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Relationships Among Intelligence, Piagetian Developmental, & Achievement Assessments in a Sample of Disadvantaged Preschool Children

Mary Hill
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RELATIONSHIPS AMONG INTELLIGENCE, PIAGETIAN DEVELOPMENTAL, AND ACHIEVEMENT ASSESSMENTS IN A SAMPLE OF DISADVANTAGED PRESCHOOL CHILDREN

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RELATIONSHIPS AMONG INTELLIGENCE, PIAGETIAN DEVELOPMENTAL, AND ACHIEVEMENT ASSESSMENTS IN A SAMPLE OF DISADVANTAGED PRESCHOOL CHILDREN

Mary Ann Hill July 1980 54 pages

Directed by: Harry R. Robe, Leroy P. Metze, and Carl R. Martray

 Department of Psychology Western Kentucky University

Much research has been conducted on the relationships among psychometric intelligence as measured by standard IQ tests, level of cognitive maturity as defined by Piaget, and school achievement. These types of assessment have been described as measuring separate but highly correlated aspects of cognitive functioning. Little research, however, has been reported concerning the interrelationships of these three types of measures for disadvantaged children. The Wechsler Preschool and Primary Scale of Intelligence (WPPSI), a Piagetian Battery (PB), and three subtests of the Peabody Individual Achievement Test (PIAT) were administered to 20 four year old children enrolled at a Parent–Child Center in a central Kentucky county. Piagetian Intelligence was found to be the best predictor of PIAT performance for this group. Multiple regression equations were computed to determine which combination of WPPSI and PB subtests would predict achievement with the greatest efficiency; it was found that three WPPSI subtests and seven PB subtests accounted for 99% of the variance on PIAT performance.
INTRODUCTION

A great deal of research has been conducted in the past two decades on the relationships among psychometric intelligence as measured by standard IQ tests, level of cognitive maturity as defined by the theories and instruments of Jean Piaget and his followers, and school achievement. Results have been inconclusive but general findings indicate that the three types of assessment measure separate but highly correlated aspects of cognitive functioning (Kuhn, 1976; Devries, 1974; Kohlberg, 1968). These researchers concur that psychometric intelligence and success on school achievement tests depend on the amount and range of experience with specific kinds of knowledge assessed by such tests, while Piagetian intelligence depends on the density of occurrence of activities which spur cognitive restructuring, independent of the ability to profit from such activities.

Factor analytic studies indicate that the theoretical differences between intelligence and achievement measures and Piagetian measures have an empirical basis, i.e. Piagetian task performance involves abilities other than those measured by standard intelligence and achievement tests (Kohlberg and Devries, and Hathaway [reviewed in Devries, 1974]; Stephens et al., 1972).
IQ and achievement tests are known to correlate highly; indeed the exclusive use of IQ tests for prediction and placement has been criticized on the grounds that both IQ and achievement tests measure success on school-type items which have no theoretical basis, and furthermore that the validity of IQ tests is often based on high correlations with achievement measures (Devries, 1974; Kohlberg, 1968). Certain educators have suggested that developmental criteria, such as Piagetian assessments, or pluralistic methods, such as the System of Multicultural Pluralistic Assessment, or devised evaluations of learning potential are theoretically and empirically more valid for analyzing intelligence and performance levels in heterogeneous populations than the traditional IQ and achievement tests (Kohlberg, 1968; Devries, 1974; Kaufman and Kaufman, 1972; Feuerstein and Rand, 1975; Mercer, 1977).

Investigations into the relationship between Piagetian stage level, IQ, and school achievement as measured by standard instruments have had mixed results (Kohlberg, 1968; Devries, 1974; Kuhn, 1976). There have been few attempts to integrate developmental and psychometric measures for the purpose of predicting achievement. The purpose of the present study is to assess the relationships among performance on the Wechsler Pre-School and Primary Scale of Intelligence (WPPSI), a Piagetian battery (PB), and three subtests of the Peabody Individual Achievement Test (PIAT) for a rural population of culturally and
economically disadvantaged children aged four to five years; furthermore, this study was designed to determine the amount of unique variance added to the prediction of achievement by each of the measures. Regression equations were computed to determine the contributions of WPPSI and PB subtests to achievement for the purpose of obtaining information to validate the construction of a shorter and hopefully more discriminating psychometric-developmental battery.

Little research has been reported concerning the interrelationships of Piagetian performance and psychometric IQ and achievement scores for disadvantaged children, and results are inconclusive. Kaufman (1979) has pointed out that traditional IQ tests may adequately measure the intelligence of individuals raised in environments which stress verbal communication, but are likely to be rather insensitive to the capacities of people raised in cultures which emphasize intuitive non-verbal performance; moreover, he characterized higher Performance IQ rather than Verbal IQ scores (P>V) for disadvantaged children as typical and indicative of true intellectual ability despite a lack of learning opportunities.

Kaufman (1979) described WISC-R (Wechsler Intelligence Scale for Children-Revised) Verbal-Performance differences as indicative of discrepancies in fluid and crystallized ability--fluid ability involving problem-solving through adaptation and flexibility in unfamiliar stimulus situ-
ations, and crystallized ability referring to cognitive functioning in areas involving previous education and habituation. As the "fluid ability" measured by the Performance Scale bears a great resemblance to the notion of Piagetian Intelligence, it was hypothesized (by extending the WISC-R relationships to the WPPSI, as Kaufman does) that, for the present sample, mean Performance IQ would surpass mean Verbal IQ, and Performance IQ would correlate more highly with Piagetian Intelligence than would Verbal IQ. It was expected that, as previous studies have determined, correlations among all measures would be high, positive, and similar in magnitude.

In addition to the investigation of the hypotheses and calculation of the measures discussed above, the present study includes in the review of research several views on the relevance of Piagetian theory and assessment to current interest in multicultural evaluation, criterion-referenced measurement, information processing, and evaluation of learning potential, and to current trends in educational placement, prediction, and philosophy.
Theoretical Positions and Empirical Support

Theoretical differences between Piagetian and psychometric conceptions of intelligence have recently been validated empirically, and considerable research has been devoted to further clarification and interpretation of these differences (Kohlberg, 1968; Devries, 1974; Kuhn, 1976). Factor analytic studies indicate that Piagetian task performance involves abilities different from those measured by standard intelligence and achievement tests, and suggest varying degrees of overlap and non-overlap (Devries, 1974).

