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A Factor Analytic Study of the Weschsler Intelligence Scale for Children-Revised

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A FACTOR ANALYTIC STUDY

OF THE WECHSLER INTELLIGENCE SCALE FOR CHILDREN-REVISED

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A FACTOR ANALYTIC STUDY OF THE

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TABLE OF CONTENTS

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OF THE WECHSLER INTELLIGENCE SCALE FOR CHILDREN-REVISED

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Since the original Wechsler Intelligence Scale for Children (WISC, 1949) had recently undergone a major revision in content structure of the test and in the populations utilized for standardization, the present study sought to examine the factor structure of the Wechsler Intelligence Scale for Children-Revised (WISC-R, 1974) using test data from 126 white and black fifth graders from a predominantly lower middle class socioeconomic background. The analysis of data was performed by a principal components method of factor analysis utilizing Varimax rotation. The results of the data analysis indicated the presence of three primary group factors, and these factors closely resembled those found by researchers using the WISC. The first factor accounted for 42.3% of the total variance and was heavily loaded with Verbal subtests of the WISC-R, e.g. Information, Vocabulary, and Similarities. The second factor accounted for 10.7% of the total variance and was heavily loaded with Performance subtests of the WISC-R, e.g. Block Design, Object Assembly, and Picture Completion. The third factor accounted for 9.3% of the total variance and was heavily loaded with two Verbal subtests (Arithmetic and Digit Span) and one Performance subtest (Coding).

Chapter 1

Introduction

One of the distinquishing features of contemporary psychological testing is its "differential approach" to the measurement of ability. During the past three decades, there has been a rapid increase in the development and application of instruments that permit an analysis of performance with regards to different aspects of intelligence. This type of instrument yields not a single global measure as IQ but a set of scores in different aptitudes.

A number of events have contributed to the growing interest in differential testing of abilities. First, there has been an increasing recognition of intra-individual variation in performance on intelligence tests. Crude attempts to compare an individual's relative standing on different subtests or item groups antedated the development of multiple aptitude batteries by many years. However, most intelligence tests were not designed for the purpose of intra-individual comparisons. The subtests or item groups are often too unreliable. In the construction of intelligence tests, moreover, items or subtests are generally chosen to provide a unitary and internally consistent measure. In such a selection, an effort is made to minimize, rather than maximize, intra-individual variation. Subtests that correlate very low with the rest of the scale would generally be excluded. Yet these are the very parts that would probably have been retained if the emphasis had been on the differentiation of abilities. Because of the way in which intelligence tests are constructed, it is unlikely that performance on these tests can be differentiated into more than two categories, such as the verbal or the nonverbal (Anastasi, 1968).

The development of multiple aptitude batteries was further stimulated by the gradual realization that so-called general intelligence tests were in fact less general than was originally supposed. It soon became apparent that in many such tests only verbal comprehension was being measured (Anastasi, 1968). Certain areas, such as those of pure mechanical abilities, were usually untouched, except in some of the performance and nonlanguage scales. As these limitations of intelligence tests became evident, some psychologists began to qualify the term "intelligence." Distinctions between "academic" and "practical" intelligence were suggested by some. Others spoke of "abstract," "mechanical," and "social" intelligence. In some cases, tests of special aptitudes were designed to supplement the intelligence tests. Closer analysis, though, showed that intelligence tests themselves could be said to measure a certain combination of special aptitudes, although the area covered by these tests was loosely and inconsistently defined.

In solution to this problem, the application of factor analysis to the study of trait organization provided the theoretical basis for the construction of multiple aptitude batteries. Through factor analytic techniques, the different abilities loosely grouped under "intelligence" could then be selected more systematically, identified, sorted, and defined. Tests could then be selected so that each represented the best available measure of one of the traits or factors identified by factor analysis.

Spearman (1927) was one of the earliest proponents of a factor analytic approach to intelligence. Spearman proposed a two-factor theory of intelligence to account for patterns of correlation which he observed among group tests of intelligence. The theory stated that a general factor (g) plus one specific factor per test can account for performance on intelligence tests. Any intellectual activity involves both a general factor, which it shares with all other intellectual activities, and a specific factor which it shares with none.

Thorndike (1927) felt that intelligence is comprised of a multitude of separate elements, each accounting for a distinct ability. He believed that certain mental abilities have elements in common and combine to form clusters. Three such clusters were identified--social intelligence, concrete intelligence, and abstract intelligence.

One of the most prominent multifactor theorists has been Guilford (1967). He developed the Structure of the Intellect model as a way of organizing intellectual factors into a system. The model is three dimensional with one dimension representing operation categories, a second dimension representing content categories, and a third dimension representing product categories. Intellective tasks can be understood by the kind of mental operation performed, and the resulting product.

