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ABSTRACT

Relationships between school achievement and two theoretically different measures of intelligence, Piagetian and psychometric, are explored in 143 bright, average, and retarded elementary school students. Factor analyses of the California Test of Mental Maturity, the Metropolitan Achievement Test, the Stanford-Binet, and fifteen Piaget-type tasks indicated that these tests overlap to some degree, but that Piagetian tasks appear to measure a different intelligence and a different achievement than psychometric tests. Implications for education are discussed. (SBT)

ABSTRACT

Empirical relationships are explored among the theoretically different Piagetian and psychometric assessments of intelligence, and school achievement. Ss were 143 bright and average children chronologically aged 5, 6, and 7 years. Factor analyses of performance on CTMM, MAT, Stanford-Binet, and 15 Guttman-scaled Piaget-type tasks indicated that Piagetian, IQ, and achievement tests overlap to some degree, but also measure different aspects of cognitive functioning.

Relationships Among Piagetian, IQ, and Achievement Assessments[1]

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IQ tests such as the Stanford-Binet Intelligence Scale are believed to measure intelligence. Belief in psychometric intelligence is so thoroughly ingrained in American psychology and education that hardly a school system or professional journal can command respect without taking account of IQ in educating or studying children. Recently, however, McClelland (1973) challenged the validity of IQ tests as measures of intelligence. His review of the literature led him to argue convincingly that the high correlations between IQ scores and various measures of occupational success or life adjustment are likely due to social class rather than to intelligence.

School achievement tests have also recently been under attack. Kohlberg and Mayer (1972) reviewed the literature and found that school achievement only predicts further school achievement and fails to predict anything else of value (such as occupational success).

The crumbling assumptions that an IQ score represents intelligence and that school achievement prepares children for later success lead to a demand for alternatives in theory and practice. Kohlberg and Mayer (1972) suggest that Piagetian "cognitive stage measures provide a rational standard for educational intervention where psychometric intelligence tests do not (p. 489)." This alternative suggestion is congruent with McClelland's (1973) less specific advocacy of tests with scores which "change as the person grows in experience, wisdom, and ability to perform effectively on various tasks that life presents to him (p.8)." Therefore, the Piagetian alternative to psychometric methods seems worth examining.

The issue with regard to intelligence is: Are there theoretical and empirical differences between psychometric and Piagetian conceptions of intelligence?

The issue with regard to school achievement is: Are there theoretical and empirical differences between school achievement and knowledge measured by Piagetian tasks? This study is therefore concerned with the empirical relationships among the theoretically different Piagetian and psychometric assessments of intelligence, and school achievement. Let us first consider theoretical differences and related research findings.

Theoretical and Empirical Relationships between Psychometric and Piagetian Conceptions of Intelligence

IQ tests are not derived from any theory of intelligence, but are based, instead, on certain assumptions about intelligence. IQ testmakers assume that the more correct answers the child gives relative to others of the same chronological age, the more intelligent he is. IQ is thus defined in terms of individual differences with regard to a wide variety of items which have no theoretical significance in themselves (that is, one cannot conclude anything about a child's general intelligence from his response to a single item). To a large extent, these items simply tap bits of surface information (such as the days of the week, the difference between a baseball and an orange, and perceptual discrimination of similarities and differences). Their surface nature is indicated by the fact that psychologists try so hard to keep their test answers secret in order to prevent "spuriously high" scores by individuals who simply learn the answers.

In contrast, Piaget's task are derived from (and contributed to) a research-based theory of intelligence. Concerned with finding out what intelligence is rather than with quantifying it, Piagetian research has demonstrated universal, qualitative changes in the reasoning of humans from birth through adolescence. The theory accounts for these changes in terms of a gradual development of basic [illegible]itive structure. Piagetian tasks are concerned with how the individual views and reasons about reality (for example, whether there are more blocks or more blue blocks, whether a quantity changes in amount when changed in shape, and whether one is a sister to one's sister). Each task has theoretical significance and in itself reveals something important about the individual's general development of his intelligence. Assessment is not concerned just with right answers, but with kinds of wrong answers as well. Wrong answers are important for assessment because research has shown that a child must go through many instances of being wrong before he finally constructs adult-level knowledge and intelligence. Thus, intelligence is defined by Piaget in terms of an individual's place in a universal sequence of development toward formal operational reasoning.

Research findings bearing on the relationship between psychometric and Piagetian intelligence are mixed. Relationships reported between Piagetian tasks and IQ are sometimes low (Dodwell, 1960, 1962; Beard, 1960) and sometimes moderate (Elkind, 1961; Almy, 1966, 1970; Dudek, Lester, Goldberg, and Dyer, 1969; Honig, personal communication). Moderate correlations are usually reported between mental age and Piagetian performance (Russell, 1940a, 1940b; Mannix, 1960; Kohlberg, 1963; Freyberg, 1966). Factor-analytic studies generally indicate that Piagetian measures define factors separate from psychometric intelligence factors. Kohlberg and DeVries (1969) found three factors in the performance of bright and average 6-year-olds:

