

THE EFFECT OF LACK OF FORMAL SCHOOLING ON
NUMBER DEVELOPMENT

Thesis for the Degree of Ph. D.

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Egon Mermelstein

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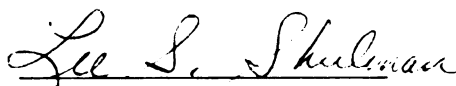
THE EFFECT OF LACK OF FORMAL SCHOOLING
ON NUMBER DEVELOPMENT

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ABSTRACT

The Effect of Lack of Formal Schooling
on Number Development
by
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The primary purpose of this study was to examine whether lack of formal schooling alters and affects the attainment of stages of number development. A secondary purpose of this study was to examine the effects of employing particular types of questions and non-verbal techniques in assessing a child's performance.

It was hypothesized that lack of schooling does not alter and affect the stages of number development on non-verbal tasks. On verbal tasks, however, it was hypothesized that lack of schooling does alter and affect the stages of number development. As to the secondary purpose of the study, it was hypothesized that phrasing of the question does not affect performance of subjects on Piagetian tasks and further it was hypothesized that the proportion of subjects passing only the non-verbal task is significantly greater than the proportion of subjects passing only a verbal discontinuous task.

One hundred twenty Negro children, sixty males and sixty females, six and nine years old, were randomly assigned to the experimental treatments. Four verbal

Piagetian conservation of substance tasks and a non-verbal conservation task were administered to each child. Each child was asked one of a possible three questions on the verbal tasks.

Sixty Ss, thirty males and thirty females were selected from Prince Edward County, Virginia, a small rural community of which thirty nine-year-old males and females were deprived of formal schooling. Sixty Ss from Flint, Michigan were matched to Prince Edward County children on the basis of age, sex and socio-economic class.

The findings for non-verbal tasks support the hypothesis that lack of schooling does not alter and affect the stages of development. On the other hand, the findings on the verbal tasks do not support the hypothesis that schooling affects and alters the stages of number development.

As to the secondary purpose of the study, the findings support the hypothesis regarding phrasing of the question with continuous tasks but reject the hypothesis for discontinuous tasks. And finally, the results support the hypothesis that the number of subjects only passing the non-verbal task is significantly greater than the subjects only passing the verbal discontinuous tasks.

Consistent with the literature (5), it is concluded that formal schooling plays a minor role in number development. Further, it is concluded that questioning does not generally influence performance; however, further research is needed in this area. It is also concluded that the remarkable difference in performance on verbal and non-verbal tasks suggests that the "presence" or "absence" of language is a relevant variable in studying number development.

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by

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Introduction and Statement of Problem

In 1959 leading scientists and educators, under the direction of Jerome Bruner, met to discuss how instruction in science and mathematics might be improved in our primary and secondary schools (1).

The results of the conference further stimulated the growth of new programs in mathematics and science. The School Mathematics Study Group, the Madison Project, the Illinois Project and the Physical Science Study Committee are but a few of the committees concerned with revising the mathematics and science curriculum (1).

All of these committees have stressed teaching for understanding. The emphasis, as Bruner states, was placed on the structure of the subject matter. On this basis, Bruner formulated his bold hypothesis, "that any subject can be taught effectively in some intellectually honest form to any child at any stage of development." Apparently, for Bruner, children are always ready as long as you structure the environment in some honest form. Tyler (16, p. 210) accepts this interpretation when he states that Bruner's hypothesis negates the concept of readiness. Other educators have seized on this hypothesis to justify teaching abstract mathematical concepts to 6 and 7 year olds. Suppes (15) is teaching geometric

concepts, sets and logic in the lower primary grades. Seven-year-old English children are taught to manipulate numbers in several bases other than the decimal systems; some 8 year olds are taught to simplify quadratic equations.

Tyler points out the apparent inconsistency between the Bruner hypothesis and Bruner's acceptance of Piaget's position on intellectual development when he states: "it is, therefore, difficult to understand how he [Bruner] can maintain that any subject can be taught effectively in some intellectually honest form to any child at any stage of development, and at the same time say first, that the 'preoperational' child cannot grasp the idea of 'reversibility' and second, 'because of this fundamental lack the child cannot understand certain fundamental ideas that lie at the basis of mathematics and physics'." (16, p. 220)

The research findings of Jean Piaget suggest to the present investigator that you cannot teach most 6-year-olds to understand the concept of number. Piaget argues that the understanding of number is contingent upon the child first having passed a particular stage in his cognitive development. Chronologically speaking, most children under 8 have not passed the particular stage of development necessary for understanding the concept of number. In addition, Sigel's interpretation of Piaget's results suggest that neither home nor school experiences are suf-

ficient to alter the "natural processes of adaptation which take place in the child's adjustment to his objective world." (11, p. 9)

The school environment has generally been considered the source of the child's number experiences. In school the child is taught to count, add and is provided with many concrete applications of number. The absence of formal schooling would, then, tend to diminish the frequency and intensity of these number experiences. According to Bruner, the structure of the environment plays the major role in concept acquisition. Particularly with reference to formal number experiences, the structure of the environment of children who have had formal schooling is vastly different from the structure of the environment of children who have been deprived of formal schooling.

Formal number experiences, as measured by arithmetic achievement tests, correlate fairly well ($r = .59$) with success on Piagetian number tasks, according to Dodwell (3). This suggests a positive relationship between success on Piagetian number tasks and formal academic achievement. Consequently, Bruner might argue that formal school experiences would contribute more to number development, as measured by Piagetian tasks, than little or no formal schooling at all. If this argument is correct, we should expect children who have had formal schooling to be at a

"higher" developmental level on Piagetian number tasks than children who have been deprived of schooling. On the other hand, if the argument is incorrect, we should expect children who have had formal schooling to be at the same developmental level for number as those children who have been deprived of schooling. The extent to which the absence of school experiences influences number development affords a test of Piaget's theory and, indirectly, of Bruner's bold hypothesis. This study attempts to resolve this issue by examining the effects of lack of formal schooling on the attainment of stages of number development.