Twin studies have shown that 50% of reliable variation in general intelligence scores of normally-reared, healthy school-age American children is contributed by hereditary factors (Kohlberg, 1968); furthermore, for children up to age five, the regular increase in correlations between IQ of foster children and the education of their real mothers almost exactly parallels the increase in child-mother correlations found for home-reared children (Kohlberg, 1968). Although tests administered during the first year of life have not been found to predict intelligence, and factor analytic studies indicate very little overlap between the content of infant developmental scales and IQ tests, factor analysis does
reveal what appears to be a general cognitive factor in IQ tests given after age four (Kohlberg, 1968). An exception to these general findings is Wach's study (1975), in which infants were tested at three month intervals between 12 and 24 months on the Uzgiris-Hunt scale, a Piagetian-based scale of infant development. The children were also tested on the Stanford-Binet L-M at 31 months. Results indicated that each of the Piagetian abilities measured by the Uzgiris-Hunt scale correlated significantly with Binet scores; object permanence had the highest correlation with Binet performance, with development of schemata and causality also correlating highly with Binet scores. Research (reviewed in Kohlberg, 1968) has demonstrated that IQ tests at school entrance tap hereditary contributions to adult intelligence and that about 50% of a child's final psychometric intelligence and about 33% of his performance on achievement tests is predictable from intelligence tests when s/he enters school; it is speculated that the stability of intelligence test scores after age six is due to a continuing stability of both heredity and environment after this age (Kohlberg, 1968). For both Piagetian and psychometric assessments, the proportion of variance accounted for by genetic factors decreases with age, and the proportion accounted for by environmental factors increases. Kuhn's research findings (1976) indicate that environmental factors which cause middle class children to do well on IQ tests are not the
same as those which cause them to progress through the
cognitive stages, and that correlations between the two
measures decrease with age. Also the fact that Piagetian
stage development remains tied to chronological age
(CA) in older subjects supports the view that some form
of physical-social experience is most relevant to cognitive
advancement (Kuhn, 1976).

By convention IQ tests are thought to measure what
a child has learned in the relatively distant past and
achievement tests to measure recent learning (Sternberg,
1979). Whereas the rationale for the construction of
standard psychometric instruments is the existence of "g"
--the general intelligence factor--as the major source of
individual differences (Sternberg, 1979), Piaget rejected
the idea of intelligence as a "hypostatized...special
force" (Flavell, 1963). Rather, he accepted the existence
of an intellectual core but one comprised of the
"functional invariants" of assimilation and accommodation
as opposed to structural invariants. Piaget averred that
universal cognitive structures are the result of inter-
action and are not predetermined or maturational. His
theory defines action as the raw material of intellectual
functioning and the basis for perceptual and cognitive
adaptation; moreover his theory postulates that the
quality of an individual's activity will determine how
and to what degree his experiences will be reflected in
the modification of future behavior (Flavell, 1963).
Changes in behavior which are irreversible, general over a wide range of situations, sequential, and hierarchical are called stages (Kohlberg and Mayer, 1973). Kohlberg (1968) relates "g" and Piagetian intelligence by proposing a hereditary, general ability component of psychometric intelligence which, along with other factors, contributes to general cognitive-structural development. He found that, after Binet mental age (MA) and other psychometric intelligence factors are removed, Piagetian tasks still "hang together," suggesting a general factor separate from innate rate factors involved in the Binet. Piaget himself considered concept development and psychometric intelligence to be measures of the same thing, the latter in a less pure and conceptually understandable form (Kohlberg, 1968).

Research on the components of information processing has been concentrated on the ability to solve analogies, a proven and powerful predictor of general intelligence, and one which is measured on almost every IQ test. Findings demonstrate that children appear to be unable to perform the mapping component until about the age of nine or ten, and this component is not firmly fixed until about the age of 11 or 12. This development is consistent with the shift from concrete to formal operations in Piagetian theory and indicates that the ability to perform analogical reasoning is indeed the hallmark of this stage transition (Sternberg, 1979).
The IQ tests of Spearman, Binet, and Wechsler were designed to measure fixed biological capacity; experience factors are assumed to wash out, and the more experience-specific an IQ item is, the worse it is. On the other hand, Piaget, instead of using a wide range of items to balance out specific experiences, concentrated on general cognitive operations and used test items which would elicit those operations. Devries (1974) criticizes psychometric tests on the grounds that individual differences are defined by success or failure on various items which have no theoretical significance. In contrast, Piaget's conception of intelligence testing is described as the measurement of universal, qualitative changes in cognition through observation of the gradual development of basic logical structures; unlike IQ items, Piaget's tasks have theoretical significance and indicate something important about an individual's development on a continuum ranging from the sensory-motor stage through formal operations. This broad perspective also allows focus upon the operations which make specific learning possible. Devries points out that IQ tests are often inappropriate for the prediction of permanent mental retardation, since some retardates advance through the Piagetian stages during their twenties; on the other hand, a comparison of performance on the two types of assessment indicate that children scoring at the average level or above on IQ tests usually demonstrate strengths and weaknesses across Piagetian tasks, whereas retardates generally perform at the same level across
tasks (Devries, 1974). A notable limitation of cognitive stage tests is the low predictive value of particular patterns of comparative progress. Devries recommends Piagetian assessment as a concomitant measure to IQ tests on the grounds of its theoretical and empirical validity.

According to Kohlberg and Mayer (1973), Piagetian tests measure cognitive competence and IQ tests measure cognitive performance; the emphasis in Piagetian assessment is on level of thought process, not difficulty or correctness of thought product. The authors suggest that stage level tests may reflect growth in cognitive development due to environmental or educational experience more accurately than do psychometric measures. For example, in pre-school enrichment programs, increases in IQ scores cannot be considered increments of cognitive competence since there is not corresponding improvement on cognitive task performance—IQ increases are thought to be due to changes in cognitive motivation rather than capacity. On the other hand, children who are initially high on Piagetian tests and low on the Binet improve considerably on Binet IQ at a later date. These authors believe that non-verbal Piagetian tests can measure cognitive ability which is obscured by timidity or distractibility given the requirements of IQ test administration, and may eliminate some non-cognitive, situational, and verbal factors due to experience. Moreover, whereas psychometric intelligence assumes fixed capacity, Piagetian assessment provides
rational standards and defines important behavior changes for the purpose of educational intervention—in this sense developmental level has more in common with achievement than intelligence. Kohlberg (1968) reiterates Piaget's position that developmental phases of sensitivity are related to behavioral level, not chronological age, i.e. a stimulus is only a stimulus if it can be assimilated to previously developed schemata. Furthermore, Piaget suggested that a child's sensitivity to stimuli increases with development (not age) and that the effects of stimulus deprivation would become more critical with advances in development. Since chronological age correlates with cognitive development when Binet MA is controlled, except under conditions of cultural deprivation, Kohlberg suggests that the Piagetian factor "represents a general and longitudinally predictive residue of the effects of experience upon cognitive development" (p. 1052). He strongly recommends implementing the psychological study of development to concretely define educational goals, and points out the need to determine how structural development as an educational target relates to current definitions of skills in the school curriculum. Kohlberg and Mayer (1973) propose that the basic aim of education be the avoidance of stage retardation:

Piagetian test content has cognitive value in its own right. If a child is able to think causally instead of magically about phenomena, for instance, his ability has a cognitive value apart from arbitrary cultural demands—it is not a mere indicator of
brightness, like knowing the word 'envelope' or *amanuensis."This is reflected in the fact that Piaget test scores are qualitative; they are not arbitrary points on a curve. The capacity to engage in concrete logical reasoning is a definite attainment, being at mental age six is not. We can ask that all children reason in terms of logical operations; we cannot ask that all children have high IQ's (p. 488).