1. General psychometric intelligence (eleven tests or subtests drawn from a variety of psychometric measures)
2. Conservation (Liquid, Length, Ring Segment)
3. Classification (Sorting and Class Inclusion)

Stephens, McLaughlin, Miller, and Glass (1972) found five interpretable factors in the performance of normal and retarded children from 6 to 18 years of age:

1. Verbal (13 Wechsler and 3 Wide Range Achievement Test variables)

2. Piagetian reasoning (23 Piagetian measures), CA, MA
3. Classification (4 Class Inclusion tasks)
4. Spatial reasoning
5. Performance (Wechsler Performance IQ and Object Assembly)

In a second study of the same Ss four years later, Stephens (1972) found the following seven factors:

1. Verbal (6 Wechsler verbal subtests, and 3 Wide Range Achievement subscores)
2. Conservation (Substance, Weight, Volume, Length, Liquid)
3. Performance (5 Wechsler performance subtests)
4. Flexibility of thought processes (MA, CA, 4 Piagetian measures of spatial reasoning, relationships, and classification)
5. Classification (3 Class Inclusion of Animals tests)
6. Mobility in dealing with concrete and abstract spatial relations (3 tasks)
7. Transition from concrete to abstract operational thought (Dissolution of Sugar, Conservation of Weight and Volume, Class Inclusion of Animals, Transfer from Two to Three Dimensions, and Changing Mobile Perspectives)

Hathaway (1973), analyzing data collected by Dudek, Lester, and Goldberg, was able to identify three independent factors among 100 children 5 to 8 years of age:

1. WISC subtests
2. Seven Piagetian tasks
3. California Achievement Test subtests, some WISC subtests, and four Piagetian tasks.

The general picture presented by these findings is not clear, but does suggest some degree of overlap and some degree of non-overlap of psychometric and Piagetian measures of intelligence.

Theoretical and Empirical Relationships between School Achievement and Piagetian Conceptions of Knowledge

Piaget's view of knowledge is much broader than that reflected by school achievement tests. In the larger sense, Piaget views the development of knowledge and the development of intelligence as the same. In the narrow psychometric sense of achieving right answers to specific questions, Piaget (1964) points out that it is general cognitive development which makes specific learning possible. Since it is well known that achievement tests are highly correlated with IQ tests, the question arises as to whether Piagetian and achievement assessments overlap. For example, does Piagetian number conservation predict arithmetic achievement?

The research literature contains little regarding the relationships among Piagetian measures and measures of psychometric achievement, but a few studies suggest that these assess different kinds of knowledge. In the Hathaway study described above, an achievement factor included some Piagetian tasks but was independent of a factor comprised of other Piagetian tasks. Ross (reviewed in Hathaway, 1973), studying 8- and 9-year-olds, found four Piagetian classification tasks to form a factor separate from Reading Comprehension, Slosson IQ, and Paragraph Meaning. Hood (1962) studied the relationship between five grades of arithmetic competence (based on teacher's judgments) and three Piagetian stages on number-related tasks, and found that no child at the lowest level on one measure was at the highest level on the other; in between these extremes, however, the relationship was not linear, Almy (1966) reports that for children 5 to 7 years of age, conservation of number and liquid are moderately correlated with reading readiness but correlated at a low or negative level with vocabulary. The general picture presented by these findings is also unclear, but suggests some non-overlap between Piagetian and school achievement measures.

In order to clarify further the relationships among performance of young children on Piagetian tasks and psychometric tests of intelligence and achievement, the present study considers the following two questions:

1. To what extent do IQ tests and Piaget-type tasks measure the same intelligence? Specifically, how does Stanford-Binet mental age[2] (MA) relate to performance on Piaget-type tasks? Also, how does IQ on the California Test of Mental Maturity (CTMM) relate to performance on Piaget-type tasks?
2. To what extent do school achievement tests and Piaget-type tasks measure the same knowledge? Specifically, how does performance on Piaget-type tasks relate to performance on the Metropolitan Achievement Test (MAT)?

Method

Subjects

Ss were 143 white children, of bright, average, and retarded psychometric abilities (measured by performance on the Stanford-Binet Intelligence Scale) enrolled in the public schools of Champaign, Illinois (including some retarded pupils in Urbana and St. Joseph, Illinois). High-IQ and Average-IQ children were chronologically aged 5 to 7 years. Low-IQ Ss were mentally aged 5 to 7 years and chronologically aged 6 to 12 years. Table 1 shows the distribution and characteristics of the sample.

INSERT TABLE 1 ABOUT HERE

Procedure

Fifteen Piaget-type tasks[3] were individually administered in three sessions totalling about two hours, as follows:

Session 1: Guessing Game (DeVries, 1970)
Conservation of Mass
Sibling Egocentrism
Left-Right Perspective
Constancy of Generic Identity (revised photograph form of the test described in DeVries, 1969)
Class Inclusion

Session 2: Conservation of Number
Constancy of Sex Identity (Kohlberg, 1963; DeVries, 1969)
Conservation of Mass in the context of the ring-segment illusion (Jastrow effect)
Dream Interview
Conservation of Length

Session 3: Length Transitivity
Conservation of Liquid
Magic Interview (Kohlberg, 1963)
Object Sorting (Kohlberg, 1963)

Scores on the California Test of Mental Maturity and the Metropolitan Achievement Test were obtained from school records and interpolated for time of Piagetian testing.

