AN EVALUATION OF VARIOUS WAIS-R FACTOR STRUCTURES IN A PSYCHIATRIC SAMPLE

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This report examines the factor structure of the Wechsler Adult Intelligence Scale-Revised (WAIS-R) in a sample of 229 psychiatric patients from two community mental health centers (ages 16 to 85). One-, two-, and three-factor solutions were evaluated. The robustness of an overall intelligence dimension was supported. The two-factor solution proved more informative and showed both that the Verbal and Performance domains are highly correlated and the presence of a second-order factor that may represent a kind of intellectual orientation or style. The three-factor solution provided the least compelling results and was not seen as a viable representation of the WAIS-R factor structure.

A continuing controversy in the area of intelligence testing concerns the factor structure of the Wechsler Adult Intelligence Scale-Revised (WAIS-R). Since its introduction (Wechsler, 1980), a number of studies have been performed that have used a variety of statistical techniques (e.g., Fraboni, Salstone, & Cooper, 1989; O'Grady, 1983; Parker, 1983), but without reaching any clear consensus. Some studies suggest that there exists only one real underlying dimension that reflects general ability (O'Grady, 1983; Silverstein, 1982); others find two dimensions that correspond to the Verbal and Performance subscales (Blaha & Wallbrown, 1982; Ryan, Rosenberg, & DeWolfe, 1984); still others maintain that there are three robust factors that reflect Verbal Comprehension, Perceptual

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Organization, and Memory (Beck, Horwitz, Seidenberg, Parker, & Frank, 1985; Waller & Waldman, 1990).

From a theoretical perspective, both the one- and two-factor interpretations are consistent with extant theories of intellectual ability. The one-factor perspective treats intelligence as representing one general ability factor, or "g," which subsumes other related group and specific factors (Blaha & Wallbrown, 1982). This orientation is also consistent with Wechsler's aim of assessing general intelligence. Those who advocate a two-factor model argue that the Verbal and Performance subscales reflect primary intellective abilities with any general dimension a second-order factor (Atkinson & Cyr, 1984; Ryan et al., 1984). Both of these theoretical orientations are consistent with the organization of the WAIS-R itself. The WAIS-R provides a measure of overall functioning as well as more specific verbal and performance indices. How one chooses to emphasize the intelligence quotients (IQs) may be a matter of preference at this point, but in either case these IQs directly represent intellectual capabilities. However, such is not the case for the three-factor approach, which postulates the presence of a nonintellective dimension.

Initially proposed by Cohen (1952, 1957), the three-factor model includes the "major" dimension of "Freedom from Distraction" or "Memory," and it has become the preferred factor solution for clinical usage (Hill, Reddon, & Jackson, 1985). Although the Memory factor has been embraced widely because of its clinical relevance, this dimension is not something one would expect to find a priori in the WAIS given the present scales. Cohen (1952) defined the factor as representing the ability to attend or concentrate and as defined by the Arithmetic and Digit Span scales.[1] Given the departure of this orientation from the model on which the WAIS-R was based (i.e., as a measure of intellectual abilities), it seems necessary to demonstrate whether the third factor represents a general dimension of the WAIS-R itself or a more specific subject variable. Further, given that Cohen's initial work was conducted nearly 40 years ago on an earlier version of the WAIS-R, the need does exist to demonstrate empirically the continued relevance of the model.

That the Memory factor is defined by only two subscales is strong evidence that it represents a limited construct, one that probably relies on the unique variance of these constituent scales. In fact, the term "memory" suggests more a specific, functional capacity (i.e., the extent to which information can be retained and recalled) than an intellective ability (i.e., the ability to organize information in new ways). Further, that both Arithmetic and Digit Span involve a memory for numbers also suggests that this dimension may even be a method factor. Or, conversely, the numeric basis to these tasks may provoke a particular reaction in some respondents (e.g., anxiety), and, therefore, scores reflect a subject variable.

Both of these alternatives place the construct in a more circumspect position: Scores on the Memory dimension may reflect an individual's particular affective state during the test or facility in handling numbers. Fortunately, whether or not the Memory factor represents a general performance dimension can be evaluated empirically. If Cohen's (1952) initial interpretation of this factor is correct, a number of expectations that relate this dimension to other variables can be formulated. Two such hypotheses will be tested in this study.