Various methods may be employed to ascertain the effects of lack of formal schooling upon the attainment of number concepts: (1) Piaget's clinical method, (2) standardized interview techniques, and (3) non-verbal techniques.

Piaget's clinical method which employs non-standardized questions, has been criticized. His critics have maintained that where a child's performance was deficient, either the appropriate question was not asked or the child did not understand the question. However, other critics claim that Piaget often attributes superior performance to a child by interpreting his responses in ways which go far beyond what the child meant by them (12).

Critics also argue that the type of question asked may influence the child's performance. In addition, language they claim, may obscure whether a child has a particular Piagetian concept. Therefore, our secondary purpose is to study the effects of employing particular types of questions and non-verbal techniques in assessing the child's performance. The tasks we have selected involve determining whether or not a child has attained the concept of conservation of substance.

Conservation of Substance

The attainment of the concept of conservation of substance in Piaget's system is a critical test of whether the child has acquired the concept of number. By the word "substance" Piaget means "amount of matter," or "amount of material." Piaget maintains that, by two years of age, a child builds a picture of the world as consisting of a number of objects that continue to exist even when the objects disappear; the child learns that, as a rule, objects maintain their size and shape. For Piaget, the schema of the permanent object presupposes the most primitive of all principles of conservation. Further, Piaget maintains that conservation or object constancy is a necessary condition for all reasoning. Arithmetical thought is no exception to the rule, though additional

conceptions of conservation must also be attained. For example, a discontinuous substance such as a set or collection (beads, shells) is conceivable by the child even if it remains unchanged irrespective of the changes in the relationships between the elements. A continuous quantity such as length or volume can be used in reasoning only if it is a permanent whole irrespective of any possible rearrangement of its parts.

Piaget has discovered that up to 7-8 years of age, the average child does not appear to understand that the "amount of matter" stays the same regardless of any changes in shape or position (8). According to Lovell (6), this concept of conservation of substance (or invariance of substance) is an important one, for the mind can deal effectively with a lump of plasticine, a glass of water, or a collection of sea shells, only if it remains constant in amount independent of the rearrangement of its individual parts.

From his many experiments involving children's judgments about continuous substances (water, plasticine) and discontinuous substances (beads, shells), Piaget concluded that children pass through three stages in attaining the concept of conservation of substance; non-conservation, transition and conservation.

In a typical experiment, two identical glasses are filled to the same height with water. Children 4-6 years will admit that the amounts of liquid in the two glasses are the same. Next, the water in one glass is left undisturbed, but the water in the other glass is poured into three glasses. The child is then asked, in appropriate language, if the amount of water in the undisturbed glass is the same as the combined amounts of water in the other glasses. Children of 4-6 years of age deny that the amounts are the same. They notice that the levels in the three glasses are lower, and so for them, there must be less liquid; or they notice that there are three glasses and think there must be more water.

By 6 or 7, some children will affirm that the amount of water is the same when it is poured into two glasses, but they will still deny that the amount of water is the same when it is poured into three glasses.

However, by 7 or 8 years of age, the child stands firm in his conviction that the amounts are the same no matter in how many glasses you pour the water. At this point the child is said to have acquired the concept of conservation.

Theory and Related Research

Formal Schooling and the Acquisition of the Concept of Conservation of Substance

Piaget maintains that the attainment of the concept of conservation of substance is necessary for number work. This concept develops sequentially through a series of discrete stages. The question arises about the role of formal academic training in accelerating or inhibiting this attainment.

Although Peel (8) does not deny the role of formal training in concept attainment, he also stresses the importance of play in intellectual growth. A child may acquire the concept of conservation of substance by playing frequently with water pails, milk bottles, grain feed, an abacus, science experiment kits or Cuisenaire rods. The determining factors for acquiring the concept of the conservation of substance are the perceptible qualities of the objects and the amount of knowledge the child has about the objects. Sigel (11) supports this view as follows:

For example, one of the concepts that has been widely described in stage terms is animism: attributing life to inanimate objects. Laurendeau and Pinard report that the child goes through a variety of steps before he shifts from an animistic point of view to an objective one. When and how he does so depends upon the kinds of objects with which he is dealing. Where rocks and tools are concerned, he loses his sense of animism earlier

than would be the case if he were dealing with such objects as automobiles and airplanes. Children tend to lose the concept of animism in relation to the amount of knowledge they gain about particular kinds of things."

Lovell and Ogilvie's (7) research also supports the claim that the determining factors in the acquisition of the concept of conservation of substance are the perceptible qualities of the object and the amount of knowledge about the object. For example, they found that about one-third of those children who were non-conservers in a Piagetian plasticine type experiment were conservers in a rubber band experiment. Similarly, Hyde (5) found that some children who were non-conservers in the test using plasticine balls were conservers when liquid was poured from one vessel into others of different shapes.

Such evidence clearly suggests that the kind of content with which the child plays influences his acquisition of the concept of conservation of substance. The data further suggest that a wide range of experiences in play, school, etc., might facilitate the acquisition of conservation of substance. The foregoing implies that deprivation of a particular set of experiences, such as school, will not necessarily affect the acquisition of the concept of conservation of substance. One might predict that an "academically deprived" child, that is, one from whom formal schooling is withheld, should acquire

the concept of conservation of substance at the same age for any given tasks as the "academically experienced" child, if the contents of the tasks are not directly and solely academic in nature.