Analysis

A Guttman scale was constructed for each of the Piaget-type tasks which met Green's (1956) criterion of an Index of Consistency greater than .50. Each scale also met Kohlberg's (1963) criteria for developmental sequentiality. That is, mean scale scores increase with age, success on each scale item increases with age, and the sequence of items is justified with a logical rationale based on Piaget's theory. Each S was assigned a scale score on each task.

Factor analyses, using the principal component method,[4] with both orthogonal and oblique rotations,[5] were performed with two groupings of variables:

1. Stanford-Binet MA and 15 Piagetian tasks (N=122)
2. Stanford-Binet MA, 15 Piagetian tasks, CTMM language and Non-Language IQ, and 4 MAT subscores (N=50)

Only Ss were included for whom data were complete on all variables. Since CTMM and MAT data were available on only 50 bright and average Ss, the first factor analysis was performed in order to establish the patterning of Piagetian and mental age variables with a large sample which included the retardates. The second analysis could thus be validated against the first.

Results

For both groupings of variables, the oblique rotations revealed nearly identical factor structures to those of the orthogonal rotations. Therefore, the results below focus on the outcome of orthogonal rotations.

Factor Analysis of Stanford-Binet MA and Piaget-Type Tasks

Table 2 shows the intercorrelations among mental age and Piagetian

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INSERT TABLE 2 ABOUT HERE

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tasks for the larger sample of 122 bright, average, and retarded Ss for whom all data were available. Low to moderate correlations were found between mental age and these tasks. Table 3 shows the results of the factor analysis.

INSERT TABLE 3 ABOUT HERE

Three main factors emerged: a first conservation factor, accounting for one-third of the variance, a second factor containing most of the remaining Piagetian variables and MA, and a third identity factor closely related to the conservation factor (r=.36). Three tasks (Sibling Egocentrism, Length Transitivity, and Object Sorting) form two other weak factors.

These results suggest that Stanford-Binet mental age is a poor predictor of performance on most of these Piaget-type tasks. MA related to performance on five tasks (Guessing Game, Left-Right Perspective, Magic, Class Inclusion, and Dream), but is independent of performance on Conservation, Identity, Sorting, Sibling, and Transitivity tasks.

This evidence indicates that intelligence as defined by Stanford-Binet mental age overlaps to a moderate degree with Piagetian intelligence, but that they are not identical. Therefore, the theoretical differences between Piagetian and psychometric intelligence do seem to correspond to real differences in cognitive measurement.

Factor Analysis of Stanford-Binet MA, Piaget-Type Tasks, CTMM, and MAT

Table 4 shows the intercorrelations among MA, Piagetian tasks, CTMM .

INSERT TABLE 4 ABOUT HERE

Language and Non-Language IQ, and MAT subtests, for the subsample of 50 bright and average 6- and 7-year-olds for whom all these data were available. Correlations are similar, though generally somewhat lower, in comparison to the correlations reported in Table 2 for the larger sample. Table 5 shows the result of the factor analysis. Essentially the same grouping of Piagetian variables appeared as found

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INSERT TABLE 5 ABOUT HERE

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for the larger sample, a finding which engenders confidence in the relationships found for the smaller and more restricted sample. The conservation and identity factors were especially stable. Four main factors emerged which accounted for 61.3 percent of the total variance. The first factor, accounting for one-third of the variance, included Stanford-Binet MA, CTMM Language and Non-Language IQ, Left-Right Perspective, Class Inclusion, and Magic (with substantial minor loadings of Ring Segment Conservation, Dream, and MAT Arithmetic). The second factor included all the conservation tasks and Sibling Egocentrism (with substantial minor loadings of the two identity tasks). The third factor was defined by the four MAT subtests and Dream. The fourth factor included the two identity tasks and Object Sorting. The minor fifth and sixth factors were defined, respectively, by Guesing Game and Length Transitivity.

The oblique rotation indicated that the first and second factors were related (r=.33), due primarily to the loading of Ring Segment Conservation on both factors. The first factor was also related to the third factor (r=.34), due primarily to the loading of S-B MA, MAT Arithmetic, and Dream on both factors. Figure 1 represents the relationships among the three main factors.

INSERT FIGURE 1 ABOUT HERE

These results confirm the general finding of the analysis with the larger sample. Some overlap does exist between Piagetian and psychometric assessments. However, the overlap is limited, and Conservation, Identity, Sorting, Guessing Game, and Transitivity stand out as particularly different from psychometric mental age.

In addition, this result indicates that, with the exception of the Dream measure, no overlap exists between knowledge on Piaget-type tasks and school achievement knowledge as measured by the MAT. The correlation of only .20 between Number Conservation and Arithmetic achievement is particularly striking. Therefore, the theoretical differences between these two measures of knowledge also correspond to real differences in cognitive measurement.