A hierachichal theory of intelligence has been developed by Vernon (1950). The highest level is a general intellectual factor, followed by two major group factors: Verbal, Educational and Practical; and Mechanical-Spatial. Each of these groups is further broken down into minor group factors. Specific group factors, peculiar to certain tests, form the last level. The theory synthesizes the work of Spearman and Thurstone, but gives central importance to g.

Cattell (1963) proposed that general intelligence is composed of two factors--fluid intelligence and crystallized intelligence. These factors are viewed as distinct but correlated. Fluid intelligence is a basic capacity for learning and problem solving, independent of education and experience. Fluid intelligence is general to many different fields and is used in tasks requiring adaption to new situations. Crystallized intelligence is the result of the interaction of the individual's fluid intelligence and his culture; it consists of learned knowledge and skills.

Through the use of factor analytic techniques, the theoretical position of Wechsler (1958) has been explored. To him an intelligence test is not to evaluate, as some assert, a subject's cognitive abilities; nor are its purposes, as proclaimed by those who are opposed to the IQ or the concept of general intelligence per se, to appraise his educational, vocational, or other competencies. An intelligence test is not just a mental abilities test. Intelligence tests inevitably do measure mental abilities, but the information so obtained, in the opinion of Wechsler, is relevant only to the extent that it establishes and reflects whatever it is one defines as overall capacity for intelligent behavior. Wechsler has challenged the position of Anastasi (1968), that of the lack of validity of intelligence subtest scores, and has made the assumption that particular subtests of the Wechsler Intelligence Scale for Children (WISC), tap not only general intelligence, but other "non-intellective factors." Some of these factors are specific to particular subtests (e.g., specific skills such as memory); others are more general and affect several or all subtests (e.g., drive). While these assumptions fit well into general testing theory in accounting for the various intercorrelations, it is difficult to find any explicit statements about which subtests are affected by what factors (Littell, 1960).

Since the original intelligence test for children has been revised by Wechsler (1974), the present study sought to explore the factor analytic loadings on specific subtests of the Wechsler Intelligence Scale for Children-Revised (WISC-R).

Chapter 2

Review of the Literature

The Wechsler Intelligence Scale for Children

The Wechsler Intelligence Scale for Children (WISC) was developed by Wechsler (1949) as a downward extension of the Wechsler-Bellevue Scale, and in particular, of Form II of the adult scales. To make Form II more suitable for children, easier items were added to the low end of the subtests. The WISC was applicable to children between ages 5-0 and 15-11 years.

The WISC contained 12 subtests, six of which form the Verbal Scale (Information, Comprehension, Arithmetic, Similarities, Vocabulary, and Digit Span) and the other six, the Performance Scale (Picture Completion, Picture Arrangement, Block Design, Object Assembly, Coding, and Mazes). The IQ tables in the manual are based on 10 of the 12 subtests.

The WISC was standardized on 2200 white American boys and girls selected to be representative of the 1940 U.S. census. However, in the standardization group, there was an over-representation of children from the middle and upper socioeconomic levels. Therefore, children from the lower-middle and lower socioeconomic groups and minority ethnic groups may be penalized because they were not adequately represented in the development of the norms (Sattler, 1974).

Wechsler developed the WISC and the other Wechsler scales without using the mental-age concept, which, together with the ratio IQ, he found to be limited in a number of ways. Wechsler was willing to accept the mental-age concept if it was limited to a level of test performance (Wechsler & Weider, 1953). However, he believed that more than this operational definition is implied or subsumed. For example, Wechsler rejected the notion that the mental age be considered to represent an absolute level of mental capacity, with the assumption, difficult to verify, that the same mental age in different children represents identical intelligence levels.

In Wechsler's scales, the IQ is a deviation that is obtained by comparing each examinee's scores with the scores earned by a representative sample of his own age group. IQ's obtained by this method are standard scores, so that the mean IQ's and standard deviations at each age level are equal (100 and 15, respectively). IQ's obtained on successive retests give the examinee's relative position in the age group to which he belongs at the time of the testing. This procedure avoided the problems that were associated with unequal standard deviations found on the Stanford Binet prior to the 1960 revision. After the raw scores on each subtest are obtained, they are converted to standard scores within the examinee's own age group. Tables in the manual are provided for the conversion by four-month age intervals between ages five and 16 years. Each subtest has a mean scaled score of 10 and a standard deviation of three.

Factor Analytic Studies of the WISC

Both in discussion of the WISC and its use a distinction was made between the Verbal and Performance Scales, Wechsler (1958) tentatively identified the factors as measured by the "adult" scales as a verbal comprehension factor and a nonverbal factor (variously identified as performance, nonverbal, space, and visual-motor organization). Gault (1954) reported a factor analysis of the intercorrelations printed in the WISC manual (Wechsler, 1949) and found the same pattern of factors as reported by Hammer (1950) for the adult scales. The four factors worthy of note were called a "general educative factor, a verbal comprehension factor, a spatial-motor factor, and a memory factor." The verbal comprehension factor and the spatial-motor factor correspond roughly with the Verbal and Performance Scales.