Evidence for the assertion that lack of formal schooling does not necessarily impair acquisition of pre-number concepts, such as conservation of substance, is presented by Wöhwill (7) who, in an analysis of the attainment of the abstract concept of number, found that specific related experiences (such as counting or numbers) had little relationship to the concept development, but the concept acquisition was related more to a child's cumulative general life experience.

Similarly, Hyde (5), in her studies of conservation of number, also found no significant association between results on tests of conservation of substance and the number of terms spent by the subjects at school. Hyde suggests that although sampling may be partly responsible for these results, social and environmental factors other than schooling may play a larger part in success on these tests of conservation of substance than Piaget's theories lead one to expect.

Smedslund's studies (12) on conservation of substance reinforce Hyde's. They suggest that a child, "regardless of his environment," cannot be taught the concept in question unless he has already attained a particular level of cognitive maturity. For example, children who had acquired conservation of weight in the course of their normal experience did not give up that concept in the face of challenging experimental conditions. This was in contrast to those who had acquired the concept during the experiment. Subjects were presented with two plasticine objects. One was changed in shape and the experimenter surreptitiously stole a piece from it. When the child said the quantity was the same despite the change in shape, the experimenter proved this answer wrong by weighing the object on a scale. The children who had previously acquired the concept of conservation actually were resistant - insisting for example, that a piece of plasticine must have fallen to the floor. However, the children who had acquired conservation experimentally quickly reverted to non-conservation.

It is therefore hypothesized that, on a non-verbal task which confronts the child with experimental conditions that challenge his belief in conservation, 9-year-old children who have had the benefit of regular formal

schooling¹ will be categorized at the same developmental level as 9-year-olds who have been deprived of regular formal schooling.² Six-year-olds from each area will also be examined with the same tasks in order to demonstrate that any differences found are attributable to academic background rather than region. Hence, it is hypothesized that 6-year-olds from both backgrounds will be categorized into the same developmental level, regardless of the verbal or non-verbal character of the tasks.

Success on the Piagetian tasks appears to be influenced by language facility. Increased language facility suggests increased ability to comprehend the experimenter's questions. Children who come from intellectually stimulating homes and attend school appear to manifest superior language facility than children who come from intellectually impoverished homes and attend school. Consequently, one might expect children who come from intellectually impoverished homes and attend school to manifest superior language facility than

¹Negro children who attend an elementary school in Flint, Michigan.

²Negro children from Prince Edward County, Virginia, who received no formal schooling for four years.

children who come from intellectually impoverished homes and do not attend school. Accordingly, it is hypothesized that academically experienced 9-year-old Flint children will be categorized into a higher developmental level on Piagetian number tasks than academically deprived 9-year-old Prince Edward County children.

Phrasing of the Questions and the Acquisition of the
Concept of Conservation of Substance

In his book, Language and Thought of the Child, Piaget considers the concepts of "egocentrism" and "syncretism" central to understanding child communication, in general, and to understanding children's responses to questions, in particular. According to Piaget, egocentric thought differs from socialized thought in that:

1. It is non-discursive and goes directly from premises to conclusion in a single act, without any intervening steps of deduction.
2. It makes use of personal schemas of imagery, and,
3. Of schemas of analogy, both of which are extremely active in the conduct of thought and yet extremely illusive because they are uncommunicable and arbitrary.

These three features also characterize the phenomenon called "syncretism of thought." According to Piaget, syncretic thought describes a type of thinking which

assimilates reality into global, undifferentiated schemas; the individual contents of the assimilated reality interpenetrate and fuse with one another, anything being joined to or combined with anything else. Syncretic thought is a pervasive characteristic of child thought which emerges from his egocentric thought. (4, p. 273)

The construct, egocentric thought, describes the child viewing all reality from only his frame of reference. Only his own point of view can really figure in other activities, since he is unaware that others see things differently. The child assimilates reality to his own perspective, which includes his own motives and inner promptings. Thus, much of the child's talk is talk-for-self, even when in the company of others. Further, the child finds it difficult or unnecessary to communicate with others, since this frequently demands focusing on the others' perspectives. Moreover, the child assumes that since he knows the information to be communicated, everyone else does also. Therefore, there is no need to communicate with others. Consequently, egocentric thought serves to satisfy the child's basic needs in the same way that communication satisfies certain adult needs.

According to Piaget, in egocentric thought, arguments seem convincing because the premises and conclusions are connected by schema; primitive structures which tie things together in terms of the needs and motives of the child. It is through schemas that the hunch leaps from a premise to a conclusion. Little value is attached to proving or checking conclusions. The vision of the whole brings about a state of belief and a feeling of security far more rapidly than if each step in the argument were made explicit. In arriving at conclusions, egocentric thought mobilizes personal schemas of analogy and memories of earlier reasoning. Visual schemas also play an important role since they frequently take the place of proof in supporting the deduction that is made.

Because egocentric thought is essentially unanalytical, the result is that the child ignores isolated words and deals with whole sentences, understanding them or altering them as they stand, without analyzing them in detail. Furthermore, the child emphasizes events themselves rather than the relations of time (order) or cause which unite them.

The child's egocentrism induces him to believe that he understands everything and prevents him from understanding word for word the terms and propositions he hears. Therefore, instead of analyzing what he hears in detail, he reasons about it as whole.

Piaget maintains that up until 7 or 8 years, all child thought is characterized by egocentrism in general and syncretism in particular. After 7 or 8, the consequences of egocentrism do not disappear immediately, but occur in purely verbal thought (those thoughts not connected with immediate observation). Piaget chooses to call this verbal syncretism - a phenomenon which manifests itself until 11 or 12 years of age.