Mercer (1977) has provided much support for the interpretation of IQ and achievement tests as culturally-biased measures of school functioning level, rather than of ability or potential. Her studies have refuted the long-standing belief that achievement and intelligence tests measure different attributes, and that environmental factors make a greater contribution to achievement test performance than to IQ scores. Working with samples of Spanish-American, Black, and Anglo-American children, Mercer concluded that achievement tests could not be differentiated from IQ test scores either by socio-cultural factors or by their correlations with IQ. The rationale for her pluralistic assessment model is given in terms of achievement and aptitude:

In practice...all tests measure both aptitude and achievement...If two students have had the same opportunity to acquire verbal skills, and if one has picked them up while the other has not, the test does indeed measure 'aptitude.' But if one child has been raised speaking Spanish and another English, the test measures the Spanish-speaking child's mastery of a foreign language. If the Spanish-speaking child does worse than the English-speaking, this shows lower achievement in this area, but it need not imply less aptitude...When everyone is equally well-prepared, achievement tests become aptitude tests. When people are unequally prepared, aptitude tests become achievement tests (p. 70).

Mercer controls for IQ bias by constructing norms by "ethclass" and specifying strict criteria for equality in
preparation; if these criteria are met, individuals may be compared to others of their ethclass, and interpretations of learning potential within the larger culture may be made.

Gray (1978) conceptualizes the deficiencies of IQ/achievement testing as a result of the separation of performance (e.g., number of correct responses to specific questions) from the criteria used to judge performance (e.g., norms). He proposed an assessment model based on a combination of criterion-referenced measurement (CRM) and Piagetian theory:

Neither CRM nor Piagetian theory has to separate performance from the criterion against which the performance is compared. The reason for this is quite simple: a CRM instrument reflects specific competencies on an achievement continuum, and an individual either does or does not demonstrate a competency defined on the continuum. Likewise, within Piaget's system, assessment and inference are based on the behavior that the child does or does not exhibit (p. 245).

Gray states that Piagetian assessment provides a psychological basis for CRM, allowing not only an evaluation of specific competencies but also providing information about how a child conceptualizes and interacts with his world. In addition to indications about content mastery, Piagetian/CRM tests would offer a basis for facilitating learning and curriculum development, since knowledge of a student's cognitive level within a specific content domain would allow teachers to aim instruction at instead of beyond the student's level.

Echoing the foregoing objections to the idea of fixed intellectual capacity as a rationale for educational
decision-making, Narrol and Bachor (1975) have discussed the cognitive assessment model developed by Reuven Feuerstein (1975). This approach is based on suggestions of behavioral geneticists that environments have differential effects on genotype. Feuerstein claims that traditional psychometric assessments are not sensitive to the cognitive capacities of the undeveloped thinker, and suffer from low predictive validity for evaluating intellectual potential in individuals whose learning experiences have been hampered by lack of stimulation and conceptual modeling, environmental trauma, and emotional reaction to consistent educational failure. He insists that the concept of intelligence as a quantity is naive, and that the emphasis on the stability of IQ scores and the irreversibility of cognitive deficit has discouraged efforts to improve individual ability to profit from instruction. Feuerstein terms psychometric testing "static testing" because it simply inventories acquired knowledge as opposed to assessing the changes which might be produced in problem-solving behavior under more advantageous conditions; as he points out, this is an ironic situation since intelligence tests are used primarily to predict capacity for learning, yet none of them involves any learning. Feuerstein's method of assessment involves a change from a product to a process orientation very similar to that of Piagetian theory and yields an index of cognitive modifiability (Feuerstein and Rand, 1975). He points out that the syndrome of "cultural
deprivation," most frequently found among disadvantaged socio-economic groups, is also observed in individuals belonging to other classes. Feuerstein modifies the Piagetian view of the prerequisites of cognitive development--direct exposure to stimuli, and the adaptation, through assimilation and accommodation, to more efficient management of these stimuli, leading to higher levels of response and enlargement of cognitive schemata. Whereas Piagetian theory places the human factor in the objectal world as one of many classes of stimuli, Feuerstein conceives of the human factor as "assuming the role of transmitter and mediator of the history of human development of which our culture is the product" (Feuerstein and Rand, 1975, p. 18). The cognitive development of the child is not simply the result of maturation and interaction with the world of stimuli, but the combined result of direct experience with the world and the mediated experience by which certain values vis-a-vis the stimuli are transmitted:

The organism which has not been subject to MLE (Mediated Learning Experience) can be considered as culturally deprived in the sense that the world to which it was exposed had a nature of immediacy, directness without the dimension of past and its mediation which are characteristic of what we use to call culture (p. 19).

Thus the culturally-deprived individual is one whose modifiability through direct exposure to stimuli is limited and impaired. Feuerstein points out that economic impoverishment does not necessarily restrict the amount of stimuli impinging on an individual; in fact middle-class parents
have more control over the variety and intensity of stimuli experienced by their children than do lower-class parents. Also the opportunity for manipulation of objects, which Piaget considered so crucial for cognitive development, is often more varied, more prolonged, and available at an earlier age for the disadvantaged child than the middle-class child in his or her protected, proscribed, scheduled world. Feuerstein concludes that:

The retarded cognitive development or the inappropriate cognitive functioning cannot therefore be accounted for by poverty of stimulation, but rather by the incapacity of the organism receiving the stimuli to use, to register and integrate the stimuli into a larger array or previously experienced elements in view of a higher level of functioning (p. 19).

Kaufman (1979) compared right- and left-brain functioning to intuitive versus computer-like, logical performance. He postulates that the right half of the brain is responsible for common sense and adaptive behavior within a specific subcultural environment, and concluded that intelligence tests may adequately measure intellectual functioning in individuals with experience in left-brained environments, but possibly measure a much smaller portion of mental capacity of people from cultures stressing non-verbal communication and visual-spatial skills. He points out that the WISC-R measures mental functioning under fixed experimental conditions, and that there is no provision for assessing a child's cognitive processing as is possible using Piagetian methods. Within the context of the WISC-R, however, Kaufman states that higher Performance Scale than
Verbal Scale scores (P>V) for culturally disadvantaged children may indicate cognitive potential masked by inadequate learning experiences, and points out that poor achievement for such children is unilaterally related to low Verbal IQ; strengths in the Performance area suggest adaptive, flexible strategies which can be utilized to improve achievement in appropriate learning situations. Kaufman cites research showing that children from professional families tend to score V>P, while the reverse is true of children of unskilled workers; this finding supports the view that a child's previous experiences can help determine relative verbal and non-verbal skills.