Factor analyses of the Wechsler scales have been conducted with a variety of subjects ranging from eighth grade pupils to the old-age standardization samples and including both normal and abnormal groups (Anastasi, 1968). Researchers have also employed different statistical procedures and have approached the analysis from different points of view. Some studies have been directly concerned with age changes in the factorial organization of the Wechsler subtests, but the findings of different investigators have been inconsistent. As an example, we may find the factor analyses of the WAIS conducted by Cohen (1957a, 1957b) with the intercorrelations of the subtests obtained on four age groups in the standardization sample (18-19, 25-34, 45-54, and 65-75+). The major results of this study were in line with those of other investigators using comparable procedures (Guertin, _et al_., 1962, 1966).

That all subtests have much in common was demonstrated in Cohen's studies by the presence of a single general factor that accounted for about 50% of the total variance in the battery. In addition, three major factors were identified. One was a "verbal comprehension" factor, with large weights in the Vocabulary, Information, Comprehension, and Similarities subtests. A "perceptual organization" factor was found chiefly in Block Design and Object Assembly. This factor may have actually represented a combination of perceptual speed and spatial visualization factors repeatedly found in factor analyses of aptitude tests. The results of an earlier investigation by Davis (1956), in which the reference tests measuring various factors were included in the Wechsler subtests, support this composite interpretation of the perceptual organization factor.

The third major group factor identified by Cohen was described as a "memory" factor. Found principally in Arithmetic and Digit Span, it apparently included both immediate rote memory for new material and recall of previously learned material. Ability to concentrate and to resist distraction may be involved in this factor. Of special interest is the finding that the memory factor increased sharply in prominence with the old age sample. At that age level, it had significant loadings not only in Arithmetic and Digit Span, but also in Vocabulary, Information, Comprehension, and Digit Symbol. Cohen pointed out that during senescence memory begins to deteriorate at different ages and rates in different persons. Individual differences in memory thus come to play a more prominent part in intellectual functioning than had been true at earlier ages. Many of the WAIS subtests require memory at all ages. Until differential deterioration sets in, however, individual differences in the retentive ability required in most of the subtests are insignificant.

It should be noted that the results of Cohen's study failed to support the standard practice of grouping tests into Verbal and Performance Scales, each yielding a separate IQ. Although the use of Full Scale IQ is by and large the general factor content of all subtests, the verbal comprehension factor occurs in only four of the six Verbal Scale subtests. The memory factor is found in the two remaining Verbal subtests, as well as in other subtests from both scales in the case of older subjects. In the perceptual organization factor, there were significant loadings in two of the five Performance Scale subtests only. The remaining Performance subtests seem to have largely specific variance, not shared with other subtests in this battery.

Working with normal samples and using item intercorrelations and other procedural variations, Saunders (1959, 1960a, 1960b, 1961) found evidence of at least 10 identifiable factors in the WAIS performance. There was not, however, a one-to-one correspondence between these factors and the WAIS subtests. Several subtests proved to be factorially complex, and certain factors cut across more than one subtest.

Lotsof, Comrey, Bogartz, and Arnsfielf (1958) reported a factor analysis of the WISC and the Rorschach scores of 72 under-achieving children with reading disabilities. They found four factors which they called verbal intelligence, productivity, perceptual-movement, and performance speed. The Verbal and Performance Scales were not factorially pure, however, the Block Design was loaded significantly with the verbal intelligence factor, and the Comprehension and Arithmetic were loaded with the performance-speed factor. They concluded that "the verbal and performance aspects of the WISC are not independent of each other."

For the most part though, early evidence seemed to support the rough factorial distinction between the Verbal and Performance Scales. Beyond this evidence on the division of the WISC into Performance and Verbal Scales, there seemed to be no systematic investigation of the nature of any other of the somewhat general or specific factors tapped by the WISC subtests. This was of particular importance in early evaluations of the clinical and diagnostic use of the WISC (Littell, 1960).

Cohen's (1959) factor analytic findings, arrived at by the centroid analysis of common factor variance for the 7½, 10½, and 13½ year levels of the WISC and using the total standardization sample reported in the WISC manual, were presented in each individual subtest. The five primary factors were: Verbal Comprehension I, Verbal Comprehension II, Perceptual Organization, Freedom from Distractibility, and Quasi-Specific. According to Cohen, the Verbal Comprehension I factor reflects that aspect of verbally retained knowledge which is produced by formal education. Information and Vocabulary subtests were found to be heavily loaded in this factor. The Perceptual Organization factor is a nonverbal factor and reflects the ability to interpret and organize visually perceived material against a time limit. The Picture Completion subtest was found to load heavily on this factor at the 10½ and 13½ year levels, the Object Assembly subtest at the 7½ and 10½ year levels, and the Block Design subtest at all three age levels. The Freedom from Distractibility factor measures the ability to remain undistracted. The Digit Span subtest was found to have a high loading at each of the three age levels, however, only at the 13½ year level did it combine with Arithmetic to form the Freedom from