The syncretic nature of child thought suggests that questions which are non-identical in the specific words employed, but equivalent in their general content regarding specific tasks will be perceived as identical. Consider the following task: An experimenter presents a child with two containers of water, one long and narrow, the other short and stout. Three possible questions, of varying complexity, all emphasizing amount are:

1. "Is the amount of water the same, more, or less?"
2. "Does one glass have more water?"
3. "If you were thirsty, which glass would you drink?"

An examination of the literature reveals that most experimenters have utilized these question types. (7, 9, 13)

These three questions may be ordered as to their complexity. The first question involves a disjunctive

relation; the second a comparison and the third a comparison related to a need.

To the present investigator, the first question appears the most difficult for the child because of the disjunctive relation. Further, children are infrequently asked such abstract questions. The third question appears the simplest to the child because it is part of his everyday experience. Children frequently choose between two glasses of water or soda. For example, a child may be unhappy because his daddy has the larger glass with more soda. The second question appears next in difficulty. It is neither as abstract as the first nor as concrete as the third. Because of its less abstract nature, the second question represents a midpoint in difficulty.

However, all three questions emphasize amount or quantity. We may consider amount or quantity an event. The questions differ in the way they ask the child to relate to the event. If syncretic thought dominates the child's mental processes, he will attend to the event, but not to the relationships to the event. On the basis of this, one can hypothesize that children, regardless of which of the questions is asked, so long as the events are the same, respond as if the questions are identical. For our purposes, we will define a question whose events

are identical to another question, but which calls for attention to different relationships, a "rephrased question."

The underlined sentences in the following two examples of Piaget's clinical approach to data-gathering are "rephrased questions."

Blas (4;0): 'Look, your mummy has poured out a glass of lemonade for herself (L) and she gives you this glass (L¹). We want you to pour into your glass as much lemonade as your mummy has in hers. - (She poured rather quickly and exceeded the level equal to that in L that she was trying to achieve.) - Will you both have the same like that? - No - Who will have more? - Me - Show me where you must pour so that you both have the same. - (She poured up to the same level.) - Will you and mummy have the same amount to drink like that? - Yes - Are you sure? - Yes - Now watch what I'm doing (putting L¹ next to L). I am going to pour that one (L) into this one (L¹). Will that make the same here (L¹) as there (L)? - Yes - (When I did so, the child laughed); Mummy has more. - Why?'

Mus (5;0): 'Look (same story as for Blas). Show me with your finger how far I must pour. - There (indicating the same level in L as in A). - (I filled it slightly higher). Will there be the same amount to drink? - You've put too much. There's a little more there (in L). I've a little more to drink - What could you do to see if its the same? (Putting L¹ next to L) - Where will it come up to if we pour that one (A) into this one (L¹)? - To there (pointing to the same level as in A). - (I did so.) - Mummy has more (with great surprise) - How did that happen? - Because the glass (L¹) is smaller - And if I pour this one (L¹) back into that (A) which will have the most? - Both a little, both the same. - (I poured it back). Whose has more to drink? - Both less.'

Both questions stress the event, i.e., amount, but the questions differ in their relationships to the event. The question in the second example appears less complex than the first since it focuses more on action than the first. Also, the question in the second example is a more common experience to the child than the question in the first example.

The two above examples are typical illustrations of Piaget's clinical method. This method Flavell (4, p. 28), states "has more in common with diagnostic and therapeutic interviews, with projective testing, and with the kind of informal exploration often used in pilot research throughout the behavioral sciences. The crux of it is to explore a diversity of child behaviors in a stimulus-response-stimulus-response sequence; in the course of this rapid sequence, the experimenter uses all the insight and ability at his command to understand what the child says or does and to adapt his own behavior in terms of this understanding."

Furthermore, according to Flavell, Piaget feels that only through such a method can one get to the heart of the child's cognitive structure and describe it as it really is." . . . Once a task is presented to the child, one is committed to try and to follow the child's thought wherever it

seems to be going, and this precludes a standard, unvarying interview. Piaget freely admits the usefulness of more standardized, 'test-like' procedures for a number of psychometric purposes. However, if one's primary concern is simply to describe and explain the variety of intellectual structures which children at different levels possess rather than to construct rigorous developmental scales for diagnostic purposes, Piaget believes the clinical method to be the method of choice."

Flavell agrees with Piaget in his estimate of the advantages of the clinical method, but stresses that Piaget could have retained these advantages and secured obvious additional ones by a semistandardization procedure. For example, children could be asked a set of identical stimulus questions; over and above that, however, there would be relative freedom given to the experimenter in working with the child.

Lovell's (7) questioning technique does combine the clinical approach with some degree of standardization. For example, a test of conservation of weight:

Technique -

(1) "Say, 'Here are two balls of plasticine. I want you to tell me which one is heavier. Use the scales if you like.' Record the child's actions and his reply. Whatever the child decides is accepted provided that he has held the two balls in his hand. If he is content to judge merely by

looking, he is told to pick up the balls and satisfy himself as to which is the heavier.

(2) How do you know that (indicates the ball chosen) is heavier?

(3) One ball (R2) is rolled into a 'sausage.' Say - Now which is heavier, the sausage or the ball? Don't pick them up, try to think it out.

(4) Why do you think that?

(5) The 'sausage' is further rolled so that it becomes even longer and thinner. Say - Which is heavier now?

(6) Why are you so sure?

To this point we have followed the Piagetian procedure closely so that conservers, in his sense of the word, are those who answer questions 3 and 5 correctly, and in addition, gave such answers to questions 4 and 6 as 'nothing has been added or taken away;' 'They were the same before;' 'The sausage is longer but its thinner;' 'You've only rolled one ball.'