Experimental Studies

Studies of middle-class populations. Most of the research on comparative Piagetian and psychometric test performance has involved middle-class subjects. Performance of pre-school and primary children on the Wechsler (WISC), Stanford-Binet L-M (Binet), Otis, Lorge-Thorndike, and Pinter-Cunningham Intelligence Scales has been compared to performance on a number of reliable batteries of Piagetian tests (Pinard and Laurendeau, 1962; Kaufman, 1971); Devries, 1974; Kohlberg, 1968). Correlations reported have for the most part been positive and significant. Kohlberg (1968) reported that average correlations between performance on the Binet and Piagetian batteries (PB) are in the .70's. Dudek et al. (1969) found correlations of .52, .56, and .62 between WISC Full Scale IQ and PB scores for kindergarten,
first, and second grade children respectively. Kuhn (1976) found a correlation of .69 between mental age (MA) as measured by the WISC and progression towards the concrete operational stage for six to eight year olds. Isaacson (1977) found a significant correlation between WISC and PB performance, a higher correlation of PB with IQ than with MA, and a higher correlation of PB with Full Scale IQ than with the Verbal Scale or Performance Scale separately. Little (1972) reported the results of a longitudinal study in which a sample of children aged 4½ to five years were tested on Piagetian tasks and retested two years later. The subjects were divided into three IQ groups based upon Binet results. Little found that children with higher IQ scores gave higher level responses on Piagetian tasks. The follow-up study yielded the finding that while all IQ groups improved in quality and quantity of cognitive response, the highest IQ group showed a greater and more consistent change; Little concluded that MA was associated with the transition from the pre-operational to the concrete operational stage. Results also indicated that high verbal ability was positively associated with stage progression, and, in regard to cognitive stage, that CA was more highly related at the 4½ to five age level and MA more highly related by the time the subjects were tested two years later. Freyburg (1966) reported a relationship of .52 between Piagetian performance and MA for a large sample of children aged six to nine.
Goldschmid (1967) investigated the relationship between different conservation and non-conservation responses and age, sex, IQ, MA, and vocabulary in a population of first and second grade upper-middle and lower-middle class, normal and disturbed children. The author found that conservation ability was positively and moderately correlated with IQ, MA, and verbal ability as measured by the Pinter-Cunningham, Otis, Binet, and WISC Vocabulary Subtest. Previous studies have demonstrated similar correlations between conservation and vocabulary. Normal older subjects performed significantly better than normal younger subjects even though the age difference was only one year. The author also found that boys scored significantly higher than girls on many tasks with age, IQ, and vocabulary skills held constant, and suggested that possibly boys in their play have more opportunity to manipulate objects and perceive them after transformations than do girls. Goldschmid concluded that such factors as IQ and vocabulary may differentiate children of equal age with respect to their performance on conservation tasks.

On the other hand, Devries (1974) found low to moderate correlations between MA and PB scores and described Binet MA as a poor predictor of cognitive maturity. Camp (1975) found a significant degree of association between PB performance and IQ on only one Piagetian task (primary addition of classes). Bohm (1976) found that performance on selected subtests from the Verbal Scale of the WISC and PB scores
were not significantly related for a population of normal and learning disabled children.

Jordan and Jordan (1975) compiled a review of studies on the relative strengths of IQ, MA, and CA for predicting Piagetian performance in populations of intellectually normal children from 40 to 216 months of age. Results revealed that averaged correlations between Piagetian tests and MA were consistently higher than the corresponding correlations for IQ and CA. The authors also found that PB/IQ correlations were higher within a narrow age range; PB/CA correlations were higher within a wide age range; PB/MA correlations showed no effect for size of age range.

IQ and achievement tests are known to correlate highly; indeed the use of IQ tests for prediction and placement has been criticized on the grounds that both IQ and achievement tests measure success on school-type items which have no theoretical basis, and that the validity of IQ tests is often based on high correlations with achievement measures (Devries, 1974; Kohlberg, 1968; Mercer, 1977). Research findings on correlations between performance on Piagetian tasks and achievement tests have been mixed. Dudek et al. (1969) found that the WISC and a PB were equally effective in predicting achievement (California Achievement Test and teachers' grades) in a population of middle-class children aged five to eight years. The PB was a better predictor of achievement (average correlations of .55 vs. .46) for kindergarten children but IQ and PB were
equally correlated with achievement for grades I and II (averaged correlations of .58 and .56); a possible explanation for this result is the poor test construction of the WISC for age 5. Results of partial correlations indicated that the WISC and the PB were measuring highly correlated but separate cognitive processes in reference to achievement. The authors also combined the best achievement-predictors among PB and WISC subtests with a motor scale previously shown to correlate highly with achievement; use of the best four kindergarten measures (Picture Arrangement, motor scales, Time, and Seriation) resulted in multiple Rs of .80 and .74 for predicting first and second grade achievement respectively.

Kaufman and Kaufman (1972) reported that scores on the Lorge-Thorndike Intelligence Test added little to the prediction of first grade achievement (Stanford Achievement Test) obtained by using a PB in a population of middle-class kindergarten children (PB/SAT correlation: .64; MA/SAT correlation: .58). Bohm (1976) found that, although WISC and PB scores were not significantly related in a population of normal and learning-disabled first, second, and third graders, PB scores and performance on the Gates-McGinitie Reading Tests were significantly correlated. Moreover the achievers were more cognitively mature than the learning-disabled children. Devries, however, reported very low correlations between Piagetian and achievement performance (Metropolitan Achievement Test) in a population of bright, average, and retarded five, six, and seven year
Murta (1972) studied the relationship between the ability to conserve and reading ability (Durrell Analysis of Reading Difficulty) in a population of seven and eight year old reading-disabled and non-reading-disabled children. Significant differences were found to exist between children classified as reading-disabled and non-reading-disabled in conservation of length on one task and in the stage of development on all tasks administered; also Murta found an apparent relationship between level of functioning on specific tasks and specific subtests of the Durrell.

