A FACTOR ANALYTIC STUDY OF THE RESPONSES OF MENTAL RETARDATES ON THE WAIS [1]

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ABSTRACT

From 2 state institutions for the retarded, 124 WAIS tests were obtained from *Ss* with a mean CA of 27–4 and mean FSIQ of 60.0. The 11 subtest raw scores were factor analyzed by the principal axis method and rotated to the Varimax criterion. 4 factors were extracted and identified as general, verbal, performance and trace factors.

The trace factor loaded on arithmetic, digit span and digit symbol. This pattern of loadings was interpreted as supporting the trace theory of Ellis which suggests that mental retardates have a short-term memory deficit. The pattern of loadings was similar in many respects to previous factor analytic studies reported by Baumeister and Bartlett of the WISC on mentally retarded populations.

A THEORY has been proposed by Ellis (1963) in which he postulates a short-term memory deficit in mental retardates. He theorizes that the stimulus trace in retardates is reduced in duration and amplitude as compared with non-retarded *Ss*. Thus, it follows that retardates should perform at lower levels than normal *Ss* on tasks which require the utilization of short-term memory. Such tasks as delay of response, delay of reinforcement and serial learning are situations in which short-term memory is necessary to perform adequately. Elements of these tasks are included in the subtests of the Wechsler tests of intelligence.

Two factor analytic studies of the WISC have been reported on samples of retarded adolescents. Baumeister and Bartlett (1962a) factor analyzed the intercorrelations of WISC subtests obtained on a sample of 100 special education students. Later (Baumeister & Bartlett, 1962b) they reported the results of a similar analysis on a sample of 130 special education students and 714 institutionalized retardates. From the standardization sample of 13 to 14 year old boys and girls on the WISC, they (1962a) obtained three orthogonal factors which they identified as general, verbal and performance factors. However, in the samples of retarded *Ss*, they extracted another factor which they identified as a trace factor since it loaded on subtests which seem to require short-term memory such as Arithmetic, Picture Arrangement and Coding.

Cohen (1957) has factor analyzed the standardization samples of the WAIS. Rotating to a criterion of oblique simple structure, he defined five factors at each of the four age levels used in the standardization sample except that he did not obtain the fifth factor (E) at the 60–75 age level. Factor C, which he labeled Memory, was found at all four age levels. At the age 60–70 level more subtests loaded

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on the memory factor, and the loadings generally were larger than at the three younger age levels.

A factor analytic study of the WAIS on mentally retarded *Ss* has not been reported previously. It seemed worthwhile to perform such an analysis and to compare the results with the previous factor analysis of the WISC in consideration of the current interest in this area.

METHOD

Subjects

From two institutions for the mentally retarded (Muscatatuck State School[2] and Lincoln State School[3]) 124 WAIS records were obtained from adult retardates; Table I presents mean ages and IQ's. No *S* was included in the study who obtained an IQ of 80 or greater on either the Verbal, Performance, or Full Scale scores. Tests were given by experienced psychologists who were employed at the two institutions.

TABLE I

MEANS AND STANDARD DEVIATIONS OF AGES AND IQ'S FOR SUBGROUPS AND TOTAL GROUP

Group	N	Age		VIQ		PIQ		FSIQ	
		M	SD	M	SD	M	SD	M	SD
Muscatatuck	57	29-4	12-4	61.0	7.2	59.8	9.7	58.2	7.5
Lincoln	67	25-7	8-4	63.1	9.2	63.2	11.0	61.4	9.2
Total	124	27-4	10-6	62.2	8.4	61.6	10.5	60.0	8.6

Experimental Design

The raw score values from the 11 subtests of the WAIS were intercorrelated, and these intercorrelations analyzed by the principal axis factor analysis method using squared multiple correlations as the communality estimates. Following the extraction of four factors, the factors first were rotated to the Varimax criterion (Kaiser, 1958). A second rotation then was performed using the Wherry-Gaylord (Wherry, 1959) method.[4] Additionally, a similar factor analysis and Varimax rotation was performed on the intercorrelations given in Table 8 of the WAIS Manual (Wechsler, 1955) for 25-34 year old *Ss*.

RESULTS

The intercorrelations of the 11 subtests for the retarded adults are listed in the lower half of Table II. For comparison, the data on the intercorrelations for 25-34 year old sample of the WAIS is presented in the upper half of Table II.

Table III presents the rotated factor loadings obtained from the data on retarded *Ss*. Seven of the 11 subtests load on the general factor. All six of the verbal subtests load on the verbal factor, and one performance subtest—

[2] The data from this group of *Ss* were collected when the senior author was employed at Muscatatuck State School, Butlerville, Indiana. Some (30) of the *Ss* were tested as preadmission applicants and then most of them subsequently admitted to the institution.