First, an ability to concentrate reflects a capacity to become involved in the performance of a task: To attend to the relevant stimuli and processes necessary to complete the task. Problems with concentration can manifest themselves as delays in task completion. For the three subscales on which performance time directly influences one's score (Picture Arrangement, Block Design, and Object Assembly), it is reasonable to

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[1]Although not originally identified by Cohen, later clinical usage of this dimension has come to include scores on Digit Symbol as well.

hypothesize that longer performance times on these scales should be associated with lower scores on the Memory dimension. Second, Cohen (1952) has noted that within a psychiatric sample two sources contribute to the variance of scores on this dimension: Anxiety and disturbances in reality testing. Whereas schizophrenics usually are characterized by both variables, they should have significantly lower Memory scores than other nosological groups (e.g., affective or anxiety disorders). A failure to confirm these hypotheses would lobby for a re-examination of the initial conceptualization of this construct.

This study attempted to extend the current knowledge base in two ways. First, previous research in this area typically has focused on specific factor models (e.g., Parker, 1983; Silverstein, 1982). The lack of multi-model comparisons within many studies forces inter-model evaluations to be done over multiple studies, statistical techniques, and populations. This study simultaneously evaluated the statistical merits of several different factor models. Second, given that Cohen's initial work involved the original Wechsler-Bellevue scales, it is entirely possible that his formulations are no longer appropriate for the currently available, third-generation form of this instrument—the WAIS-R. The psychiatric sample included in this study provides an ideal opportunity to conduct an exact replication of Cohen's study with this new measure. It is entirely possible that the revisions made to the Wechsler scales have modified the clinical efficacy of the Memory factor. Further, this study evaluated the degree to which this Memory factor operates in a way consistent with its original theoretical formulations. Demonstrating such a correspondence would go far toward supporting the continued validity of this particular model.

Method

Subjects

Subjects were 229 psychiatric patients (146 men, 83 women) who were receiving either in- or outpatient care from the Massachusetts Mental Health Center or the Boston University Medical Center. The average age at the time of testing was 32.7 years (SD = 12.1; low = 16, high = 85). Included were 144 Caucasians, 8 Hispanics, 2 Asians, 62 Blacks, and 13 persons with unknown ethnic background. Sixty percent were unemployed, 22.7% were involved in manual, clerical, or technical pursuits, 6% had white-collar positions, 8% were students, 3% were housewives, and the occupations of the remaining percentage were unknown. Overall performance was in the low-average range: Mean Verbal IQ was 93.6 (SD = 17.6), mean Performance IQ was 86.4 (SD = 15.1), and mean Full Scale IQ was 89.6 (SD = 16.3). Diagnoses of these subjects represented a wide range of psychopathology including organic disorders (n = 10), schizophrenia (n = 82), affective disorders (n = 46), psychoses (n = 20), anxiety syndromes (n = 5), adjustment disorders (n = 13), and personality disorders (n = 49). The diagnostic process has been documented elsewhere (Piedmont, Sokolove, & Fleming, 1989).

Although these subjects may not be representative of all psychiatric patients, the fact that they include all subjects who received the WAIS-R at these two centers over a 6-year period makes it likely that they are representative of the kinds of individuals seen at urban, community-based psychiatric centers.

Procedure

In all the factor analyses performed in this study, an oblique rotation (SPSS-X oblimin) was used. Although varimax rotations have been the preferred method (Hill et al., 1985), there are both theoretical and technical reasons that argue against such an approach. First, there is no reason to assume that intellectual abilities represent distinct, independent clusters. To our knowledge, there is no theory that suggests that one set of intellectual abilities is separate and distinct from any other set of abilities. Second, whereas factor rotations are used to approximate simple structure in the data (which enhances factor interpretability), an examination of the results of analyses that use varimax rotations usually shows considerable nonzero loadings of the subscales (e.g., above .2) on the nondominant factors (e.g., Atkinson & Cyr, 1984; Beck et al., 1985; Ryan et al., 1984). Such cross-factor loadings indicate a failure to attain such simple structure (hence factor interpretability becomes impaired) and that the factors may indeed be correlated. There is evidence that oblique solutions do provide better fits to WAIS-R data (e.g., O'Grady, 1983).[2] Further, an oblique rotation permits the derivation of possible higher-order factors. Finally, in his original study Cohen (1952) himself used an oblique rotation, and, therefore, it is proper that any replications of this study do the same.

