Factor Structure of the WAIS-R by Educational Level: An Examination of Elderly Persons

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A factor analysis of the WAIS-R by educational level for persons 75 years and older was conducted. Two- and three-factor solutions were generated for persons with 0 to 11 years of education and for high school graduates. A two-factor solution composed of verbal and perceptual-organization factors best explained the WAIS-R scores for subjects with 11 or fewer years of education. However, a three-factor solution emerged for persons with 12 or more years of schooling and consisted of the verbal comprehension, perceptual-organization, and freedom from distractibility factors. Clinicians must be aware of the potentially different factor structures generated by educational level to provide the most accurate interpretation of WAIS-R scores for elderly persons.

Numerous factor analytical studies of the Wechsler Adult Intelligence Scale-Revised (WAIS-R; Wechsler, 1981) have been conducted (for reviews see Kaufman, 1990; Leckliter, Matarazzo, & Silverstein, 1986). With minor variability, when a two-factor solution is found, the first usually reflects verbal abilities and is primarily composed of Information, Comprehension, Vocabulary, and Similarities. The second factor assesses perceptual-organization abilities and usually consists of Picture Completion, Block Design, and Object Assembly. When a third factor emerges, it most often consists of Digit Span and...
Arithmetic, and is described as a measure of attention-concentration. In general, similar two- and three-factor solutions have been reported for persons in the age range 16 to 96 years (Glass, 1982; Gutkin, Reynolds, & Galvin, 1984; Parker, 1983; Ryan, Paolo, & Brungardt, 1990; Ryan, Rosenberg, & DeWolfe, 1984; Smith et al., 1992; Waller & Waldman, 1990) and for groups according to gender and race (Glass, 1982; Kaufman, McLean, & Reynolds, 1991).

Factor solutions that address important demographic characteristics often provide interpretive hypotheses that may have relevance for individual clients. The most potent demographic characteristic on WAIS-R performance is the variable of education. Years of schooling relates significantly to WAIS-R IQs (Matarazzo & Herman, 1984; Ryan, Paolo, Dunn, & Van Fleet, in press), intersubtest scatter (Ryan & Paolo, 1992a), Verbal-Performance IQ discrepancies (Matarazzo & Herman, 1984; Ryan & Paolo, 1992b), and the occurrence of specific test profiles such as the Fuld pattern (Ryan, Paolo, Oehlert, & Coker, 1991). In addition, overall ability level influences the WAIS-R factor structure for persons 16 to 74 years of age. Prifitera and Bornstein (1988) analyzed the WAIS-R standardization sample by level of Full Scale IQ and found that a two-factor solution best explained the test scores of persons at the lower end of the ability spectrum (i.e., FSIQ ≤ 84). Conversely, a three factor solution was the most parsimonious for persons with higher levels of ability (i.e., FSIQ ≥ 85).

To make accurate test interpretations, clinicians must have a thorough understanding of the WAIS-R factor structure according to relevant demographic variables. The present investigation is intended to assist practitioners by reporting the results of a factor analysis of the WAIS-R by educational level for persons 75 years and older.

**METHOD**

**Subjects**

Two hundred and twenty-five normal, healthy individuals 75 to 96 years of age served as subjects. All resided in the midwestern portion of the United States (Kansas, Missouri, Iowa, and Indiana) and were recruited from senior citizen organizations, retirement communities, newspaper advertisements, and by word of mouth. Means for age and education were 80.69 years (SD = 5.00 years) and 10.89 years (SD = 2.92 years), respectively. There were 129 White females, 65 White males, 21 Black females, and 10 Black males.

**Procedure**

All subjects were screened with a medical history questionnaire, a medication review, and the Geriatric Depression Scale (Yesavage et al., 1983) prior to
inclusion in the study. All volunteers were considered free from neurological disease or damage, major systemic illness, and/or significant depression. After screening, each subject was scheduled for an interview and WAIS-R administration conducted by one of four qualified examiners.

Subjects were divided into two groups, 0 to 11 years of education (n = 106) and 12 or more years of schooling (n = 119). The means for age and education for persons with less than 12 years of schooling were 81.52 years (SD = 5.51) and 8.41 years (SD = 1.51), respectively. This group consisted of 36 males and 70 females, and racial composition consisted of 84 Whites and 22 Blacks. Subjects with a high school diploma averaged 79.96 years of age (SD = 4.38) and 13.10 years of schooling (SD = 1.91). There were 39 males and 80 females, and 110 Whites, and 9 Blacks.

For both groups, separate principal components analyses were conducted (1’s in the diagonals) to determine objectively the number of factors to retain using the criteria of eigenvalues greater than one. Next, for each group, principal factor analyses were conducted (R-squared values in the diagonals), followed by varimax rotation with iterations of two and three factors. Each rotated factor was composed of subtests with loadings > .50. The latter criterion was arbitrary, but consistent with our previous research (Ryan, Paolo, & Brungardt, 1990).