Caballero (1975) compared first and second grade students' performance on a PB, the Metropolitan Readiness Test (MRT), and the SAT, with level of placement on the Individually Paced Instruction Tracking Card in Reading (IPI). The results were significant at the first grade level; the correlation between the PB and IPI was .68; the correlation between the MRT and IPI was .52; and the correlation between the PB and MRT was .61. The correlation for the second grade group was lower but significant, and for both groups it was concluded that the PB was a reliable predictor of reading ability. Simpson (1972) investigated the relationship between performance on multiple classification and class inclusion tasks and reading achievement as measured by teacher evaluations. Results indicated that good classifiers are usually good readers and that poor readers are likely to be preoperational. The author
speculated that children who have problems grouping according to certain criteria or dealing with part-whole relationships within categories might have problems classifying letter-sound relationships required for efficient reading. Malone (1975) tested the hypothesis that Piagetian cognitive development was positively related to reading achievement with the effects of sex, age, grade level, and language ability held constant. Performance on a PB and the reading and language portions of the Comprehensive Test of Basic Skills was compared, and the results indicated that reading ability was a positive correlate of Piagetian concept development.

Wolcott (1978) compared the conservation of number to means of mathematics concept scores and total mathematics scores on the SAT in a population of first and second grade children. Results were mixed, with some Piagetian tasks showing a direct relationship with test scores and others showing no relationship. Wong (1977) studied the association between the development of the concept of reversibility and the understanding of arithmetic equations in a population of second graders, and found a significant relationship between the two variables only among the female subjects. The author concluded that this study lent qualified support to the hypothesis. Jordan and Jensen (1979) summarized and reviewed previous correlational studies of Piagetian development and mathematics achievement. They inferred that a moderate relationship exists
between the two variables; furthermore no systematic differences occurred in the size of the PB/math achievement correlations between standardized and non-standardized arithmetic tests. The authors also reported that many conserving children perform higher on arithmetic tests than do children who cannot conserve, although some of the latter attain comparable levels of mathematics performance.

**Studies of disadvantaged populations.** Relatively little research has been reported concerning the inter-relationships of Piagetian, psychometric, and achievement measures for disadvantage children. Almy (reviewed in Little, 1972) compared the performance of middle and lower class kindergarten children on conservation tasks with assessments repeated at six month intervals. She reported significant differences at all age levels between the quantity and quality of responses given by the middle and lower class children; moreover, since there was approximately 14 points difference between mean IQ scores for the two groups, it was inferred that psychometric intelligence was a factor in the differences in cognitive maturity. Backus (1974) investigated the relationship between conservation and performance on Cloze passages related to the concepts of number, quantity, and volume in a population of sixth grade public school children of low socio-economic background. Results indicated that conservers performed significantly better than non-conservers and that IQ was more highly related to performance on Cloze comprehension
tasks than was conservation ability.

Hilliard (1971) tested the effects of an experimental Piagetian method of instruction on the cognitive development of disadvantaged first grade Mexican-American children. The subjects were pretested at the beginning of the school year with the MRT; near the end of the year, the experimental group was enrolled in a six-week training program emphasizing manipulation and classification of materials and the development of language and concepts of number, size, weight, length, and reversibility in relation to several kinds of transformations. The control group was simultaneously given a traditional arithmetic program. The author found that there was no difference between the medians of the control and experimental groups or between the numbers of subjects in each group placing at the various stages of conservation on a PB; moreover there was no difference between the medians of the control and experimental groups on the Numbers subtest of the MRT.

Anastasiow and Hanes (1974) examined the relationship between cognitive development and language acquisition in populations of black inner-city, white middle-class, and rural white kindergarten, first, and second graders. The authors found that even though differences in language development and cognitive development existed between the subcultural groups, removal of the variance predictable by differences in cognitive development resulted in nonsignificant differences in language performance between subcultural group means. It was concluded that, although envir-
environmental factors may delay language development, within subcultural groups cognitive development remains a significant factor for language acquisition.

In summary, investigations into the nature and magnitude of the relationships between IQ, Piagetian, and achievement assessments have indicated that the three measures are highly and positively related, and that PB and IQ performance may predict school achievement with similar degrees of efficiency (Kohlberg, 1968; Kuhn, 1976; Devries, 1974). Results of the few published studies of relationships among cognitive stage, IQ, and achievement for disadvantaged subjects are congruent with the findings of investigations of middle-class children. Some researchers have reported low mean IQs, slow cognitive stage development, or low average achievement for disadvantaged subjects relative to the performance of middle-class subjects (Almy [reviewed in Little, 1977]; Anastasiow and Hanes, 1974).

Few theorists or researchers advocate substitution of Piagetian tests for traditional IQ tests in assessing cognitive ability. There is a great deal of support for using PBs or other evaluations of learning potential in conjunction with IQ tests, particularly for disadvantaged children. In this case, the usefulness of the PB lies mainly in the development of instructional programs, rather than placement or prediction (Kohlberg, 1968; Devries, 1974; Gray, 1978).
The purpose of the present study was to determine if previously reported relationships would be observed in a sample of four-year old disadvantaged children. Furthermore, regression equations were computed to assess the contributions of WPPSI and PB subtests to performance on first-grade achievement tasks of the PIAT; it was hoped that the results would lend validity to the concept of a psycho-developmental battery which would provide an assessment of learning ability and potential and useful information for the establishment of instructional programs.
METHODS

Subjects

The sample was composed of all members of the four to five year age group attending a Parent-Child Center for enrichment of cognitive and motoric activity for disadvantaged children. The Center is located in a central Kentucky county which has higher unemployment and lower mean per capita income than state averages. Eighty percent of the children attending the center come from families whose financial resources render them eligible for federal poverty program services. Average length of time previously spent by subjects in attendance at the Center was 23 months. The sample included 20 children, 11 females and nine males, with a mean age of four years, seven months. There were 18 whites and two blacks in the sample.

Description of Measures

Wechsler Pre-School and Primary Scale of Intelligence (WPPSI). The WPPSI is an individually administered intelligence test which consists of ten subtests and one supplementary test, each of which when treated separately is considered to measure different verbal and performance factors; subtest scaled scores are combined, yielding a composite score which is considered to measure overall
intellectual capacity (Wechsler, 1967). Verbal, Performance, and Full Scale IQs were calculated for each subject.

**Piagetian Battery (PB).** The 20-25 minute individually administered battery, a slightly modified version of one developed by Kaufman (1971), is constructed from several of Piaget's tasks. It includes items from the areas of number, logic, space, and geometry. Items requiring performance as opposed to verbalization were used whenever possible, and every test had been investigated in at least one carefully conducted study (Kaufman, 1971). The PB is a reasonably reliable instrument (coefficient alpha = .80; standard error = 5-6 score points).

The tasks in the PB are described below:

1. **Conservation of length.** The subject is asked to compare the lengths of a curved and a straight piece of Play-Doh, matched on end points, and to explain the answer. S/he is then asked to compare the lengths of the two "roads" and to explain the answers after running a finger over both roads, after having the notion of movement introduced, and after viewing the curved road stretched out and then put back into place.