Discussion

The results of this study are in general agreement with the findings of other factor-analytic studies of performance on Piagetian, IQ, and achievement tests. To a very large extent, Piagetian tasks do appear to measure a different intelligence and a different achievement than do psychometric tests. This finding suggests examination of the nature of this difference and the implications for assessment of intelligence, for education, and for research on children.

Two primary differences can be noted between Piagetian and psychometric measures. First, they differ in their general perspective, and second, they differ specifically in how they assess intelligence.

The psychometric perspective takes a standard of normal intelligence closely related to school success. Psychometric intelligence is defined in terms of success on school-type items, and evidence of validity is frequently offered in erms of high correlations with school achievement. Cronbach (1960) even asserts that "The term 'intelligence test' is being replaced by such terms as 'test of general mental ability' or 'test of general scholastic ability' (p. 164)." Thus, the psychometric definition and perspective of intelligence is a very narrow one, defined by educational expectations of children.

In contrast, Piaget's definition of intelligence is not limited to school-type success, but takes the long-range perspective of the evolution of knowledge and intelligence in the individual. This evolution is described in terms of changes with age in the structure of knowledge. Thus, the Piagetian perspective is a broader one, defined by children's changing reasoning about reality.

In terms of how they try to measure intelligence, psychometric IQ tests assess how many correct answers a child can give in a highly structured situation. Reality is structured for the child, and, as McClelland (1973) has noted, what is required is ...ndent behavior, not the operant kind of behavior necessary in life situations where one cannot "choose between defined-in-advance responses (p. 11)." Basically, IQ tests measure, as Inhelder (1943) pointed out, "the results of previous activities and acquisitions (p. 44)." These characteristics are also true of standardized achievement tests.

In contrast, Piaget's tasks focus on the child's reasoning behind his conclusions. These tasks confront the child with ambiguities of reality and ask him to impose his ideas onto these ambiguities Basically, this is an assessment of the structure of the child's logic in terms of its future development. The focus is upon the operations which make possible many specific acquisitions.

McClelland (1973) emphasized that what intelligence tests mainly predict are test-taking and symbol manipulation competencies. Inhelder (1943) commented that the Binet test gives a numerical sum of successes and failures, but that:

> It remains a very tricky problem to go further and conclude from this summation of results anything about the way the child arrived at them, the intellectual constructions that enabled him to do so, or the nature of the deficiencies from which his failures stemmed (p. 45).

Inhelder concluded that "Although the Binet-Simon test is an excellent means for the rapid detection of mental anomalies, it cannot meet the demands of a psychological 'diagnosis' of thought. . . .(p. 44)."

Given these differences in perspective and method, let us consider the implications for assessment of intelligence. The question is: What is the most valid measure of intelligence? Many challenges to the validity of IQ tests have already been mentioned. In addition, Inhelder (1943) found that IQ tests are often faulty even in their assessment of permanent mental retardation, the purpose for which they were originally designed. Her study of children (and some adults) classified as retarded on the basis of IQ revealed that the IQ measures were not sensitive to differences between children who eventually become formal operational (but whose rate of development was slow) and true retardates who never progressed past the concrete operational stage. Piagetian tasks did differentiate between these two groups, though in some cases a diagnosis could not be made with certainty until adolescence. Later longitudinal study of retardates by Stephens (1972) indicates that many retardates continue to progress through Piagetian stages even past the age of 20.

These findings suggest that IQ assessment often categorizes individuals as permanently retarded when, in terms of the development of reasoning, they are simply slow in their rate of development. (It may be that such inappropriate labeling even contributes to creating permanent retardation by relegating low-IQ children to educational situations which prevent or fail to promote their continued development.)

Piaget's tasks do seem to provide a theoretically and empirically more valid assessment of intelligence than psychometric measures. However, Piagetian tasks are not proposed as substitutes for psychometric tests. IQ tests probably do serve a purpose in providing, as Inhelder (1943) suggested, a "first approximation" to assessment of a child's intelligence.

It should also be pointed out that even Piagetian tasks are limited in their ability to assess an individual's intelligence. At levels below the level of formal reasoning, it is tempting to try to evaluate individual children's strengths and weaknesses on Piaget's various tasks. However, such attempts would be mistaken primarily because particular patterns of comparative progress have no long-range predictive value. That is, the fact that a child is more advanced on physics problems than no mathematics problems has on long-range significance in terms of his general intelligence. However, the fact that he is more advanced in <u>some</u> area of reasoning may be significant. Sinclair (personal communication) relates that while retardates generally perform at the same level across all Piagetian tasks, normal children typically show advances in some areas. Sinclair speculates that it may be that such advances create a disequilibrium which prompts dissatisfaction with lower-level thinking in other areas. Such dissatisfaction with lower-level reasoning is necessary before a child feels the need to construct something different.

Sinclair also cautions that apparently established structures (pseudo structures) may sometimes seem to disappear. For example, a child who previously conserved weight may give nonconservation responses when his focus shifts from weight to local pressure. We simply do not know enough about decalages on Piagetian assessments to draw firm conclusions about the intelligence of a child relative to other children. Perhaps it is unrealistic to expect to be able to make valid fine-grained assessments of individual intelligence which have long-range predictive value.