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[4] We are indebted to Dr. Claude J. Bartlett for performing this rotation.

TABLE II

INTERCORRELATIONS OF SUBTEST RAW SCORES FOR RETARDED ADULTS (LOWER HALF) AND STANDARDIZATION SAMPLE INTERCORRELATIONS FOR AGES 25-34 (UPPER HALF)*

		1	2	3	4	5	6	7	8	9	10	11
1.	Inf.	..	70	66	70	53	81	57	67	58	62	45
2.	Comp.	41	..	49	62	40	73	44	56	49	57	43
3.	Arith.	46	49	..	55	49	59	43	50	51	49	37
4.	Simil.	29	42	35	..	46	74	53	56	52	52	39
5.	D. Span.	37	23	42	35	..	51	41	39	39	47	30
6.	Voc.	50	43	28	35	26	..	60	61	53	62	43
7.	D. Sym.	25	26	40	20	48	18	..	48	47	51	44
8.	P. C.	23	46	30	26	23	23	45	..	62	57	54
9.	B. D.	25	45	44	23	28	21	39	41	..	58	61
10.	P. A.	32	46	42	31	22	30	37	39	34	..	52
11.	O. A.	18	39	32	23	17	11	40	39	61	35	..

* Decimal points in this table and following tables have been omitted.

Picture Arrangement—also loads on the verbal factor. But only one of the five performance subtests loads on the performance factor. Two of the verbal subtests and one performance subtest load on the trace factor, namely Arithmetic, Digit Span and Digit Symbol.

The rotated factor loadings obtained from the 25-34 year old standardization sample may be found in Table IV. The loadings are larger than those obtained from the retarded *Ss*, and loadings larger than .30 are obtained on most of the subtests for the first three factors. Nine of the 11 subtests load on the general factor. Eight subtests load on the verbal factor, but the largest loadings—those above .40—are obtained on the verbal subtests. Ten of the subtests load on the performance factor, but the largest loadings are obtained on the performance subtests. However, none of the subtests load on the trace factor which is contrast to the results of the rotated factor loadings obtained from the retarded *Ss*.

When the factors obtained from the retarded *Ss* are rotated by the Wherry method, as used by Baumeister and Bartlett (1962b), results quite similar

TABLE III

FACTOR LOADINGS ON THE WAIS FOR ADULT RETARDATES

		General	Verbal	Performance	Trace
1.	Inf.	11	.61	—06	27
2.	Comp.	.47	.59	11	03
3.	Arith.	.37	.46	—10	.38
4.	Simil.	19	.47	08	19
5.	D. Span	12	.30	—00	.60
6.	Voc.	07	.63	08	11
7.	D. Sym.	.40	11	20	.56
8.	P. C.	.48	24	.32	20
9.	B. D.	.68	20	—03	21
10.	P. A.	.40	.40	18	17
11.	O. A.	.70	10	04	14

Loadings >29 underlined.

TABLE IV

FACTOR LOADINGS ON THE WAIS FOR THE 25–34 STANDARDIZATION SAMPLE

		General	Verbal	Performance	Trac
1.	Inf.	66	49	38	−01
2.	Comp.	67	23	36	01
3.	Arith.	39	53	32	−04
4.	Simil.	61	39	31	09
5.	D. Span	30	49	24	09
6.	Voc.	74	40	32	14
7.	D. Sym.	38	34	40	24
8.	P. C.	43	27	59	−03
9.	B. D.	28	30	68	00
10.	P. A.	39	34	54	12
11.	O. A.	21	16	67	07

Loadings >29 underlined.

to their findings are obtained if the differences between the two Wechsler tests are taken into account. These loadings are presented in Table V. Comparing the two rotations in Table III and Table V, certain differences are ascertainable. First, more of the subtests (ten as compared with seven) load on the general factor when the Wherry method is used, and most of these loadings are larger. Second, fewer subtests (five as compared with seven) load on the verbal factor with the Wherry method. Third, more of the performance subtests (three as compared with one) load when the Wherry method is used. Finally, there is only one difference between the two loadings on the trace factor; the Arithmetic loading with the Wherry method does not reach the arbitrary .30 level as is the case with the Varimax rotation. These differences probably are attributable to the tendency for the

TABLE V

FACTOR LOADINGS (WHERRY) ON THE WAIS FOR ADULT RETARDATES

		General	Verbal	Performance	Trace
1.	Inf.	40	51	−09	19
2.	Comp.	57	50	12	−17
3.	Arith.	63	31	01	20
4.	Simil.	35	44	05	07
5.	D. Span	40	25	08	50
6.	Voc.	27	58	−02	05
7.	D. Sym.	50	06	39	33
8.	P. C.	46	12	45	−05
9.	B. D.	72	01	19	−08
10.	P. A.	47	−05	38	−17
11.	O. A.	66	−05	27	−15

Loadings >29 underlined.

