilities and a control group matched in demographic characteristics. The instrument demonstrated strong factorial invariance when the standard subtests were used. When the standard and supplemental subtests were included in the model, the WAIS-IV four-factor structure provided a model of measurement for the Subtest Scores in the intellectual disability group, but the Perceptual Reasoning factor demonstrated differentiation into Fluid Reasoning and Visual-Spatial factors in the matched control group. In general, the research findings suggest that the four-factor structure of the WAIS-IV is invariant across the intellectual disability and matched control groups.

1. Introduction

The Wechsler Adult Intelligence Scales (WAIS; Wechsler, 1939, 1955, 1997, 2008a) have a long history of being the most commonly used instruments to assess adult intelligence. One important function of adult intelligence assessment is to accurately diagnose intellectual disabilities (ID; American Association on Intellectual and Developmental Disabilities, 2010; American Psychiatric Association, 2000). The ability of a clinician to accurately diagnosis ID, however, is proportional to the instrument's construct validity. With the introduction of the popular WAIS-IV (Wechsler, 2008a), questions remain regarding the use of the four-factor structure of the WAIS-IV for those with intellectual impairments. The current study addressed those questions.

The previous version of the WAIS, the WAIS-III (Wechsler, 1997), has a strong history of excellent psychometric properties (e.g., Kaufman, Lichtenberger, & McLean, 2001; Sattler & Ryan, 1999). Investigational findings of the WAIS-III factor structure generally supported a hierarchical model with a second-order *g* factor, and four first-order factors, Working Memory, Perceptual Organization, Processing Speed, and Verbal Comprehension (Arnau & Thompson, 2000; Ryan & Paolo,

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2001; Taub, McGrew, & Witta, 2004; Wechsler, 1997). Although those studies supported the WAIS-III structure in both typically developed and mixed patient samples, that same structure was not suitable among adults with intellectual disabilities (Jones, Van Schaik, & Witts, 2006; MacLean, McKenzie, Kidd, Murray, & Schwannauer, 2011).

In the transition from the WAIS-III to the WAIS-IV, the hierarchical four-factor structure has not substantially transformed, despite the addition of new subtests, modifications to subtest items, and changes to subtests included in the composite scores (see Wechsler, 2008b). The Perceptual Organization Index, however, is now referred to as a Perceptual Reasoning Index (PRI) because of a greater emphasis on Fluid Reasoning.

The number of first-order factors reported in WAIS-IV studies has varied, but to some extent the variation depends on the type of analysis used or, more subjectively, researchers' interpretations of intelligence or, in exploratory factor analysis, the choice of factor extraction criteria. For example, exploratory factor analyses (EFA) did not replicate the four-factor model. Using scores from young adults ages 16–19 (Canivez & Watkins, 2010a) and from young adults and adults ages 16–90 (Canivez & Watkins, 2010b) in the Wechsler norming sample, researchers showed that different extraction criteria (i.e., eigenvalue > 1, scree test, standard error of the scree, Horn's parallel analysis, and minimum average partial) suggested one to two factors when 10 subtests were factor analyzed and one to four factors when 15 subtests (only ages 16–69 were used with 15 subtests) were factor analyzed. When the Schmid-Leiman procedure was applied in those two studies the subtests were properly aligned with the four theoretical first-order factors. Nevertheless, the researchers suggested that interpretation of the WAIS-IV should be limited to measuring general intelligence because, amongst other reasons, the general factor accounted for the greatest proportion of common variance among subtests.

Confirmatory factor analyses (CFA) of WAIS-IV scores have demonstrated that the number of first-order factors is similar either to the WAIS-IV factor structure or to an alternative five-factor structure with the Perceptual Reasoning factor split into Fluid Reasoning (Gf) and Visual Spatial Ability (Gv) factors, and one subtest, Arithmetic, migrating to the Fluid Reasoning factor (cf. Benson, Hulac, & Kranzler, 2010; Niileksela, Reynolds, & Kaufman, 2013; Ward, Bergman, & Herbert, 2012; Wechsler, 2008b; Weiss, Keith, Zhu, & Chen, 2013). The four- and five-factor interpretations were plausible from an empirical standpoint (Lichtenberger & Kaufman, 2013), with the latter being based on Cattell-Horn-Carroll (CHC) taxonomy of human cognitive abilities (Carroll, 1993; Horn & Cattell, 1966; Schneider & McGrew, 2012). Therefore, similar to WAIS-III research, the multiple-factor structure of the WAIS-IV has been generally supported. Nevertheless, it is because of these similarities in factor structures across the WAIS-III and IV instruments that some of the same problems existing with the WAIS-III factor structure for those with intellectual disabilities may remain in the revision.

1.1. WAIS and adult intellectual disability assessment

One concern with the WAIS-III was that the factor structure did not generalize to populations of adults with intellectual disabilities. Using EFA, Jones and colleagues (2006) found only Verbal and Performance factors within the WAIS-III, as opposed to the suggested four factors. They concluded that the WAIS-III factor structure in the ID population ($IQ < 75$) differed substantially from the structure found in the standardization sample. MacLean et al. (2011) performed CFA using WAIS-III subtests in an independent sample composed of 264 individuals with mild intellectual impairment ($55 < IQ < 69$) and 140 individuals with moderate to severe intellectual impairment ($IQ < 55$). The WAIS-III four-factor structure fit poorly in both samples. The researchers interpreted those findings as indications of the WAIS-III lacking measurement invariance for those with intellectual impairment.

MacLean et al. (2011) cited several possible reasons for differences in the factor structure for the WAIS-III across populations. One potential reason was attributed to Spearman's law of diminishing returns (Spearman, 1927), or the empirical observation that intelligence test scores correlate more strongly at the lower end of the ability continuum (Detterman & Daniel, 1989). Such a phenomenon suggests that if correlations are analyzed, either fewer factors or factors with stronger correlations should emerge. Although this occurrence would not necessarily influence the fit of the four-factor structure in a CFA, it may be related to the emergence of fewer factors in an EFA (Jones et al., 2006). In contrast, MacLean et al. noted the opposite concern, speculating that selecting scores from a restricted range based on a FSIQ (e.g., <70) may reduce the correlations among the subtests, with some correlations possibly being spuriously negative. Given the general assumption that test scores correlate positively with one another, an abundance of negative or zero subtest correlations is certainly a valid concern. MacLean et al. also suggested that floor effects could potentially explain the misfit of the WAIS-III factor structure. Such floor effects also present concerns in practical settings due to the likelihood that intellectual ability may be over-estimated at lower ranges, and thus making it difficult for clinicians to discriminate IQs at the very low range of IQ. Others have also suggested that floor effects in general may alter the understanding and assessment of cognitive processing of those with intellectual impairments (Whitaker, 2010).

A final trepidation about using the WAIS-IV for those who have intellectual impairments is their lack of representation in both the standardization and sampling procedures (e.g., Suen & Greenspan, 2009). Researchers have interpreted the small sample size of individuals with ID in the Wechsler scales' standardization samples as evidence of a probable discrepancy between the indexes used on the WAIS and the cognitive factors in those with ID (MacLean et al., 2011). Whitaker (2010) suggested that the psychometric properties of the WAIS are population-specific, and that low IQ samples are not as validly tested using this factor structure. A lack of representation of a subpopulation in a standardization sample, however, does not