Further questions were then put to both conservers and non-conservers. For example, the latter gave their reasons for failing to conserve weight (7, p. 139). "

On the other hand, Smedslund (1) stresses the standardized questions and minimizes the use of the clinical technique. For example:

Test of Conservation of Substance: 'Two equal balls of plasticine were presented and the child was told that they contained the same amount of clay. This was emphasized and repeated so to ensure proper attention. Then the experimenter changed one of the balls into another form, commenting on it by saying: 'Now I change this one into a . . . (ring, cross, etc.); after each deformation the following standard question was asked: 'Do you think the . . . contains more or the same amount as or less clay than the ball?' After each answer, the experimenter asked in a neutral but interested voice: 'Why do you think so?'

At this point, the research appears equivocal as to the superiority of either the clinical or the standard technique, or some combination of them. Peel (8) indicates that Piaget's findings concerning stages of development have repeatedly been confirmed. This suggests that the questioning technique plays a minor role in ascertaining whether a child has attained a particular concept. The questioning technique, however, dictates the approach whether clinical or standardized. The clinical technique utilizes "rephrased" questions, whereas the standardized approach does not. Clearly, then, the question of which technique is most appropriate depends largely upon whether "rephrasing" of the question affects performance.

A secondary purpose, then, of this investigation is to study the extent to which "rephrasing" of the question affects performance.

The Acquisition of Conservation of Substance; Verbal and Non-Verbal Tasks

According to Piaget, language is molded on habits of thought. The present investigator interprets this to mean that language is formulated from perceptions, i.e., perception precedes language in development. Perceptions initially are characterized by egocentrism and hence are syncretic - that is, inaccurate observations of things, heaped upon each other. Since language comes later in

development than perception, it would be reasonable to assume that, at a given moment during language development, the perceptions associated with a given task might be less egocentric and, consequently, less syncretic than the language. For example, two tasks are given a child, one which involves language and one which does not. It seems plausible, assuming the tasks are measuring the same phenomenon, that the perceptions of the non-verbal task would be less syncretic, since the child's perceptions on the verbal task are further corrupted by syncretic verbal understanding. Therefore, one would expect 6- and 9-year-olds' responses to be categorized at a higher developmental level on non-verbal tasks than on verbal tasks. Although the literature is scanty with respect to non-verbal tests of conservation of substance, Zimiles (19) attests to the superiority of Wohlwill's non-verbal test procedure over the verbal test procedures when he states:

At no time in the verbal test is a specific request made for a numerical rather than a spatial response. This is in sharp contrast with the non-verbal test procedure where S's response to the altered spatial arrangement must be made in terms of numerical symbols rather than ambiguous language. According to the interpretation presented here, the necessity to respond in terms of number serves as a set to use numerical rather than spatial criteria; hence, the superiority of non-verbal as opposed to verbal test performance in both the pre- and post-sessions.

Smedslund (14) implies the use of the non-verbal cues, shock and surprise, as indices of conservation of mass when he states that children (non-conservers in the Piagetian sense) were not shocked or surprised when the law of conservation was violated. Dixon (2) takes surprise, confusion and the spontaneous verbalization of nursery-school children as indicators of familiarity with an apparently contradicted size relationship. Dixon reports good agreement between two observers and between two presentations on the task. In view of this, Dixon (2) suggests that contradiction of expectations provides another approach to studying children's un-verbalized generalizations.

Theoretical Considerations in Selecting Tasks

As mentioned earlier, language may be a source of difference between academically deprived Prince Edward County children and academically experienced Flint, Michigan children. Accordingly, experiments involving both verbal and non-verbal communication must be utilized if we wish to investigate the developmental changes in children's thinking as a function of their school backgrounds.

Standard Piaget experiments and a non-verbal technique, the Magic Experiment, will be employed to ascertain whether a child has attained the concept of conservation

of substance. The standard Piagetian conservation of substance experiments involve considerably more linguistic communication than the Magic Experiment.

Task 1: Magic Experiment

The Magic Experiment involves first getting the child to agree that two 150 m.l. beakers are filled with an equal amount of water. Then pouring one of the beakers into a 1000 m.l. jar and "noting" the comments of the child as the water from the 150 m.l. beaker apparently fills the 1000 m.l. jar (Figures 1 and 2, p. 26, 27) the child has the concept of conservation of substance, then this apparent distortion of reality will elicit comments such as "that's funny," "crazy," a gesture of surprise or a smile of incredulity. On the other hand, if the child does not have this concept, he will not make any noticeable gestures indicative of surprise or astonishment.

Tasks 2, 3, 4 and 5 are the standard Piagetian conservation of substance experiments. Piaget (9), Lovell (6, 7), Smedslund (12) and others have employed these tasks regularly to ascertain whether a child has the concept of conservation of substance. They will be described in detail in the next section.