Now let us turn to implications of this study for education. The finding that school achievement is almost entirely unrelated to the development of reasoning on Piagetian tasks suggests a reassessment of the overall objectives of education. The Piagetian perspective leads to the view that the aim of education should be the long-range development of the individual (not only cognitively, but emotionally, socially, and morally) (Kohlberg and Mayer, 1973; Kamii and DeVries, in press). Academic achievement as an educational goal would then be reduced in proportion and placed in the larger developmental perspective.

It is not suggested that Piaget's tasks substitute for tests of a child's academic knowledge. Certainly tests of reading ability, computational skills, etc., have an appropriate place. However, their meaning becomes clearer when placed in the broader context of Piaget's theory of development.

Finally, what are the implications of this study for research on children? Virtually all contemporary studies take account of psychometric intelligence, and many studies actually are structured in such a way that other behaviors of children are viewed through the lens of the IQ. Such acceptance of the IQ as intelligence may obscure our possibilities for advancing our knowledge about child development. Serious reassessment of research methods and interpretation of findings which rest on IQ measures seems warranted.

Footnotes

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[2]Mental age is taken as the measure of psychometric intelligence on the Stanford-Binet Test because it is defined in terms of increase with age and might therefore be assumed to correspond with Piagetian developmental changes.

[3]The battery is referred to as "Piaget-type" because some tasks are included which Piaget never studied (Guessing Game, Constancy of Generic and Sex Identity, Ring Segment Conservation, and Magic). Nevertheless, these were inspired by Piaget's work and are similar in focus and method to Genevan tasks. Tasks and scoring are described in detail elsewhere (DeVries, 1971).

Footnotes (continued)

[4] A principal factor analysis was also performed, with essentially the same results.

[5] The oblique rotation permits factors to be dependent. Piagetian tasks would be assumed to be related and the oblique rotation was judged necessary in order to ascertain whether the restriction of orthogonality (independence) of factors was distorting the factor picture.

TABLE 1

Mean Chronological Age, Mental Age, and IQ of Bright, Average, and Retarded Subjects (N=143)

Age Group	Character-istics	Bright			Average			Retarded[a]		
		Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
5	N	8	8	16	9	8	17	8	5	13
	CA[b]	5-5	5-8	5-7	5-6	5-6	5-6	7-10	7-4	7-8
	MA[b]	6-10	7-5	7-2	5-10	5-9	5-9	5-6	5-3	5-5
	IQ	130	133	132	108	105	106	69	67	68
6	N	8	8	16	8	9	17	8	8	16
	CA[b]	6-6	6-6	6-6	6-7	6-5	6-6	8-6	8-9	8-7
	MA[b]	8-2	8-2	8-2	6-10	6-11	6-10	6-4	6-5	6-5
	IQ	129	129	129	104	107	105	74	72	73
7	N	8	8	16	8	8	16	8	8	16
	CA[b]	7-7	7-7	7-7	7-9	7-7	7-8	9-11	10-1	10-0
	MA[b]	9-8	9-9	9-9	7-11	7-11	7-11	7-5	7-6	7-6
	IQ	130	130	130	101	105	103	75	74	75
Mean All Ages	N	24	24	48	25	25	50	24	21	45
	CA[b]	6-6	6-7	6-7	6-7	6-6	6-6	8-9	8-11	8-10
	MA[b]	8-3	8-5	8-4	6-10	6-10	6-10	6-5	6-7	6-6
	IQ	130	131	130	104	105	105	72	72	72

[a]Age group classification for this group is mental age, rather than chronological age.

[b]Years and months.

TABLE 2

Intercorrelations among Stanford-Binet MA and Fifteen Piaget-Type Tasks for Bright, Average, and Retarded Children

(N=122)

	MA	Guessing Game	Sibling Egocentrism	Generic Identity	Left-Right Perspective	Mass	Number	Sex Identity	Class Inclusion	Liquid
MA	1.00	0.45	0.30	0.41	0.44	0.28	0.33	0.35	0.59	0.40
Guessing Game	0.45	1.00	0.10	0.19	0.29	0.16	0.33	0.13	0.26	0.29
Sibling Egocentrism	0.30	0.11	1.00	0.21	0.11	0.20	0.11	0.19	0.14	0.26
Generic Identity	0.41	0.19	0.21	1.00	0.05	0.21	0.32	0.72	0.27	0.35
Left-Right Perspective	0.44	0.29	0.11	0.05	1.00	0.07	0.04	0.14	0.30	0.06
Mass	0.28	0.16	0.20	0.22	0.07	1.00	0.57	0.21	0.09	0.61
Number	0.33	0.33	0.11	0.32	0.04	0.57	1.00	0.32	0.24	0.62
Sex Identity	0.35	0.13	0.19	0.72	0.14	0.22	0.32	1.00	0.27	0.30
Class Inclusion	0.59	0.26	0.14	0.27	0.30	0.09	0.24	0.27	1.00	0.22
Liquid	0.40	0.29	0.26	0.35	0.06	0.61	0.62	0.30	0.21	1.00
Length	0.35	0.22	0.12	0.34	0.05	0.44	0.62	0.34	0.20	0.54
Transitivity	0.32	0.25	-0.05	0.14	0.18	-0.00	0.20	0.15	0.24	0.07
Magic	0.56	0.24	0.18	0.37	0.25	0.23	0.30	0.40	0.49	0.30
Ring Segment	0.60	0.28	0.26	0.44	0.32	0.41	0.55	0.45	0.35	0.56
Sorting	0.00	0.18	0.11	0.06	-0.08	-0.00	0.02	0.01	0.06	0.12
Dream	0.58	0.35	0.13	0.38	0.28	0.19	0.44	0.36	0.40	0.40