The analyses performed herein used the SPSS-X FACTOR procedure. Consistent with previous research, factors were extracted by means of a principal components analysis with unities on the diagonal and rotated via the oblimin option. Given the high reliabilities of the WAIS-R scales and the amount of shared variance, it is highly unlikely that these procedures introduced more stability into the analyses than what actually exists in the data.[3] Given the relatively small size of this sample, all analyses were done collapsing over age. Because age may influence WAIS-R performance, this variable was partialled out from the subscale correlation matrix prior to factoring. Scales scores for the subscales served as the elements for all factor analyses.

Results

Factor Structure

Table 1 presents the results of the factor analyses for the one-, two-, and three-factor solutions. As can be seen, the first unrotated factor clearly represents general intelligence, and all subscales load significantly (i.e., $> .60$) on it. This factor is quite similar to those obtained in previous studies. Congruence coefficients (Everett, 1983) for this factor were found to be greater than .99 with the one-factor solutions presented by Atkinson and Cyr (1984), Blaha and Wallbrown (1982), and Parker (1983). The former included psychiatric patients, while the latter two used the original standardization sample. Clearly, there is a general intellective factor represented in WAIS-R performance that is quite robust and generalized over several samples.

An examination of the eigenvalues and scree plot indicates two large factors that account for 71% of the total variance. When obliquely rotated, a very clear factor structure emerges: Verbal and Performance subscales, respectively, constitute their own factors and support the usage of separate verbal and performance IQs. The two factors are

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[2]In an attempt to demonstrate both the similarity of this data set to previous research and the greater clarity afforded by an oblique rotation, two- and three-factor varimax solutions also were performed. In all but one case, congruence coefficients that ranged from .94 to .99 were found with comparable solutions presented by Atkinson and Cyr (1984), Beck et al. (1985), and Ryan et al. (1984). The one exception concerned factor 3 (the Memory dimension), which related only .82 with the same factor presented by Atkinson and Cyr. This may indicate either a degree of unreliability for this dimension or a lower interpretive efficacy inherent to the varimax approach using this type of data. An examination of the factor loadings showed factor 1 to represent Verbal ability in both the two- and three-factor solutions. Loadings for the Performance subscales on this factor ranged from .17 to .42 (M = .29). Factor 2 represented Performance ability, with loadings of the Verbal subscales that ranged from .23 to .36 (M = .29). Finally, on factor 3, the Memory Factor, loadings for Digit Span and Arithmetic showed the highest values, while the weights for the other scales ranged from .11 to .46 (M = .26). These findings show a clear failure to obtain simple structure when a varimax rotation is used.

[3]Principal axis factor analyses also were performed, and the results were in substantial agreement with the ones presented here. Factor coefficients were very similar, and the pattern of findings was identical. In the two-factor case, 65% of the common variance was explained and 68% in the three-factor case.

Table 1
Two- and Three-factor Solutions Using an Oblique Rotation

Scale	Communality	First unrotated factor	Factor 1	Factor 2	Factor 1	Factor 2	Factor 3
Information	.77	.84	.91	−.02	.71	.01	.28
Digit Span	.50	.73	.75	.02	.10	.11	.80
Vocabulary	.87	.86	.98	−.08	.85	−.05	.20
Arithmetic	.63	.80	.79	.07	.37	.12	.54
Comprehension	.66	.81	.80	.06	.93	.05	−.12
Similarities	.66	.81	.81	.06	.84	.06	.00
Picture Completion	.58	.73	.05	.79	.12	.76	−.03
Picture Arrangement	.59	.74	.10	.75	.03	.75	.12
Block Design	.70	.81	.22	.69	−.03	.71	.34
Object Assembly	.68	.69	−.18	.99	−.09	.96	−.07
Digit Symbol	.45	.70	.26	.53	.38	.50	−.11
Percent total variance			60.5	10.0	60.5	10.0	5.5
Eigenvalues			6.7	1.1	6.7	1.1	.60

Note.—Age at testing has been partialled out.

quite related, $r = .66$, which suggests that orthogonal rotations are not an appropriate method for analyzing this kind of data.