Fig. 1

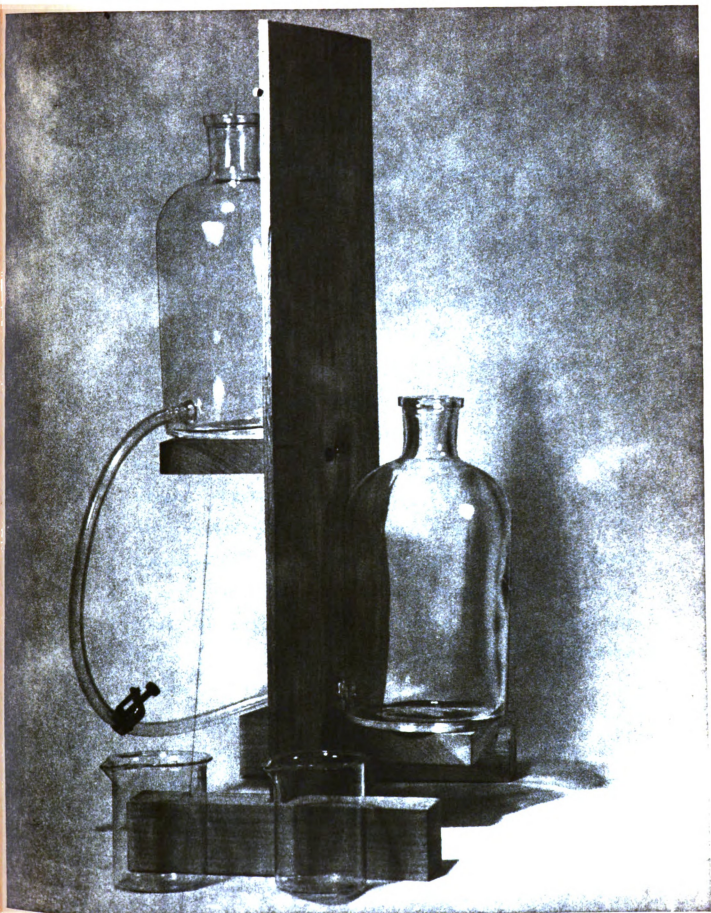


Fig. 2

PROCEDURES

Statement of Hypotheses:

- A. No significant difference exists between Prince Edward County, Virginia and Flint, Michigan subjects in the frequency of responses scored at any particular developmental stage.
- B. No significant difference exists in the frequency of responses at any particular developmental level between Prince Edward County, Virginia 6-year-olds and Flint, Michigan 6-year-olds on the verbal Piagetian tasks (Tasks 2, 3, 4 and 5).
- C. Flint, Michigan 9-year-olds make significantly more stage 3 responses than Prince Edward County 9-year-olds on the verbal Piagetian tasks.
- D. Phrasing of the question does not affect the frequency of responses at any particular developmental level. Thus, for any task, there will be no significant differences in scoring attributable to type of question asked.
- E. The proportion of subjects passing only Task 1, the non-verbal task for conservation of continuous substances, is significantly greater than the proportion of subjects passing only Task 4 and 5, the verbal tasks for discontinuous substances. This prediction is in

variance with Piaget's findings that the conservation of discontinuous substances always precedes continuous substances developmentally.

Population and Sample

In 1959 the Prince Edward County, Virginia, Board of Supervisors confronted by a court order to integrate their schools, failed to allocate funds for the operation of a public school system. The school closing presented a condition somewhat unique to modern education and presented an opportunity to investigate the role that schools play in development. The schools in Prince Edward County, Virginia, were reopened in the fall of 1963 under the sponsorship of the Free Schools Association, a private school system. A period of four years had intervened in which the schools were closed.³

During the years 1959-1963, few Prince Edward County Negro children received four years of schooling. Various organizations provided money to send some Negro children to school in different states. Among the 9-year-old Prince Edward County Negro children who participated in this study, at least 50% received no formal education

³In June, 1964, a Supreme Court Decision ordered Prince Edward County to reopen its public schools. Since Fall, 1964, Prince Edward County Negro children have received public education.

during this period; 25% of them received from 1 to 3 years and no data are available for the remaining 25%. In addition to their lack of formal schooling, most of these children came from low income families.

A sample of 60 academically experienced Flint, Michigan Negro children was selected for comparison with a sample of Prince Edward County, Virginia Negro children in order to study the effects of lack of formal schooling on number development. Males and females were equally represented in each sample, as were 6- and 9-year-olds.

Six-year-olds and nine-year-olds were selected because Piaget's writings indicate that, in general, most 6-year-olds do not yet possess the concept of conservation of substance while most 9-year-olds do possess this concept. Six and nine-year-olds were operationally defined as between 6 1/2 years to 7 years and 9 1/2 years to 10 years respectively.

Description of Tasks:

Task 1: The Magic Experiment

This experiment consists of allowing the child to satisfy himself that two 150 m.l. beakers contain the same quantity of liquid; then pouring the contents of one into a 1000 m.l. jar which apparently fills and noting the child's comments.

Scoring of Responses:

Gestures of "surprise," "puzzlement," "smile," "chee," "wow," etc., will be scored at stage 3. The absence of observable change in behavior will be scored at stage 1. The transition stage, stage 2 responses, are difficult to assess on a non-verbal task. Further, Piaget (9) questions the universality of a transitional stage. Consequently, all responses will be scored at stage 1, absence of the concept of conservation or stage 3, presence of the concept of conservation.

Task 2: The Conservation of Continuous Quantities

The child is shown two large containers of similar dimensions filled with an equal amount of liquid. He is allowed to satisfy himself that the amounts of the liquid are the same. The liquid is poured from one container into three smaller ones, and the child is then questioned about the equality of the two quantities as a result of this operation.

Task 3: The Conservation of Continuous Quantities

The child is asked to tell the examiner when a graduated cylinder is filled with water to a 50 m.l. line. Then the water is poured into a 600 m.l. beaker. He is again asked to declare when the graduated cylinder is filled to 50 m.l. The water is now poured into a 100 m.l. beaker. The child is then questioned about the equality of the two quantities as a result of the operation.

Task 4: The Conservation of Discontinuous Quantities and its Relation to One to One Correspondence

A child is told to put gum balls into a container one by one; at the same time the experimenter is putting gum balls one by one into another container. The contents of one container are then poured into a long, narrow tube. The child then is asked whether the total quantities are the same.