TABLE 2

(Continued)

	Length	Transitivity	Magic	Ring Segment	Sorting	Dream
MA	0.35	0.32	0.56	0.60	0.00	0.58
Guessing Game	0.22	0.25	0.24	0.28	0.18	0.35
Sibling Egocentrism	0.12	-0.05	0.18	0.26	0.11	0.13
Generic Identity	0.34	0.14	0.37	0.44	0.06	0.38
Left-Right Perspective	0.05	0.18	0.25	0.32	-0.07	0.28
Mass	0.44	-0.01	0.23	0.41	-0.00	0.19
Number	0.62	0.20	0.30	0.55	0.02	0.44
Sex Constancy	0.34	0.15	0.40	0.45	0.01	0.36
Class Inclusion	0.20	0.24	0.49	0.35	0.06	0.40
Liquid	0.54	0.07	0.30	0.56	0.12	0.40
Length	1.00	0.06	0.28	0.56	-0.05	0.44
Transitivity	0.06	1.00	0.15	0.29	0.16	0.19
Magic	0.28	0.15	1.00	0.43	0.02	0.44
Ring Segment	0.56	0.29	0.43	1.00	-0.02	0.46
Sorting	-0.05	0.16	0.02	-0.02	1.00	0.03
Dream	0.44	0.19	0.44	0.46	0.04	1.00

TABLE 3

Factor Matrix[1] Resulting from Varimax Rotation of Stanford-Binet Mental Age and Piagetian Variables

(N=50)

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Percent of Variance Accounted For	34.4%	11.1%	8.0%	7.3%	6.7%
Stanford-Binet Mental Age	0.28	0.79	0.25	0.08	0.10
Guessing Game	0.29	0.51	-0.09	0.42	-0.11
Sibling Egocentrism	0.12	0.21	0.14	0.18	0.82
Generic Identity	0.22	0.14	0.85	0.08	0.06
Left-Right Perspective	-0.04	0.76	-0.14	-0.13	0.05
Mass Conservation	0.79	0.03	0.00	-0.03	0.23
Number Conservation	0.84	0.14	0.16	0.09	-0.14
Sex-role Identity	0.19	0.16	0.86	-0.01	0.02
Class Inclusion	0.05	0.68	0.25	0.08	0.00
Liquid Conservation	0.80	0.14	0.15	0.16	0.19
Length Conservation	0.76	0.13	0.25	-0.11	-0.09
Length Transitivity	0.04	0.36	0.12	0.43	-0.53
Magic	0.18	0.56	0.42	-0.02	0.10
Ring Segment Conservation	0.58	0.47	0.33	-0.01	0.01
Object Sorting	-0.02	-0.09	0.05	0.90	0.12
Dream	0.38	0.53	0.31	0.05	-0.11

[1] The highest loading of a variable is underlined with a solid line. Where secondary loadings are >.40, they are underlined with a dotted line.

TABLE 4-

Intercorrelations among Stanford-Binet MA, Fifteen Piaget-Type Tasks, CTMM Language and Non-Language IQ, and Four MAT Subtests, for Bright and Average Children

(N=50)

	MA	Guessing Game	Sibling Egocentrism	Generic Identity	Left-Right Perspective	Mass	Number	Sex Identity	Class Inclusion	Liquid
MA	1.00	0.00	0.31	0.35	0.46	0.20	0.26	0.31	0.54	0.28
Guessing Game	0.00	1.00	-0.00	0.15	0.11	0.21	0.45	0.23	-0.13	0.23
Sibling Egocentrism	0.31	-0.11	1.00	0.29	0.18	0.38	0.39	0.38	0.19	0.34
Generic Identity	0.35	0.15	0.29	1.00	0.16	0.41	0.51	0.76	0.26	0.37
Left-Right Perspective	0.46	0.11	0.18	0.16	1.00	0.21	0.21	0.13	0.37	0.13
Mass	0.20	0.21	0.38	0.41	0.21	1.00	0.57	0.40	0.04	0.56
Number	0.26	0.45	0.39	0.51	0.21	0.57	1.00	0.55	0.11	0.60
Sex Identity	0.31	0.23	0.38	0.76	0.13	0.40	0.55	1.00	0.24	0.33
Class Inclusion	0.54	-0.13	0.19	0.26	0.37	0.04	0.11	0.24	1.00	0.11
Liquid	0.28	0.23	0.34	0.37	0.13	0.56	0.60	0.33	0.11	1.00
Length	0.19	0.09	0.28	0.43	0.11	0.37	0.64	0.37	0.15	0.48
Transitivity	0.37	0.19	0.23	0.21	0.19	0.04	0.23	0.16	0.17	-0.01
Magic	0.58	0.03	0.27	0.53	0.27	0.32	0.32	0.45	0.46	0.25
Ring Segment	0.56	0.18	0.43	0.44	0.41	0.31	0.59	0.45	0.38	0.46
Sorting	-0.20	0.14	0.10	0.15	-0.18	0.00	-0.02	0.12	-0.02	0.11
Dream	0.57	0.18	0.18	0.35	0.42	0.22	0.31	0.11	0.26	0.30
MAT Word Knowledge	0.55	0.01	0.35	0.45	0.28	0.31	0.31	0.40	0.32	0.31
MAT Word Discrimination	0.58	-0.08	0.45	0.39	9.27	0.29	0.22	0.37	0.32	0.28
MAT Reading	0.40	-0.01	0.10	0.27	0.17	0.20	0.09	0.17	0.24	0.07
MAT Arithmetic	0.49	0.08	0.29	0.28	0.46	0.20	0.21	0.15	0.41	0.33