Wherry method to capture as much as possible of the variance on the first factor, whereas the Varimax method tends more to distribute the variance over all factors. This difference is apparent by an inspection of the loadings on the general factor in Tables III and V.

DISCUSSION

In comparison with Baumeister and Bartlett's (1962b) data obtained from institutionalized *Ss*, their study most comparable to this one, there are certain strong similarities, but also some unexplained differences. Arithmetic and Digit Symbol (Coding if WISC nomenclature is used) load significantly on the trace factor in both studies. While Digit Span loads on the trace factor in this study, the Digit Span subtest was not included by Baumeister and Bartlett; consequently a comparison of loadings on this subtest is not possible. Picture Arrangement and Block Design reached the arbitrary .20 level set by Baumeister and Bartlett on the trace factor, but in the present study these two subtests were somewhat negatively loaded on the trace factor when the Wherry rotation was used (see Table V). It is difficult to account for these differences because the studies vary in many respects: different tests, different age retarded *Ss* and samples of *Ss* from different institutions. At this time, it is not possible to say definitively what accounts for the differences.

Since Cohen (1957) used a different factor analytic method and a different rotation than used in the present study in his analysis of the WAIS standardization samples, it is not worthwhile to attempt interpretations of the differences in the factor structure obtained between that study and this study. However, a comparison of the loadings obtained from the retarded *Ss* with those obtained from the 25–34 year old standardization sample when the Varimax rotation is used, as is the case in Table III and Table IV, indicates clearly that the trace factor accounts for much more of the variance of the subtest intercorrelations in retarded *Ss* than in normal *Ss*.

The data collected from this study appear to support Ellis' trace theory. The three subtests which load on the trace factor (see Table III) are all subtests that require the ability to retain some bit of information for the duration of time the *S* works on a particular test item. It is obvious that the *S* must remember the specific quantities given in the Arithmetic subtest as well as remembering his own partial solutions to the problem in order to produce a correct answer. Digit Span probably is described best as a measure of short-term retention. Digit Symbol also appears to involve short term memory. In order to obtain a high score on this task, *S* needs to remember the symbols which are associated with the digits, or, at least, *S* needs to remember approximately where the symbol and associated digit are located in the given sequence. *Ss* who cannot perform adequately on this test apparently do not remember the location of the symbol and associated digit in the given sequence, thus finding it necessary to scan the entire sequence looking for them. This continual scanning consumes time and, consequently, produces a lower score.

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THE EQUIVALENCE OF WISC AND PPVT IQS[1]

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ABSTRACT

The relationship between the PPVT and the WISC was studied in a group of 83 children. Correlations between the PPVT and the three WISC scales were found to be statistically significant, but of little practical utility. Agreement between the two tests was found to diminish directly with the intellectual level of the subject. It was concluded that the PPVT has only minimal agreement with the WISC when used with children of below-average intelligence, but that it might be sensitive to specific language deficits. The danger of equating significance with utility was discussed briefly.

INTRODUCTION

THE present investigation was directed toward assessing the utility of the common practice of employing the *Peabody Picture Vocabulary Test* (PPVT) (Dunn, 1959) as the major measure of intelligence in a test battery as opposed to a test such as the *Wechsler Intelligence Scale for Children* (WISC) (Wechsler, 1949). While the WISC generally is considered to be the most comprehensive measure of intelligence in children, many psychometric evaluations are limited to the administration of shorter tests such as the PPVT. The PPVT has the advantage of brief and easy administration and scoring. Test scores can be converted readily to MAs and IQs and, in many cases, IQs can be derived on children who are too severely retarded to complete the Full Scale WISC. These advantages are offset somewhat by the apparently superficial relationship that PPVT IQs bear to WISC IQs. Dunn and Brooks (1960) reported a correlation of .61 between the PPVT IQ and the Full Scale WISC IQ in their group of 56 educable retardates. Reger (1962) found similar relationships with a smaller group of institutional retardates. Kimbrell (1960) studied 62 educable retardates and found even less relationship between the two measures.

In each of the above studies it can be argued that the relationship was attenuated because of restricted range of IQ. Therefore, the present study was designed to assess the relationship between the two tests in a population of children with a much larger range of IQs than in prior studies.

METHOD

The subjects were 83 children who had been referred to the Neuropsychology Laboratory of the University of Wisconsin School of Medicine for evaluation. Each of the subjects was underachieving in school, many presented behavior problems, and all were suspected of having some kind of organic brain damage. Table 1 summarizes pertinent characteristics of the sample.

Each of the subjects was given the PPVT and the Full Scale WISC as a part of an extensive battery of neuro-

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