2. **Addition and subtraction.** The subject is asked if two piles of five pennies each have the same number in them. After agreeing that both piles contain five pennies, s/he has to state which pile has more when one penny is removed from a pile and then when one penny is added to one of the equal piles, and explain the answer.
3. Conservation of number (identity). Four beads are counted by the examiner and put on a plate. After the subject agrees that there are four on the plate, the beads are first poured into a glass and then onto the table; in each instance, the subject is asked to state the number of beads after the transformation. The six beads are counted and placed on a plate. After agreeing that there are six, the beads are poured into a glass; the subject is asked to state how many beads are in the glass and why s/he thinks so.

4. Conservation of number (equivalence). The subject is asked to match a row of seven beads with an equal number of pennies. After agreeing that both rows have seven, the subject must state following each of two transformations of the shape of the row of pennies whether there are more pennies, more beads, or the same number, and explain the reasoning for one of the answers.

5. Discrimination. A set of nine slats, the smallest being two inches long with succeeding slats increasing in size by one-half inch increments, are placed randomly on the table. The subject is asked to select the smallest stick and then the biggest one.

6. Seriation. Five of the nine slats are arranged in a row from smallest to largest by the examiner and are then placed randomly. The subject is first asked to make a row just like it and then to make a row out of all nine slats.
7. Insertion. With the nine slats arranged in order, the subject is asked to put two sticks into the row that were "accidently" left out: first a medium-sized one and then a larger one.

8. Numeration. With all of the slats arranged in order (including the inserted ones), the subject is asked to count the sticks. A doll is shown to jump over the first four sticks, and the subject is asked how many sticks the doll has jumped over. Then the doll is shown to jump over four more sticks, and the subject is asked how many sticks the doll has jumped over altogether and how many sticks the doll would have to jump over to reach the end.

9. Constructing a straight line. The subject is shown first a rectangular and then a circular "field of grass" and some "trees" (eight matchsticks in hardened clay bases). Two trees are placed as end points, and the subject is asked to make a straight line of trees from one point to the other such that the end points, when connected, would form a straight line (a) on the rectangular field, parallel to the edge facing the child and then oblique to the edge facing him; and (b) on the circular field, oblique to the orientation of the child's body.

10. Perceiving a straight line. The subject is shown five pictures of black dots, three on rectangular cards and two on circular cards. One card of each shape shows the dots in a straight line; the other cards show a curved or broken line. For each of the rectangular and circular
cards, the subject is asked if the black dots form a straight line.

11. Sorting. The subject is given eight cutouts (two green and two red circles, two green and two red triangles) and is asked to sort all of them into two plates. Then one blue square is added to the group, and the subject is asked to sort all of the cutouts into three plates.

12. Some and all. The subject is shown a set of eight cutouts: four red squares, two red triangles, and two blue triangles. S/he is asked (a) if all the blue ones are triangles, and (b) if all the squares are red, and s/he must explain the first answer. The subject is then asked (a) if all the triangles are blue, and (b) if all the red ones are square, and s/he must explain the second answer.

13. Multiple class membership. The subject is shown another set of eight cutouts: four red squares, two red circles, and two blue circles. Then the subject is shown a plate filled with various red objects and is asked if all the squares in the set belong on the plate with the red things, and why s/he thinks so. A second plate, filled with many kinds of squares, is shown to the subject and s/he is asked if the blue cutouts belong on this plate and why s/he thinks so. Finally, the subject is asked if the blue cutouts belong on a plate filled with round things and again s/he must explain the answer.
All items were scored by one practiced examiner. Scores on the items constituting each task were summed to produce raw scores, which were then converted to a common scale ranging from zero to seven; a score of seven was given to answers which demonstrated clear comprehension of the concept measured by each task, a score of five for responses indicating probable comprehension of the concept, three indicated probable lack of the concept, one indicated clear lack of the concept, and zero indicated probably lack of understanding of the question being asked. Scores of seven, five, three, and one were equated, where applicable, with Piagetian stages of concrete operations—well-established, high transitional, low transitional, and pre-operational, respectively (Kaufman, 1971).

Peabody Individual Achievement Test (PIAT). Combined raw scores from three subtests of the PIAT (Dunn, 1970), an individually administered achievement test, were used as the criterion measure in this study; the three subtests employed were Reading Recognition, Mathematics, and General Information.

Procedure

The WPPSI, PB, and PIAT were administered and scored by a trained examiner in the spring of 1979 over a period of approximately three weeks. Standardized procedures were followed for all administrations.

Statistical calculations were performed via the Statistical Package for the Social Sciences (Nie et al.,
Means and standard deviations were computed for all variables. Pearson Product Moment Correlations were calculated among WPPSI Full Scale, Verbal Scale, and Performance Scale IQ scores, PB scores, and PIAT raw scores. In addition, multiple regression equations were computed to determine which combination of WPPSI and PB subtests would account for the greatest amount of variance in predicting achievement with the PIAT.
RESULTS

The means and standard deviations for WPPSI Verbal Scale, Performance Scale, and Full Scale IQs, PB scores, and PIAT Total Raw Scores are summarized in Table 1.

Table 1
Predictor and Criterion Descriptive Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>WPPSI IQ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verbal</td>
<td>96.70</td>
<td>20.92</td>
<td>51-124</td>
</tr>
<tr>
<td>Performance</td>
<td>106.00</td>
<td>19.71</td>
<td>53-139</td>
</tr>
<tr>
<td>Full Scale</td>
<td>101.55</td>
<td>21.11</td>
<td>50-131</td>
</tr>
<tr>
<td>Piagetian Battery</td>
<td>50.90</td>
<td>16.10</td>
<td>11-66</td>
</tr>
<tr>
<td>PIAT Total Raw Scores</td>
<td>25.15</td>
<td>8.02</td>
<td>3-35</td>
</tr>
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</table>

Number of Subjects (N) = 20

The WPPSI Verbal Scale mean IQ fell below the standard-
ization mean of 100; the Performance Scale and Full Scale IQ means fell above the standardization mean of 100. No standardization parameters were available for PIAT performance of pre-school children or Piagetian Battery performance. Kaufman (1971) reported a mean of 54.8 and standard deviation of 13.9 in a sample population of 103 five to six year old middle-class children tested with his PB; the present sample yielded a mean of 50.9 and a standard deviation of 16.1. The younger age of the subjects in the present study and the wider range of scores due to two extreme low scores (see Table 1 for range) likely account for differences in the statistics derived herein and those reported by Kaufman. The wide range of WPPSI Verbal, Performance, and Full Scale IQs due to two extreme scores (see Table 1 for range) are reflected in larger standard deviations for the present sample than those found for the standardization population.