Distractibility factor score. It would appear that at the two younger age levels, there are no subtests that can be found to supplement Digit Span to form this factor score. The Verbal Comprehension II factor measures the ability to apply judgment following some implicit verbal manipulation. Verbal Comprehension I represents the formally learned verbal comprehension, whereas Verbal Comprehension II represents the application of verbal skills to situations that are new to the child. The Comprehension subtest, the Vocabulary subtest, and the Picture Completion subtest were all found to be heavily loaded on the Verbal Comprehension II factor. The Quasi-Specific factor was not found to have any psychological interpretation, and only the Coding subtest was found to load exclusively on this factor. A sixth factor of general intelligence (g) was also described by Cohen (1959). Vocabulary was found to be the best measure of g, with the Information subtest following as the second best measure. Other subtests with high loadings in g were Comprehension, Arithmetic, Similarities, Picture Arrangement (best measure among Performance Scale), and Block Design. Subtests found to have low loadings on g were Picture Completion, Object Assembly, Coding, and Mazes. Other findings indicated that the WISC Full Scale IQ and the Verbal IQ are good measures of g, while the Performance Scale IQ is a relatively poor measure of g.

Cohen advocated the use of factor scores in place of single subtest scores, which he considered to be unreliable and ambiguous, and in place of the Verbal and Performance IQ's. His proposal for factor scores included all but the Quasi-Specific factor.

Factor analytic investigations of the WISC also have appeared that have used the WISC standardization data (Maxwell, 1959), normal samples (Crokett, Klonoff, & Bjerring, 1969; Cropley, 1964; Jackson, 1960; Jones, 1962; Klonoff, 1971; Osborne, 1963), racial groups (Osborne, 1966; Semler & Iscoe, 1966) learning disabled children (Leton, 1972), and brain injured children (Grimaldi, 1970). These studies, for the most part, agree with the findings of Cohen (1959), although differences were found depending upon the sample used. Many of the studies indicated, as Burt (1960) has observed, that it is unjustifiable to assume that a given factor will appear at all levels and with all types of children.

In analysis of subtests by Witkin (1960), three major factors were identified: (a) Verbal, consisting of Information, Comprehension, and Vocabulary; (b) Attention, consisting of Arithmetic, Digit Span, and Digit Symbol; (c) Perceptual Analytic, consisting of Picture Completion, Block Design, and Object Assembly. These correspond with the three major factors in the Wechsler scales, apart from the g factor, discussed by Wechsler (1958). These factors consist of (a) Verbal Comprehension (Vocabulary, Information, Comprehension, and Similarities); (b) Non-verbal or Performance (Picture Completion, Picture Arrangement, Block Design, and Object Assembly); (c) Memory (Digit Span, Digit Symbol, and according to the age of the subject, Arithmetic and Information).

In summary, most of the factor analytic studies on the WISC have all placed emphasis on (a) a verbal comprehension factor, (b) a perceptual-motor abilities factor, and (c) an attention factor. Only in Cohen's (1959) study were the factors expanded to classify the verbal comprehension factor into two separate factors and also to label the unique and unidentifiable variance. In general, factor analytic studies on the WAIS or the WISC were not able to divide the factors distinctly and equally into Verbal and Performance IQ's.

The Wechsler Intelligence Scale for Children-Revised

The revision of the WISC represented a synthesis of two somewhat opposing aims: (1) the retention of as much of the 1949 WISC as possible because of its widespread use and acceptance, and (2) the modification or elimination of items felt by some test users to be ambiguous, obsolete, or differentially unfair to particular groups of children. In addition, a number of new items were added in order to strengthen the reliability of the tests, although at the same time an effort was made to avoid making the tests unduly long (Wechsler, 1974).

The matter of classifying items from the 1949 WISC as slightly modified or substantially modified requires explanation (Wechsler, 1974). For example, in an Arithmetic item, the change in a workman's salary from $4 a day in the 1949 WISC to $4 an hour was considered a slight modification. An Arithmetic item was considered substantially altered only if the numbers to be manipulated were changed, or if new test materials were used (e.g. the card with trees replaced blocks for counting items). In Picture Arrangement the redrawing of FIGHT (a demonstration item in the 1949 WISC) and of BURGLAR were regarded as minor changes because the basic content remained the same. The elimination of one of the five cards in SLEEPER, however, was considered a major modification. Important changes were made in all the Verbal subtests, in regard to content, except for Digit Span. The greatest number of changes in content were made in the Vocabulary subtest. Administration and scoring procedures were changed for all Verbal subtests. All subtests in the Performance Scale of the WISC-R received changes in content and also changes in administration and scoring (Wechsler, 1974).