The high correlation between the two factors also implies the existence of a higher-order factor. Extracting a second-order factor from these data could help provide a better perspective on the structure of the WAIS-R. Therefore, factor scores were calculated for subjects on each factor using the FACTOR procedure's regression option, and these values then were factor analyzed by the principal components extraction method. One dimension emerged with an eigenvalue greater than 1 and accounted for 83% of the variance. Factor 1 (which represents the Verbal subscales) correlated .91 with this dimension, while factor 2 (which represents the Performance subscales) correlated −.91. Although it is not surprising that one factor emerges from this analysis, it is interesting to note that the Verbal and Performance factors, positively correlated in the original analysis, become contrasted in this larger dimension. As recommended by Gorsuch (1983), this second-order factor was correlated to the original subscales for interpretive purposes; the results are presented in Table 2. As can be seen, all subscales with the exception of Digit Symbol correlate significantly with the dimension. The positive pole of this factor is defined by the Verbal subscales, while the other pole correlates with the Performance subscales. In addition to reflecting distinct intellectual capacities, the Verbal and Performance IQs can also be combined to represent a type of intellectual orientation (e.g., abstract reasoning vs. visual-spatial relations or verbal vs. nonverbal preferences). Finally, although not indicated by the eigenvalues or scree test, a three-factor solution was performed. This third factor accounted for only 5.5% of the total variance. As can be seen in Table 1, this factor represents the Memory dimension outlined by Cohen (1957). Although a Memory factor can be recovered from the data, the small variance associated with it argues against it being a general performance dimension.

Factor scores were calculated for subjects on each of these dimensions in a similar manner as above, and these three oblique factors were themselves subjected to a principal components factor analysis. Two higher-order dimensions emerged. The first contrasted

Table 2
Correlation between Second-order Factor and WAIS-R Verbal and Performance Subscales

Verbal subscales		Performance subscales	
Information	.39*	Picture Completion	−.30*
Digit Span	.30*	Picture Arrangement	−.27*
Vocabulary	.43*	Block Design	−.20*
Arithmetic	.30*	Object Assembly	−.49*
Comprehension	.30*	Digit Symbol	−.11
Similarities	.31*		

*$p < .005$, two-tailed.

the initial Verbal (pattern loading: −.76) and Performance (pattern loading: .95) factors and mirrors the higher-order factor found in the previous analysis. The Memory factor did not load on this higher-order dimension (pattern loading: −.05). The second dimension contrasted the Memory factor (pattern loading: .97) with the Verbal and Performance factors (pattern loadings: −.46 and −.24, respectively). These results suggest that the Memory factor represents a distinct dimension from intellectual performance.

Memory Factor

In order to evaluate the degree to which the Memory dimension conforms to expectations, factor scores from the three-factor solution were calculated for each subject. To test the hypothesis that higher Memory scores would be associated with lower task completion times, scores for factor 3 were correlated with the total time indices[4] for the three performance subscales (Picture Arrangement, Block Design, and Object Assembly). Only the correlation with Picture Arrangement was significant, $r(189) = .15$, $p < .05$, and it is in the wrong direction! The longer it took to complete this task, the higher one's score on the Memory factor (i.e., higher scores on this factor indicate better memory abilities). It may be hypothesized that those high on the Memory factor may be trading speed for accuracy, however, scores on the Memory factor were independent of performance on this scale ($r = .08$). Thus, whatever role this dimension plays, it really does not affect performance.

The second hypothesis stated that Memory scores would vary over diagnostic category and that schizophrenics would have the lowest scores. Three diagnostic groups were created: An anxiety group (including DSM-III diagnoses 300.01, 300.21, 300.29, 300.30, $n = 8$), a depressive group (296.20 to 296.82, 300.40, 301.13, $n = 36$), and a schizophrenic group (295.24 to 295.94, $n = 82$). None of these individuals had a concurrent Axis II diagnosis. A one-way ANOVA was performed with diagnostic condition as the classifying variable and scores on factor 3 as the dependent variable. A significant effect emerged, $F(2,129) = 4.16$, $p < .02$, and indicated the anxiety group to have the lowest scores ($M = -.96$), which were significantly different from both the depressive ($M = .13$) and schizophrenic ($M = .17$) groups. Again, the results are the opposite of those hypothesized. It is clear from these findings that impairments in reality testing, hypothesized by Cohen to be one source of variability, did not influence scores on the Memory dimension in the predicted direction. One could argue that the arousal experienced by those in the anxiety group was sufficient to inhibit their ability to perform,

[4]Total time indices were simply the amount of time, in seconds, for a respondent to complete all of the tasks on a subscale.

while such intense, overt anxiety may have been lacking in the other two diagnostic groups. This interpretation necessitates that the Memory factor be reinterpreted as a measure of affective arousal (i.e., anxiety) rather than some kind of generalized index of attentional capabilities.