Task 5: The Conservation of Discontinuous Quantities and its Relation to One to One Correspondence

A child is told to put gum balls into a container one by one; at the same time the experimenter is putting gum balls one by one into another container. The contents of one container are then poured into three small containers. The child then is asked whether the total quantities are the same.

According to Flavell (4), Piaget has maintained that conservation on a continuous quantity task is more difficult (i.e., exhibits higher mean age of acquisition) than on a discontinuous quantity task. If, however, Task 4 and Task 5, verbal discontinuous tasks, have a higher mean age of acquisition than Task 1, a continuous non-verbal task, then Task 1 has a lower mean age of acquisition than all continuous verbal tasks.

Scoring of the Responses: Tasks 2, 3, 4 and 5

The responses such as "the amounts are the same," "no difference," etc., will be scored at Stage 3. Responses such as "no, the amounts are not the same, but if you pour the liquid back, they are the same," or "the amounts are the same when the liquid is poured into two glasses, but not the same when the liquid is poured into three glasses," will be scored at Stage 2. Other responses such as "no, one glass has more," or "there is more in this glass," etc., will be scored at Stage 1. Any irrelevant responses such as, "Daddy says so," etc., will be scored at Stage 1.

Procedure:

Each child was presented with Tasks 1-5. The sequence in which the experiments were administered was counter-balanced to control for any order effects. Five sequences, labelled a-e in Table 1, were utilized.

In order to study the effects of different types of questions on the responses of subjects, three types of questions (A, B and C) within each of the two major samples, were systematically employed:

Type A question on Tasks 2 and 3:

"Is the amount of water the same, more or less? Why do you think that?"

Type A question on Tasks 4 and 5:

"Is the amount or number of gum balls the same, more or less? Why do you think that?"

Type B question on Tasks 2 and 3:

"Does one glass have more water? Why do you think that?"

Type B question on Tasks 4 and 5:

"Does one glass have more gum balls? Why do you think that?"

Type C question on Tasks 2 and 3:

"If you were thirsty, which glass would you drink? Why do you think that?"

Type C question on Tasks 4 and 5:

"If you could have the gum balls to keep, which glass would you want?"

On Task 1, however, the type of question was irrelevant since it is a non-verbal task.

For any particular subject, a given type of question (A, B or C) was consistently employed across all tasks. Hence, a subject asked a Type B question on Task 2 and 3 was also asked Type B question on Tasks 4 and 5. An equal number of subjects, within each of the major samples, balanced for age and sex, was assigned to each question type.

Design:

Table 1 is the 2 x 2 x 2 x 3 x 5 design used in the study. Within the design, the variables of age, sex, type of question, and sequence of tasks presented were balanced. The order of task presentation is represented by the letters a-e.

TABLE 1
2 x 2 x 2 x 3 x 5 Design Used to Study the Effects of
Schooling, Instruction and Language on Performance

Question Type	Prince Edward County						Flint					
	Male			Female			Male			Female		
	A	B	C	A	B	C	A	B	C	A	B	C
6 Year Olds	1 a	6 a	11 a	1 a	6 a	11 a	1 a	6 a	11 a	1 a	6 a	11 a
	2 b	7 b	12 b	2 b	7 b	12 b	2 b	7 b	12 b	2 b	7 b	12 b
	3 c	8 c	13 c	3 c	8 c	13 c	3 c	8 c	13 c	3 c	8 c	13 c
	4 d	9 d	14 d	4 d	9 d	14 d	4 d	9 d	14 d	4 d	9 d	14 d
	5 e	10 e	15 e	5 e	10 e	15 e	5 e	10 e	15 e	5 e	10 e	15 e
9 Year Olds	A	B	C	A	B	C	A	B	C	A	B	C
	1 a	6 a	11 a	1 a	6 a	11 a	1 a	6 a	11 a	1 a	6 a	11 a
	2 b	7 b	12 b	2 b	7 b	12 b	2 b	7 b	12 b	2 b	7 b	12 b
	3 c	8 c	13 c	3 c	8 c	13 c	3 c	8 c	13 c	3 c	8 c	13 c
	4 d	9 d	14 d	4 d	9 d	14 d	4 d	9 d	14 d	4 d	9 d	14 d
	5 e	10 e	15 e	5 e	10 e	15 e	5 e	10 e	15 e	5 e	10 e	15 e

RESULTS

The Reliability of the Scoring Categories

To check the reliability of the scoring procedure, a graduate student in Educational Psychology, familiar with Piagetian techniques, scored the responses on five tasks. As to the protocol of scoring, the graduate student read the procedure section and discussed it with the present investigator. The student was given 120 sheets, each with 5 responses, a total of 600 responses. No name, age or location was specified on the sheets. The sheets were randomly ordered to avoid any pattern of responses.

As a measure of reliability, a percentage of agreement was calculated between the investigator's scores and the graduate student's scores. The percentage of agreement was .90. In other words, agreement was obtained on 542 out of the 600 responses. Primary areas of disagreement were in the classification of Stage 2 responses on both the magic experiment and the Piagetian tasks. Frequently, what the present investigator interpreted as a Stage 1 response was construed as a possible Stage 2 response by the graduate student and vice-versa. Since Stage 2 responses are the most difficult to classify, one would expect differences here.

Categorical data and hypotheses of the independence of variables suggest the use of chi-square in analyzing the data. In certain cases where the categories were empty, the chi-square was inappropriate and the binomial test of proportion was used. The binomial test was also used to verify that the proportion of subjects passing only Task 1, the non-verbal continuous task, is significantly greater than the proportion of subjects passing only Tasks 4 and 5, the verbal discontinuous tasks. .10 level of significance was used to test the hypothesis of no difference whereas .05 level of significance was used to test the hypothesis of difference.