The sequence in which the tests are administered was changed, with Verbal and Performance tests now given in alternating order. For each of the 12 tests, the directions for administration were revised to remove possible ambiguities, and the directions for scoring--particularly for Similarities, Vocabulary, and Comprehension--were expanded to include a greater variety of children's responses, e.g. when a child fails the first item of a test, the examiner is instructed to provide the solution or the correct answer.

Another principal change involved the range of the battery. The WISC-R is intended for use with children six through 16 years of age, while the 1949 WISC was appropriate for children ages five through 15 years. The lower limit was raised to six years to reduce the age overlap with the WPPSI, which covers a range from four to six and one half years; the upper limit was raised to 16 years 11 months to make the WISC-R suitable for use with a greater number of children in high school. There were also changes in the standardization of the battery, such as the inclusion of a proportional representation of nonwhites (Wechsler, 1974).

To assess more accurately the reliability of the tests, a stability coefficient, giving indications of test-retest contamination, was computed for each subtest and age level. A comparison of the mean WISC-R IQ's on the first and second testings revealed gains of about three and one half points on the Verbal Scale, one and one half points on the Performance Scale, and seven points on the Full Scale.

Statement of the Problem

Since the original Wechsler Intelligence Scale for Children (WISC, 1949) had recently undergone a major revision in content structure of the test and the populations utilized for standardization and, as previously discussed, controversy had been presented as to the number and label of factors involved in the WISC, it would seem that the factor structure would have become more or less complicated in the revised version. The purpose of the present study was to extract a number of factors, as determined significant by statistical procedures; and to attach appropriate labels to these factors and relate them to previous research on the factor analytic structure of the WISC.

Chapter 3

Method

Subjects

The population was composed of 126 fifth grade students, with a mean age of 10 years seven months, from a predominantly lower middle class socioeconomic background, in a municipality of approximately 50,000 located in Western Southcentral Kentucky. The sample was a complete representation of all fifth graders in two elementary schools chosen for the study. In the sample, 64 subjects were female and 62 were male. The sample was composed of 87 whites and 39 blacks. The sample did not represent a stratified distribution, as employed by Wechsler, in urban-rural, occupational, geographic, or racial classifications.

Apparatus

The Wechsler Intelligence Scale for Children-Revised (Wechsler, 1974) is an individually administered test of intelligence, purported by its author to be both a measure of general intelligence and specific factors, measured by individual subtests.

Procedure

Each subject was administered the Wechsler Intelligence Scale for Children-Revised (WISC-R) by a graduate student in clinical psychology, either in his first or second year of training. Testing was conducted in individual testing rooms located in a university psychological training clinic.

<u>Analysis of Data</u>

A principal components method of factor analysis was performed via Statistical Package for the Social Sciences program, subroutine "Factor" (Nye, Bart, and Hull, 1970). Factors were extracted from the subtest correlation matrix with unities identified as the leading diagonals. Twelve variables, each of which accounted for more than 1% of the variance, were rotated. From this solution, three factors were chosen for interpretation. The number of factors chosen was determined by specifications set by "Kaiser's criterion and Cattell's scree test" (Cattell, 1952)--that is the latent root (eigenvalue) for each factor exceeded 1.00. The first factor extracted had to represent at least 10% of the total variance, with a factor loading of at least .3, to be considered significant and adjusted to the Burt-Banks formula (Burt, 1952). Varimax rotation (Kaiser, 1959) was employed.

Chapter 4

Results

The purpose of the present study was to investigate the factor structure of the Wechsler Intelligence Scale for Children-Revised (Wechsler, 1974) in a sample of fifth graders from a predominantly lower middle class socioeconomic background. The present sample had a Full Scale IQ range from 65 to 129.

An examination of the subtest Pearson r's, presented in Table 1, shows a rather consistent similarity to the values obtained by Wechsler (1974) with his standardized sample. The most notable differences in the correlation coefficients between the two groups were Arithmetic, Vocabulary, Comprehension, and Coding all having lower correlations with Picture Completion; and Vocabulary, Comprehension, and Picture Completion all having higher correlations with Digit Span. All mean values for scaled scores were very similar to those found by Wechsler, with the exception of Vocabulary which had a much lower mean scaled score. Standard deviations for all scaled scores approximated closely the values reported by Wechsler.