Discussion

The multi-model comparisons presented in this study clearly show that the three-factor solution does not appear to be the most appropriate conceptualization of the factor structure of the WAIS-R. The small variance accounted for by this factor in this sample seriously questions its statistical viability. That the two hypotheses rationally derived from Cohen's original conceptualization of the Memory Factor and evaluated in this report were not confirmed also undermines the interpretive viability of the dimension. This conceptual failure is surprising given the psychiatric sample included here: The Memory dimension originally was hypothesized to be of particular value in a clinical setting. Certainly, a more circumscribed role for this dimension seems warranted. It may be better to conceive of this dimension as a general index of a respondent's affective arousal during testing, a conclusion not unexpected given what already is known about scores from the Digit Span and Arithmetic scales (Golden, 1979; Knox & Grippaldi, 1970). Of course, given the numerous improvements made in the Wechsler scales and in diagnosis formation over the years, it is entirely possible that Cohen's original analyses do not generalize to the WAIS-R.

Whereas there are only 11 subscales on the WAIS-R, it also may be possible that any extraction of more than two factors may rely heavily on both variance specific to the subscales and error (Silverstein, 1982). These smaller factors may not be related to intelligence, but may represent a source of systematic variation that must be controlled for in hypothesis testing. Future research needs to provide more specific empirical documentation that outlines the role of this construct. If this third factor does represent some type of affective arousal, then one validation strategy would be to give measures of anxiety and attention along with the WAIS-R and then jointly factor all these measures. This would help to distinguish more clearly any underlying, nonintellective dimension.

The one- and two-factor models appear to provide clearer and statistically more robust representations of the WAIS-R's latent structure. These structures parallel the current usage of the IQ indices: There does exist one general intellectual dimension defined by all the subscales that can be specified more clearly by two smaller, correlated dimensions. These two dimensions are defined by the Verbal and Performance subscales, respectively. These latent structures were obtained regardless of extraction or rotation method employed, which underscores the robustness of the solution.

Some of the controversy that surrounds the number of factors in the WAIS-R may be exacerbated by the usage of varimax rotations. It is unclear why after Cohen's initial evaluation of the Wechsler scales that did use an oblique rotation, researchers abandoned the method in favor of the varimax procedure. The data presented here unequivocally demonstrate the enhanced simple structure obtained with an oblique rotation. Further, extracting correlated factors provides an opportunity to explore higher-order dimensions that may serve as springboards for new avenues of theoretical and empirical exploration. The second-order factor recovered here provides a possible starting point for such investigations. A brief description of the dimension and some potential implications are discussed below.

Implications of the Second-order Factor

The second-order factor derived in this study may represent another cognitive style that can be useful in linking intellectual ability to the larger enterprise of psychological functioning. Unlike the first unrotated factor outlined in Table 1, the higher-order factor contrasts the Verbal and Performance scales and, therefore, cannot be interpreted as a general intelligence, or *g*, factor. Based on what already is known about the constructs captured by the WAIS-R subscales (Allison, Blatt, & Zimet, 1988; Golden, 1979), this higher-level dimension may be interpreted to reflect a type of problem-solving style: abstract-synthetic vs. spatial-analytic. The abstract-synthetic pole may reflect a capacity to transform information into larger concepts, to create and accept novel or unconventional ideas, and a preference for concepts over details. The spatial-analytic pole may reflect a more stimulus-bound, task-oriented perspective, a preference for pictures rather than words, and a greater facility with structured vs. unstructured tests.

Although these conjectures are speculative, this dimension does have sufficient merit to warrant closer examination. First, that the dimension is based on a number of ability scales designed to widely sample the intellectual arena suggests that the dimension represents broad aspects of cognitive functioning that may be relevant to a number of classes of behavior. The amount of familiarity with this instrument provides an interpretive reference point for understanding the kinds of processes and behaviors related to the dimension. Second, the theoretical-empirical pedigree of the dimension may enable it to provide an interpretive reference point for evaluating the multitude of other cognitive constructs (cf. Widiger, Knudson, & Rorer, 1980). Finally, it does offer WAIS-R users a new interpretive facet to their research and clinical endeavors. Thus, exploring the personological implications of this dimension may provide new, clinically relevant interpretations to performance on this measure.

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