Pearson Product Moment Correlations among WPPSI Full Scale, Verbal Scale, and Performance Scale IQ scores, PB scores and PIAT raw scores with significance levels are presented in Table 2. All of the predictor variables yielded correlation coefficients significant at the $p < .001$ level. As Table 2 indicates, the correlation between WPPSI Full Scale IQ and Piagetian Intelligence was .79, which is considerably greater than the relationships reported by several previous researchers. Piagetian Intelligence was found to have a slightly higher correlation with
Performance IQ than with Verbal IQ (.79 vs. .74). Piagetian Intelligence was the best predictor of PIAT performance, accounting for 86.49% of the variance on that measure, contrasting with 71.40% of variance accounted for by WPPSI Full Scale IQ. There was only a slight difference in the correlations between WPPSI Verbal Scale and Perfor-

<table>
<thead>
<tr>
<th></th>
<th>FS</th>
<th>PB</th>
<th>PIAT</th>
<th>VS</th>
<th>PS</th>
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<td>FS</td>
<td>1.0000</td>
<td>0.7929</td>
<td>0.8452</td>
<td>0.9611</td>
<td>0.9531</td>
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<td>(.001)</td>
<td>(.001)</td>
<td>(.001)</td>
<td>(.001)</td>
</tr>
<tr>
<td>PB</td>
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<td>0.7409</td>
<td>0.7872</td>
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</tr>
<tr>
<td></td>
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<td>(.001)</td>
<td>(0.001)</td>
<td>(.001)</td>
<td></td>
</tr>
<tr>
<td>PIAT</td>
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<td>0.8125</td>
<td>0.8178</td>
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<td></td>
</tr>
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<td></td>
<td>(****)</td>
<td>(.001)</td>
<td>(.001)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VS</td>
<td>1.0000</td>
<td></td>
<td>0.8346</td>
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<td></td>
</tr>
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<td></td>
<td>(****)</td>
<td>(.001)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PS</td>
<td>1.0000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(****)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. The following abbreviations for the variables are used: FS = Full Scale IQ; PB = Piagetian Battery; PIAT = PIAT Achievement; VS = Verbal Scale IQ; and PS = Performance Scale IQ. Numbers in parentheses indicate significance levels of correlations.
mance Scale IQs and PIAT performance (.81 and .82).

Multiple regression equations were computed to determine which combination of WPPSI and PB subtests would account for the greatest amount of variance in predicting achievement with the PIAT. Table 3 presents multiple

Table 3

Multiple Correlations of Various Combinations of Predictor Scores with PIAT Achievement

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Multiple R</th>
<th>R Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information (IN)</td>
<td>.800</td>
<td>.640</td>
</tr>
<tr>
<td>IN + Straight Line Construction (SC)</td>
<td>.914</td>
<td>.836</td>
</tr>
<tr>
<td>IN + SC + Discrimination (DI)</td>
<td>.946</td>
<td>.895</td>
</tr>
<tr>
<td>IN + SC + DI + Straight Line Perception (SP)</td>
<td>.958</td>
<td>.917</td>
</tr>
<tr>
<td>IN + SC + DI + SP + Similarities (SI)</td>
<td>.966</td>
<td>.934</td>
</tr>
<tr>
<td>IN + SC + DI + SP + SI + Conservation of Length (CL)</td>
<td>.971</td>
<td>.942</td>
</tr>
<tr>
<td>IN + SC + DI + SP + SI + CL + Geometric Design (GD)</td>
<td>.976</td>
<td>.952</td>
</tr>
<tr>
<td>IN + SC + DI + SP + SI + CL + GD + Numeration (NU)</td>
<td>.985</td>
<td>.971</td>
</tr>
<tr>
<td>IN + SC + DI + SP + SI + CL + GD + NU + Multiple Class Membership (MC)</td>
<td>.991</td>
<td>.982</td>
</tr>
<tr>
<td>IN + SC + DI + SP + SI + CL + GD + NU + MC + Vocabulary (VO)</td>
<td>.995</td>
<td>.991</td>
</tr>
</tbody>
</table>

correlations and R square values of various combinations of predictor scores with PIAT achievement. The combination
of subtests resulting in maximum predictive efficiency was WPPSI Information, PB Straight Construction, PB Discrimination, PB Straight Line Perception, WPPSI Similarities, PB Conservation of Length, WPPSI Geometric Design, PB Numeration, PB Multiple Class Membership, and WPPSI Vocabulary. The ten subtests accounted for 99% of the variance of PIAT performance.

Because of the existence of two extremely low scores in the distribution, the data was analyzed after the removal of these scores as a matter of interest. Results are reported in the Appendices. Analysis of scores in the second data set (based upon an N of 18) resulted in generally lower correlations; moreover, WPPSI Performance IQ did not correlate more highly with the PB than did Verbal IQ. However the PB retained the highest correlation with the criterion measure as compared with WPPSI Verbal and Performance IQs.

When regression analysis was performed for the second data set, the selection of predictive subtests was similar to the first with one major exception. The WPPSI Information subtest, which had received the largest weight in analysis of the first data set, was not included in the selection based upon the second data set (see Appendix C for particulars).
DISCUSSION

The results of this study provide support for the hypothesis that Piagetian developmental level and psychometric IQ are equally efficient predictors of achievement as measured by the PIAT. The high degree of predictive validity which is achieved by a combination of best tests from the PB and WPPSI is encouraging by virtue of time-efficiency, as well as the theoretical and practical implications and strengths of incorporating developmental measures with a traditional assessment battery.

The correlation between WPPSI Full Scale IQ and Piagetian Intelligence was .79 using the first data set based on an N of 20, and .42 using the second data set based on an N of 18. These correlations are consistent with those reported by previous researchers.

In analysis of the first data set, Piagetian Intelligence was found to have a higher correlation with Performance IQ than with Verbal IQ, but this relationship did not hold when the two extremely low scores were removed. Therefore the hypothesis that factors underlying Piagetian intelligence are related to abilities tested by the Performance Scale as opposed to the Verbal Scale is not confirmed.
Piagetian Intelligence as the best predictor of PIAT performance for both data sets, accounting for 86.49% and 67.24% of variance respectively. There was only a slight difference in the correlations between WPPSI Verbal Scale and Performance Scale IQs and PIAT performance for both data sets (.81 and .82, and .59 and .57 respectively). This result is interesting, since one of the three PIAT subtests, General Information, would be expected to demonstrate commonality with the WPPSI Information subtests of the Verbal Scale, therefore perhaps biasing the criterion measure in the direction of a higher relationship with WPPSI IQ or at least the Verbal Scale IQ.