The results reported in Table 2 (eigenvalues and variance) indicate that Factor I accounts for the largest amount of variance with 42.3% of the total variance attributed to this factor. Factor II accounts for 10.7% of the total variance and Factor III accounts for 9.3% of the total variance. Only these three factors were considered

TABLE 1

Intercorrelation of the Tests - Mean Age 10.58

	Information	Similarities	Arithmetic	Vocabulary	Comprehension	Digit Span	Picture Completion	Picture Arrangement	Block Design	Object Assembly	Coding	Mazes
Similarities	.65 *(.60)											
Arithmetic	.53 (.51)	.52 (.49)										
Vocabulary	.73 (.63)	.67 (.71)	.54 (.48)									
Comprehension	.61 (.50)	.67 (.58)	.47 (.37)	.66 (.61)								
Digit Span	.40 (.32)	.49 (.32)	.49 (.38)	.41 (.27)	.42 (.14)							
Picture Completion	.38 (.37)	.34 (.48)	.19 (.30)	.28 (.46)	.28 (.40)	.22 (.06)						
Picture Arrangement	.34 (.32)	.25 (.37)	.26 (.27)	.36 (.39)	.40 (.33)	.20 (.17)	.29 (.30)					
Block Design	.38 (.42)	.47 (.51)	.40 (.38)	.43 (.50)	.39 (.38)	.20 (.35)	.41 (.48)	.36 (.38)				
Object Assembly	.23 (.40)	.45 (.47)	.37 (.27)	.30 (.48)	.34 (.32)	.16 (.20)	.27 (.48)	.22 (.38)	.60 (.59)			
Coding	.19 (.20)	.28 (.32)	.39 (.32)	.21 (.28)	.28 (.21)	.34 (.32)	.02 (.12)	.25 (.24)	.24 (.31)	.25 (.19)		
Mazes	.12 (.23)	.26 (.25)	.25 (.26)	.23 (.24)	.29 (.25)	.26 (.18)	.32 (.34)	.33 (.30)	.30 (.45)	.26 (.21)	.17 (.20)	
Mean	8.07 (10.2)	8.91 (9.9)	8.96 (10.0)	7.82 (10.0)	10.17 (10.2)	8.50 (10.1)	10.00 (10.3)	9.87 (10.1)	8.30 (9.7)	9.67 (9.7)	9.73 (10.0)	9.90 (10.0)
S D	2.95 (2.7)	3.43 (3.2)	2.52 (2.8)	3.46 (2.9)	3.26 (2.7)	2.88 (3.0)	2.48 (2.8)	2.83 (3.0)	2.99 (3.0)	2.90 (2.8)	3.28 (3.0)	3.71 (3.1)

*( ) Scores computed by Wechsler (1974) - Age Group 10.50 years

TABLE 2

Factors With Associated Eigenvalues and % of Variance

Factor	Eigenvalue	% of Variance	Cumulative % Variance
1	5.08181	42.3	42.3
2	1.28903	10.7	53.1
3	1.08712	9.1	62.1
4	.95624	8.0	70.1
5	.79839	6.7	76.8
6	.64351	5.4	82.1
7	.51056	4.3	86.4
8	.47137	3.9	90.3
9	.37131	3.1	93.4
10	.30394	2.5	95.9
11	.25869	2.2	98.1
12	.22801	1.9	100.0

to be of significance with reference to the associated eigenvalues. These three group factors, combined, account for 62.1% of the total variance, which leaves 37.9% residual variance.

In Table 3, the eigenvalues and % of variance for each of the three major group factors are presented. The accountable variance is highly skewed in its distribution across these factors. Factor I accounts for 77.4% of the variance, Factor II accounts for 13.4% of the variance, and Factor III accounts for 9.2% of the variance.

A representation of the principal components Factor Matrix without rotation is presented in Table 4. The highest communality values are found in the Verbal subtests (the first six) with only three of the Performance subtests (the latter six) yielding comparable values.

The results of the Varimax Rotation are given in Table 5 and indicate that Factor I is composed of eight subtests with highly significant ($\underline{p} < .01$) factor loadings and one subtest with a significant ($\underline{p} < .05$) factor loading. Factor II is composed of seven subtests with highly significant ($\underline{p} < .01$) factor loadings and two subtests with significant ($\underline{p} < .05$) loadings. Factor III is composed of five subtests with highly significant ($\underline{p} < .01$) factor loadings and one subtest with a significant ($\underline{p} < .05$) factor loading.

As presented in Table 6, three major group factors are identified. Factor I is composed of Information, Vocabulary, Similarities, Comprehension, Arithmetic, and Digit Span subtests. Factor II is composed of the Block Design, Object Assembly, Picture Completion, Mazes, and Picture Arrangement subtests. Factor III is composed of Coding, Arithmetic, and Digit Span subtests.