The degree of similarity between orthogonal factors for the two education groups was assessed with the coefficient of congruence. Because this index is inflated when most or all of the factor loadings have the same algebraic sign (Levine, 1977), a value of .90 or more was considered the minimum degree of association required to define factor equivalence (Harman, 1967).

RESULTS AND DISCUSSION

Applying the eigenvalue greater than one criteria revealed that two factors best explained the WAIS-R scores for subjects with 11 or fewer years of education, while three factors emerged for persons with 12 or more years of schooling. Tables 1 and 2 provide the two- and three-factor solutions for each group. Also given are percent of variance and eigenvalues associated with each unrotated and rotated factor.

Table 1 indicates, for persons with 0 to 11 years of schooling that Factor I (Verbal Comprehension; VC) consists of all six Verbal subtests, while for persons with 12 or more years of education it is made up of four verbal subtests. Factor II (Perceptual-Organization; PO) is composed of four Performance subtests among persons without a high school diploma. For those with higher levels of education, PO consists of four Performance subtests as well as the Arithmetic subtest. The coefficients of congruence for Factors I and II were .98 and .96, respectively. These coefficients suggest a high degree of similarity for both VC and PO between the education groups.
### TABLE 1
Factor Loadings, Percent of Variance, and Eigenvalues of Two Factor Solutions by Level of Education

<table>
<thead>
<tr>
<th>Subtest</th>
<th>Level 0 to 11</th>
<th>Level 12+</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>Information</td>
<td>80(^a)</td>
<td>15</td>
</tr>
<tr>
<td>Digit Span</td>
<td>56(^a)</td>
<td>22</td>
</tr>
<tr>
<td>Vocabulary</td>
<td>87(^a)</td>
<td>29</td>
</tr>
<tr>
<td>Arithmetic</td>
<td>57(^a)</td>
<td>41</td>
</tr>
<tr>
<td>Comprehension</td>
<td>75(^a)</td>
<td>22</td>
</tr>
<tr>
<td>Similarities</td>
<td>73(^a)</td>
<td>32</td>
</tr>
<tr>
<td>Picture Completion</td>
<td>40</td>
<td>59(^a)</td>
</tr>
<tr>
<td>Picture Arrangement</td>
<td>38</td>
<td>38</td>
</tr>
<tr>
<td>Block Design</td>
<td>44</td>
<td>68(^a)</td>
</tr>
<tr>
<td>Object Assembly</td>
<td>13</td>
<td>75(^a)</td>
</tr>
<tr>
<td>Digit Symbol</td>
<td>18</td>
<td>78(^a)</td>
</tr>
<tr>
<td>Percent of Variance</td>
<td>33.4%</td>
<td>23.6%</td>
</tr>
<tr>
<td>Eigenvalues:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unrotated</td>
<td>5.67</td>
<td>1.41</td>
</tr>
<tr>
<td>Rotated</td>
<td>5.26</td>
<td>1.03</td>
</tr>
</tbody>
</table>

Note. Decimals points for factor loadings have been omitted.
\(^a\)Factor loadings of .50 or greater

Table 2 provides the three-factor solutions and reveals that VC is identical to that extracted for the two-factor solution. That is, Factor I is comprised of all Verbal subtests for persons with 11 or fewer years of schooling, while Information, Vocabulary, Comprehension, and Similarities make up VC for individuals with 12 or more years of education. A high degree of similarity between the groups on this factor is reflected by a coefficient of congruence of .96.

Factor II is comprised of Object Assembly and Digit Symbol for persons with 0 to 11 years of schooling; Object Assembly, Block Design, and Digit Symbol constitute this factor for high school graduates. This factor could generally be considered as reflecting perceptual-organization abilities along with psychomotor speed and is highly similar across the groups (i.e., coefficient of congruence = .92).

Factor III consists of Picture Completion, Picture Arrangement, and Block Design for persons with 11 or fewer years of education, but is composed of Digit Span and Arithmetic for persons with 12 or more years of schooling. The third factor clearly reflects freedom from distractibility for high school graduates, but it is unclear what it measures among those with 0 to 11 years of schooling. The coefficient of congruence is .78, which reveals a low degree of similarity between the two education groups.
A two-factor solution could adequately account for the majority of WAIS-R subtests at both educational levels. In fact, parallel analysis criteria (Lautenschlager, 1989; Silverstein, 1990) suggests that only two factors should be extracted for both groups. Clinicians who prefer the two-factor solution for persons 75 years and older need to be aware that Digit Span and Arithmetic appear to measure verbal abilities among individuals with 11 years or less education, but for high school graduates Arithmetic seems to be more a measure of perceptual-organization skills. Digit Span does not lend itself to unambiguous interpretation because it loads equally on the verbal and perceptual-organization factors.

Considering persons with 0 to 11 years of schooling, it is clear that a three-factor solution cannot, in a clinically meaningful way, account for all WAIS-R subtests. However, a three-factor solution makes good clinical sense for persons with 12 or more years of schooling. Regardless of whether a two- or three-factor solution is selected, the pattern of subtest loadings changes enough that clinicians need to be aware of the potential influence of educational level.

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REFERENCES