TABLE 4

(Continued)

	Length	Transitivity	Magic	Ring Segment	Sorting	Dream	Word Knowledge	Word Dis.	Reading	Arithmetic
MA	0.19	0.37	0.58	0.56	-0.20	0.57	0.55	0.58	0.40	0.49
Guessing Game	0.09	0.19	0.03	0.18	0.14	0.18	0.01	-0.08	-0.01	0.08
Sibling Egocentrism	0.28	0.23	0.27	0.43	0.10	0.18	0.35	0.45	0.10	0.29
Generic Identity	0.43	0.21	0.53	0.44	0.16	0.35	0.45	0.39	0.27	0.28
Left-Right Perspective	0.11	0.19	0.27	0.41	-0.18	0.42	0.28	0.27	0.17	0.46
Mass	0.37	0.04	0.32	0.31	0.00	0.22	0.31	0.29	0.20	0.20
Number	0.64	0.23	0.32	0.59	-0.02	0.31	0.31	0.22	0.09	0.21
Sex Constancy	0.37	0.16	0.45	0.45	0.12	0.11	0.40	0.37	0.17	0.15
Class Inclusion	0.15	0.17	0.46	0.38	-0.01	0.26	0.32	0.32	0.24	0.41
Liquid	0.48	-0.02	0.25	0.46	0.11	0.30	0.31	0.28	0.07	0.33
Length	1.00	0.07	0.16	0.49	0.00	0.26	0.23	0.31	0.02	0.02
Transitivity	0,07	1.00	0.06	0.33	-0.01	0.33	0.25	0.35	0.22	0.22
Magic	0.16	0.06	1.00	0.48	0.04	0.39	0.35	0.34	0.26	0.30
Ring Segment	0.49	0.33	0.48	1.00	-0.06	0.46	0.35	0.31	0.15	0.17
Sorting	0.00	-0.01	0.04	-0.06	1.00	0.05	0.04	0.17	0.09	0.18
Dream	0.26	0.33	0.39	0.46	0.05	1.00	0.62	0.57	0.33	0.60
MAT Word Knowledge	0.23	0.25	0.35	0.35	0.04	0.62	1.00	0.72	0.66	0.54
MAT Word Discrimination	0.31	0.35	0.34	0.31	0.17	0.57	0.72	1.00	0.59	0.56
MAT Reading	0.02	0.22	0.26	0.15	0.09	0.33	0.66	0.59	1.00	0.44
MAT Arithmetic	0.02	0.23	0.30	0.17	0.18	0.60	0.54	0.56	0.44	1.00

TABLE 5

Factor Matrix[1] Resulting from Varimax Rotation of Stanford-Binet Mental Age, Piagetian Variables, California Test of Mental Maturity Non-Language and Language IQ, and Metropolitan Achievement Test Subscores

(N=50)