TABLE 3

The Three Primary Group Factors With Associated

Eigenvalues and % of Variance

Factor	Eigenvalue	% of Variance	Cumulative %
1	4.65407	77.4	77.4
2	.80234	13.4	90.8
3	.55427	9.2	100.0

TABLE 4

Factor Matrix Using Principal Factor With Iterations

	Factor 1	Factor 2	Factor 3	Communality
Information	-0.77108	0.33551	0.26297	0.77629
Similarities	-0.80180	0.10394	0.02902	0.65453
Arithmetic	-0.68829	0.09054	-0.26367	0.55147
Vocabulary	-0.79092	0.25085	0.15391	0.71217
Comprehension	-0.75928	0.14240	0.03132	0.59777
Digit Span	-0.55044	0.19395	-0.25946	0.40791
Picture Completion	-0.44930	-0.21746	0.25287	0.31311
Picture Arrangement	-0.46335	-0.13682	0.02215	0.23390
Block Design	-0.65214	-0.48718	0.11332	0.67548
Object Assembly	-0.52967	-0.42974	0.04635	0.46737
Coding	-0.40254	-0.03772	-0.48966	0.40322
Mazes	-0.39038	-0.24599	-0.05985	0.21649

TABLE 5

Varimax Rotated Factor Matrix

	Factor 1	Factor 2	Factor 3
Information	0.85031**	0.20715*	0.10168
Similarities	0.65060**	0.36606**	0.31184**
Arithmetic	0.48235**	0.25703*	0.52989**
Vocabulary	0.77480**	0.26545**	0.29345
Comprehension	0.64320**	0.31182**	0.29468**
Digit Span	0.41472**	0.09775	0.47578**
Picture Completion	0.29123**	0.47426**	-0.05804
Picture Arrangement	0.26299**	0.37191**	0.16255
Block Design	0.22854*	0.77782**	0.13506
Object Assembly	0.11446	0.63237**	0.23318*
Coding	0.08733	0.15843	0.60868**
Mazes	0.11616	0.40384	0.19978

* $(p < .05)$
** $(p < .01)$

TABLE 6

Factor 1	Factor 2	Factor 3
Information (.85031)	Block Design (.77782)	Coding (.60868)
Vocabulary (.77480)	Object Assembly (.63237)	Arithmetic (.52989)
Similarities (.65060)	Picture Completion (.47420)	Digit Span (.47578)
Comprehension (.64320)	Mazes (.40384)	
Arithmetic (.48235)	Picture Arrangement (.37191)	
Digit Span (.41472)		

Table 7 represents factor score coefficients for each subtest associated with each of the three factors. By multiplying any individual's scaled score on any particular subtest (in the present sample) by the associated coefficient, a factor score (a raw score) can be obtained for each subject on each factor. This will enable one to determine to which of the three factors any one individual's relative strengths belong.

TABLE 7

Factor Score Coefficients of Subtests

	Factor 1	Factor 2	Factor 3
Information	.56171	-.13215	-.30014
Similarities	.13526	.04274	.10918
Arithmetic	-.02431	-.03692	.37994
Vocabulary	.30841	-.06178	.04599
Comprehension	.12586	.03121	.08485
Digit Span	.03899	-.07201	.23138
Picture Completion	.00199	.17213	.11156
Picture Arrangement	-.02229	.09644	.03071
Block Design	-.14538	.57466	-.10213
Object Assembly	-.09212	.23608	.04030
Coding	-.10211	-.03055	.39805
Mazes	-.00794	.12245	.01727

Chapter 5

Discussion

On the Wechsler Intelligence Scale for Children-Revised (Wechsler, 1974), there appears to be three major group factors, at least when dealing with a population from a lower middle class socio-economic background. Summarized, Factor I appears to represent clearly verbal abilities that are heavily influenced by educational and background variables. Factor II appears to represent motor-perceptual abilities. Factor III appears to also represent verbal abilities, for the most part, but doesn't seem to be affected so much by educational and background variables as it is by a memory variable.

Considering those Verbal subtests of which Factor I is composed, it appears that this factor is a rather complicated combination of range of knowledge, long-term memory, social judgment, verbal concept formation, logical thinking, learning ability, and language development. All of these functions would be influenced by a combination of variables such as natural endowment, richness of early educational environment, sociocultural expectations, and the ability to evaluate and use past experiences, as viewed from the conceptual framework of Sattler (1974).

Factor II is primarily composed of the Picture Completion, Block Design, Object Assembly, and Mazes subtests. This factor appears to be a combination of the functions of visual-motor coordination, perceptual organization, spatial visualization, abstract conceptualizing ability, analysis and synthesis, ability to differentiate essential from nonessential details, concentration, reasoning, and planning ability. These functions would be influenced by variables such as experiences in life, rate of motor activity, color vision, precision of motor activity, and visual-motor organization (Sattler, 1974).

Factor III is composed primarily of the Arithmetic, Digit Span, and Coding subtests. It shows some crossover between the Verbal and Performance Scales. This factor appears to be a combination of the functions of reasoning ability, accuracy in mental arithmetic, concentration, attention, memory, visual-motor coordination, and speed of mental operation. The function of short term memory appears to be of predominant importance. The functions in Factor III would be influenced by variables such as opportunities to acquire fundamental arithmetic processes, rate of motor activity, and the ability to passively receive stimuli (Sattler, 1974).