Regression analysis was employed to determine the best WPPSI and PB predictors of PIAT achievement. Among the most highly predictive components were four WPPSI subtests and six PB tasks. Analysis of the second data set yielded similar results. Information received the largest weight in the first analysis, but was not among the subtests selected based upon the second data set. Subtests selected in both analyses (see Table 3 and Appendix C) were Similarities, Block Design, Geometric Design, Picture Completion, and Vocabulary. Similarities is considered to measure the ability to think and reason associatively and logically at concrete and abstract levels and theoretically shares foundations with Piagetian tasks.
WPPSI Geometric Design was found by Krebs (in Sattler, 1974) to be the most highly predictive subtest for reading achievement in a population of lower and upper class kindergarten children. WPPSI Block Design is considered to measure the ability to reproduce designs through visual–motor coordination, a skill essential in elementary reading and writing, as is the ability to discriminate essential from non–essential details which is measured by WPPSI Picture Completion. WPPSI Vocabulary has a precedent relationship with Piagetian tasks; Goldschmid (1967) and others have frequently demonstrated moderate correlations between Piagetian conservation and WISC Vocabulary performance, and concluded that this IQ measure may differentiate children of equal age with respect to their performance on conservation tasks.

The most highly predictive Piagetian tasks selected for both data sets, Straight Line Construction, Discrimination, Straight Line Perception, Conservation of Length, Numeration, Sorting, Conservation of Number, and Class Membership, place heavy emphasis upon differentiation of forms, size, order, and color. This result, along with the higher overall PB/achievement correlation, would seem to indicate the great importance of visual–spatial perception and organization in readiness and achievement skills at this age.
Limitations of the Present Study

One important limitation of the study at hand is the small number of subjects (N = 20); moreover, since the entire sample was drawn from a very restricted population and may be considered a pure selection of rural, disadvantaged children, generalization of results to other populations would be difficult. Also, due to the small N, it was not viable to examine relationships between certain variables, such as age and sex, and performance upon the various instruments.

Another limitation of the study is the abstract concept of achievement at the preschool level, and the lack of norms and established validity for the PIAT at age four. The appropriateness of measuring preschool achievement through the use of school-related tasks has not been determined.

Variables which are highly correlated do not yield orthogonal relationships in regression analysis; therefore the values obtained above may be inflated. Another possible flaw in the general validity of the results obtained involves the lack of measures of examiner reliability for the administration of each instrument. The use of two or more examiners and the calculation of interscorer reliabilities would ameliorate this situation.

Implications for Further Research

Ongoing examination and clarification of the relationships investigated above would hopefully increase external
validity through the application of less restricted sub-
ject selection procedures. An ideal sample would include
an adequately large number of subjects, a random selection
of subjects from a variety of environments, both urban
and rural, and stratification of racial composition.

It would also be useful to include measures of other
variables, such as sex and age, which have been shown to
be related to school performance; moreover, further
discriminative information on the relationships among
sex, age, and the variables studied herein is crucial
if results are to be effectively interpreted and applied
to program development.

Although IQ, Piagetian developmental level, and
achievement are highly correlated, the information
yielded by IQ and Piagetian tests on quality and strengths
and weaknesses of performance, and its potential usefulness
for constructing individual programs, far outweighs the
value of these tests as mere indicators of school
placement. It is essential that the time, skill, and
energy consumed in the testing process by both examiner
and child result in more than a score in a cumulative
folder. Since the research reported above has demonstrated
that attributes measured by IQ and Piagetian tests are
separate but related, and necessary to learning and
adaptive functioning, the data yielded by these measures
should provide a wealth of multi-level information for
facilitating educational intervention.

The results of this study support the view that developmental tests of concept formation such as those devised by Piaget and his colleagues are useful adjuncts to traditional psychometric measures for predicting achievement in preschool and disadvantaged language-deficient populations.
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### APPENDIX A

Predictor and Criterion Descriptive Statistics for the Second Data Set

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WPPSI IQ</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verbal</td>
<td>101.50</td>
<td>15.64</td>
<td>72-124</td>
</tr>
<tr>
<td>Performance</td>
<td>111.11</td>
<td>12.33</td>
<td>91-139</td>
</tr>
<tr>
<td>Full Scale</td>
<td>106.83</td>
<td>14.16</td>
<td>81-131</td>
</tr>
<tr>
<td><strong>Piagetian Battery</strong></td>
<td>55.25</td>
<td>9.20</td>
<td>37-66</td>
</tr>
<tr>
<td><strong>PIAT Total Raw Scores</strong></td>
<td>27.22</td>
<td>4.99</td>
<td>20-35</td>
</tr>
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</table>

Number of Subjects (N) = 18
APPENDIX B

Pearson Correlation Coefficients Among
Predictor and Criterion Variables
of the Second Data Set

<table>
<thead>
<tr>
<th></th>
<th>FS</th>
<th>PB</th>
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<th>VS</th>
<th>PS</th>
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<td></td>
<td>(****)</td>
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<td>(.058)</td>
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<td></td>
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<td></td>
<td>(****)</td>
<td>(.001)</td>
<td></td>
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<tr>
<td>PS</td>
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<td></td>
<td>(****)</td>
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</tbody>
</table>

Note. The following abbreviations for the variables are used: FS = Full Scale IQ; PB = Piagetian Battery; PIAT = PIAT Achievement; VS = Verbal Scale IQ; and PS = Performance Scale IQ. Numbers in parentheses indicate significance levels of correlations.
APPENDIX C

Multiple Correlations of Various Combinations of Predictor Scores with PIAT Achievement for the Second Data Set

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Multiple R</th>
<th>R Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Straight Line Construction (SC)</td>
<td>.753</td>
<td>.567</td>
</tr>
<tr>
<td>SC + Straight Line Perception (SP)</td>
<td>.881</td>
<td>.776</td>
</tr>
<tr>
<td>SC + SP + Block Design (BD)</td>
<td>.905</td>
<td>.820</td>
</tr>
<tr>
<td>SC + SP + BD + Conservation of Length (CL)</td>
<td>.922</td>
<td>.850</td>
</tr>
<tr>
<td>SC + SP + BD + CL + Picture Completion (PC)</td>
<td>.945</td>
<td>.893</td>
</tr>
<tr>
<td>SC + SP + BD + CL + PC + Numeration (NU)</td>
<td>.955</td>
<td>.911</td>
</tr>
<tr>
<td>SC + SP + BD + CL + PC + NU + Sorting (SO)</td>
<td>.963</td>
<td>.927</td>
</tr>
<tr>
<td>SC + SP + BD + CL + PC + NU + SO + Conservation of Number - Equivalence (CE)</td>
<td>.969</td>
<td>.940</td>
</tr>
<tr>
<td>SC + SP + BD + CL + PC + NU + SO + CE + Vocabulary (VO)</td>
<td>.975</td>
<td>.951</td>
</tr>
<tr>
<td>SC + SP + BD + CL + PC + NU + SO + CE + VO + Geometric Design</td>
<td>.981</td>
<td>.963</td>
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</table>