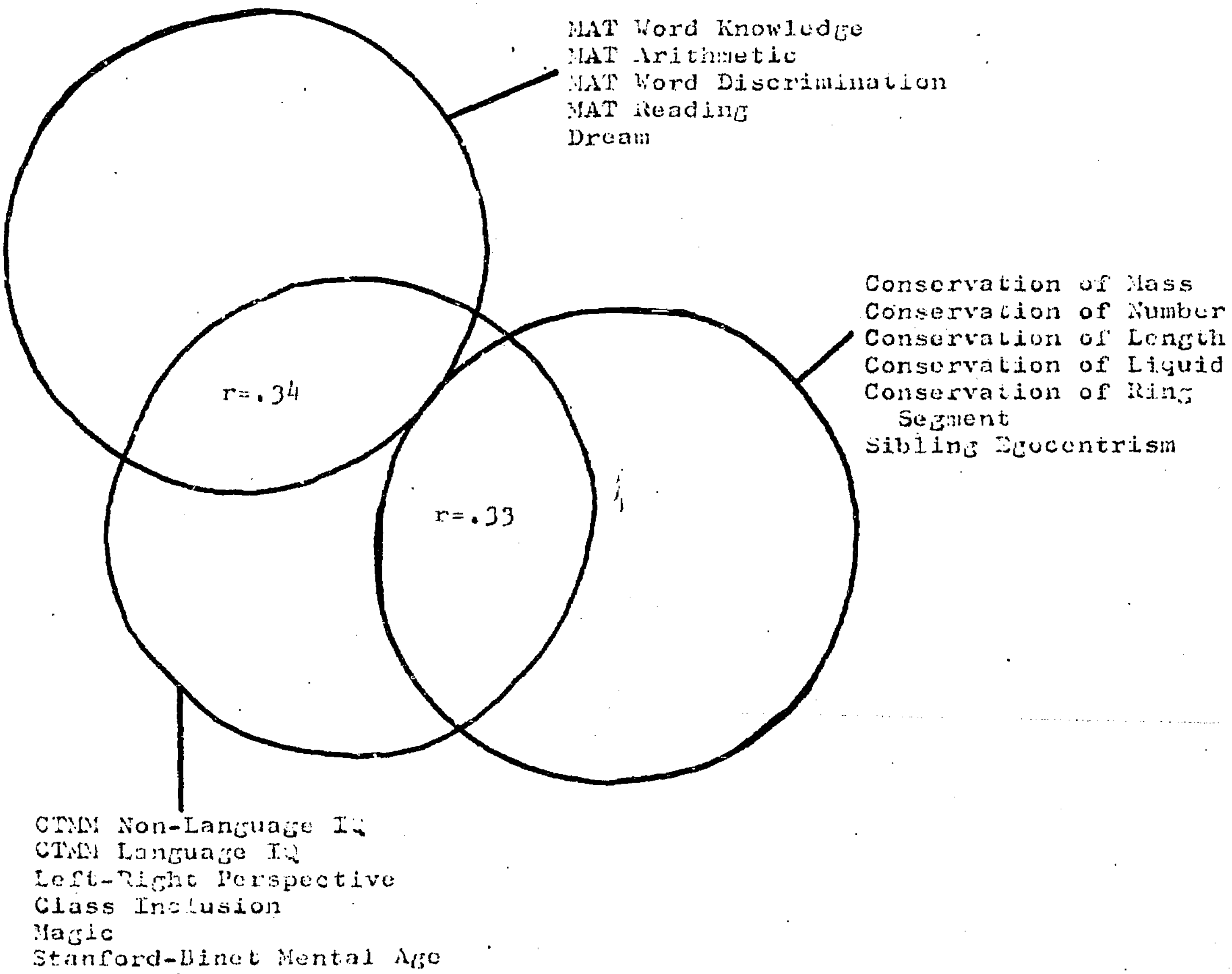
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
Percent of Variance Accounted for	35.2%	12.5%	7.8%	5.8%	5.2%	5.0%
Stanford-Binet Mental Age	0.79	0.18	0.36	-0.09	-0.02	0.22
Guessing Game	-0.01	0.17	-0.03	0.16	0.87	0.15
Sibling Egocentrism	0.13	0.57	0.24	0.01	-0.17	0.16
Generic Identity	0.28	0.48	0.13	0.64	0.07	0.13
Left-Right Perspective	0.54	0.13	0.23	-0.27	0.23	0.11
Mass Conservation	0.07	0.73	0.16	-0.01	0.23	-0.24
Number Conservation	0.18	0.80	0.01	0.12	0.36	0.15
Sex Identity	0.24	0.52	-0.00	0.63	0.04	0.19
Class Inclusion	0.72	-0.01	0.16	0.18	-0.21	0.05
Liquid Conservation	0.07	0.75	0.22	0.05	0.19	-0.25
Length Conservation	0.07	0.77	0.03	0.12	-0.13	0.13
Length Transitivity	0.10	0.03	0.26	0.01	0.18	0.85
Magic	0.74	0.21	0.06	0.37	0.03	-0.14
Ring Segment Conservation	0.53	0.57	0.03	0.09	0.06	0.34
Object Sorting	-0.28	-0.10	0.30	0.63	0.19	-0.18
Dream	0.41	0.19	0.61	-0.06	0.27	0.15
M.A.T. Word Knowledge	0.24	0.30	0.76	0.10	-0.06	0.13
M.A.T. Word Discrimination	0.20	0.29	0.78	0.14	-0.20	0.20
M.A.T. Reading	0.17	-0.02	0.73	0.12	-0.05	0.07
M.A.T. Arithmetic	0.39	0.04	0.74	0.00	0.23	-0.12
C.T.M.M. Non-Language	0.80	0.14	0.31	0.02	-0.02	-0.02
C.T.M.M. Language	0.82	0.12	0.27	-0.08	0.12	0.07

[1] The highest loading of a variable is underlined with a solid line. Where secondary loadings are < .40, they are underlined with a dotted line.

Figure 1

Diagram of Primary Factors Defined by Piagetian,

Psychometric Intelligence, and School Achievement Measures



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