Factor I is heavily loaded by verbally influenced factors and is primarily composed of the Information, Similarities, Vocabulary, and Comprehension subtests. This factor would also be the best predictor of the Full Scale IQ, but not necessarily of _g_ because of the lack of second order factors in the design and the ambiguity regarding the definition of _g_. Also, some researchers, such as Guilford, have been highly critical of the _g_ theory in the study of human abilities. Guilford claims that the presence of a major share of common variance in the first factor of a direct method is a function of factorial design and not necessarily a structural feature of human abilities.

Of major importance is the further substantiation of Wechsler's (1958) position that the Wechsler scales tap not only the Full Scale IQ (possibly g) but also factors that are specific to particular subtests. This is in contradiction to the arguments made by Anastasi (1968). The results give some substantiation to the intelligence theory of Vernon (1950), in which he defines a series of hierarchical levels of intelligence made up of a general intellectual factor, a practical-mechanical-spatial factor, and a verbal-educational factor. Only the concept of Cattell's (1963) crystallized intelligence is shown to have any importance among the three factors, most specifically Factor I.

The results of the present study are almost in complete congruence with the factor analysis of the Wechsler Adult Intelligence Scale (Wechsler, 1955) by Cohen (1959a). Cohen identified a "verbal comprehension" factor with large weights in all the subtests identified as Factor I in the present study. His "perceptual organization" factor had large weights in two of the same subtests as Factor II, Block Design and Object Assembly. The third major factor identified by Cohen was described as a "memory" factor, and it also had large weights in two of the same subtests as Factor III, Arithmetic and Digit Span. Along the same lines, the present study failed to support, as did Cohen's study, the standard practice of grouping tests into Verbal and Performance Scales. Factor I occurs in only four of the six Verbal Scale subtests. Factor II has significant loadings in only three of the six Performance Scale subtests. The remaining three Performance subtests appear to have largely specific variance not shared with other subtests in the battery.

In comparison with Cohen's (1959) factor analytic study of the Wechsler Intelligence Scale for Children (Wechsler, 1949), only the Verbal Comprehension I factor (the aspect of verbally retained knowledge that is produced by a formal education); the Perceptual Organization factor (the nonverbal factor reflecting the ability to interpret and organize visually perceived material against a time limit); and the Freedom from Distractibility (reflecting memory and the ability to remain undistracted) appear to have been extracted utilizing the Wechsler Intelligence Scale for Children-Revised (WISC-R), corresponding roughly to Factors I, II, and III respectively. A separate group factor identified by Cohen as Verbal Comprehension II (reflecting the ability to apply verbal skills to new situations) and a separate group factor identified as a Quasi-Specific factor with no psychological interpretation were not found. Cohen found that the best measures of g were, in ranked order: Vocabulary, Information, Comprehension, Arithmetic, Similarities, Picture Arrangement, and Block Design. In the present study, the best measures of the Full Scale IQ (possibly g) on the WISC-R are, in ranked order: Information, Similarities, Arithmetic, Vocabulary, Comprehension, Digit Span, and Picture Completion. Subtests, on the WISC, found to have low loadings on g by Cohen were Picture Completion, Object Assembly, Coding, and Mazes. On the WISC-R, the Block Design, Object Assembly, Coding, and Mazes appear to be poor predictors of the Full Scale IQ. The findings here substantiate Cohen's hypothesis of the Verbal IQ being a good measure of the Full Scale IQ while the Performance IQ is a relatively poor measure. In comparing the factors on the WISC-R to those found by Cohen (1959), it is important to remember that the present study utilized a rather homogeneous sample while Cohen's sample more closely approximated the standardization sample of Wechsler (1949).

In comparison to other previous factor analytic studies on the WISC, the present study very closely approximated the findings of Witkin (1960). Witkin identified three major group factors: (a) Verbal (consisting primarily of Information, Comprehension, and Vocabulary, as in Factor I on the WISC-R); (b) Perceptual Analytic (consisting of Picture Completion, Block Design, and Object Assembly, as in Factor II on the WISC-R); and (c) Attention (consisting of Arithmetic, Digit Span, and Coding, as in Factor III on the WISC-R).

Since the present sample was a rather homogeneous group in regards to socioeconomic status and included both whites and blacks, the high percentage of variance accounted for by the Verbal subtests, particularly Information and Vocabulary, seems to have serious implications for future study. According to the principles underlying factor analysis, a more heterogeneous sample would be expected to yield even higher percentages of variance. The factor structure of the WISC-R appears to be essentially the same as that of the WISC even though the sample included a more than representative proportion of blacks and both whites and blacks came exclusively from a lower middle class background. This would give basis to prevent changing the items in the critical Verbal subtests which appear to be the most influential in determining the predictive validity of the IQ score.

The use of factor scores in place of single subtest scores appears to offer much promise in the field of intelligence testing. To be able to fully utilize factor scores, data from a factor analytic study using a sample closely approximating Wechsler's (1974) is needed. Only then could the raw factor scores, available with the present data, be transformed into meaningful standard scores and the best use of factor scores be made.

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