Before a description of results is presented, perhaps an explanation is warranted for fixing the α level of significance at .10 for hypotheses of no difference. In testing hypotheses of no difference, we are primarily concerned with minimizing the possibility of accepting the hypotheses of no difference, when in fact there is a difference. In other words, we wish to minimize the possibility of committing a Type II error. Fixing the level of significance at .10 rather than the normal .05 level for a fixed N and for a fixed alternative reduces

the probability of committing a Type II error.⁴ If for a fixed α level of .10, we still have no reason to reject the hypothesis of no difference, the likelihood of "not" accepting a false hypothesis is increased.

Table 2 presents the results of Prince Edward County 6- and 9-year olds' performance and Flint, Michigan 6- and 9-year-olds' performance on Task 1, the non-verbal task. On the basis of each subject's performance, he or she was categorized at Stage 1, absence of the concept of conservation of substance or Stage 3, presence of the concept of conservation of substance. Four 6-year-old Prince Edward County subjects and one Flint, Michigan 6-year-old subject gave responses which could not be categorized into either Stage 1 or Stage 3. Although none of these children manifested outward surprise at a little glass filling a large jar, they did say the water in the large jar "looks like" more. This type of response may be similar to the responses to Piagetian tasks which were categorized into Stage 2. There were few Stage 2 responses on the non-verbal task and on the Piagetian tasks and, further, since

⁴The reader may wish to refer Dixon and Massy's Introduction to Statistical Analysis, Chapter 7, McGraw-Hill.

Piaget (9) questions the universality of Stage 2 responses, it was decided to eliminate this scoring category. The results support the hypothesis that Prince Edward County 6- and 9-year-olds and Flint, Michigan 6-year-olds and 9-year-olds' performance are categorized into the same developmental stage. The Prince Edward County 9-year-olds and Flint, Michigan 9-year-olds' data show almost identical distributions into Stage 1 and Stage 3 categories.

TABLE 2

Comparison of Prince Edward County
6 and 9 Year Olds' Performance
and Flint 6 and 9 Year Olds' Performance
On Task 1, The Non-Verbal Task

	Absence of Conservation Stage 1	Presence of Conservation Stage 3	Total
P.E.-6 Years	17	9	26
Flint-6 Years	23	6	29
Total	40	15	55
P.E.-9 Years	6	24	30
Flint-9 Years	5	25	30
Total	11	49	60

6 Year Olds: χ^2 : $\chi^2 = 1.51$ with 1 df; $p = .20$.
Not significant at .10 level.

9 Year Olds: χ^2 : $\chi^2 = 0.00$ with 1 df; $p = .99$.
Not significant at .10 level.

Table 3 presents the results of Prince Edward County 6-year-olds and Flint, Michigan 6-year-olds on Task 2 and Task 3, the Piagetian water tasks. Prince Edward County and Flint, Michigan 6-year-olds gave too few Stage 3 responses to be analyzed by chi-square. The Stage 1 responses

alone were analyzed by the binomial approximation to the normal. Since hypotheses of no difference were posited, a two-tailed test was used. The results confirm the hypotheses that both Prince Edward County 6-year-olds and Flint, Michigan 6-year-olds fall into the same developmental stage on the Piagetian water tasks.

TABLE 3

Comparison of Prince Edward County 6 Year Olds' And
Flint 6 Year Olds' Performance On Task 2 And Task 3

	P.E. 6 Year Olds Stage 1, Absence of Conservation Of Substance	Flint 6 Year Olds Stage 1, Absence of Conservation Of Substance	Total
Task 2	25	28	53
Task 3	27	29	56

Task 2: Binomial Approximation to Normal: $Z = -.28$ has a two-tailed probability of .75 under H_0 . Results not significant at .10 level.

Task 3: Binomial approximation to Normal: $Z = .13$, has a two-tailed probability of .90 under H_0 . Results not significant at .10 level.

Tables 4 and 5 present the results of Prince Edward County 6-year-olds' and Flint, Michigan 6-year-olds' performance on the Piagetian discontinuous tasks (gum ball tasks). On Task 4, there were sufficient Stage 3 responses to merit the use of chi-square; however, on Task 5 this was not the case. On Task 5 the Prince Edward County and Flint, Michigan 6-year-old Stage 1 responses were analyzed by the binomial approximation to the normal. The findings support the hypothesis that both Prince Edward County 6-year-olds and Flint, Michigan 6-year-olds are categorized into the same stages for Piagetian discontinuous tasks.

It is worth noting that for the 6-year-olds on Task 1, the non-verbal task, more Stage 3 responses were recorded than on any of the other tasks.

TABLE 4

Comparison of Prince Edward County 6 Year Olds' and
Flint 6 Year Olds' Performance on Task 4

	Stage 1 Absence Of Conservation	Stage 3 Presence of Conservation	Total
P.E.-6 Years	24	6	30
Flint-6 Years	26	4	30
Total	50	10	60

χ^2 : $\chi^2 = .49$ with 1 df; $p = .50$. Results not significant at .10 level.

TABLE 5

Comparison of Prince Edward County 6 Year Olds' and
Flint 6 Year Olds' Performance on Task 5

	P.E. 6 Year Olds	Flint 6 Year Olds	Total
Stage 1, Absence of Conservation	24	29	53

Binomial Approximation to Normal: $Z = -.53$ has a two-tailed probability of .59 under H_0 . Results not significant at .10 level.

Tables 6, 7, 8 and 9 present the results of Prince Edward County 9-year-olds' and Flint, Michigan 9-year-olds' performance on the Piagetian tasks. On all these tasks, the hypothesis that Flint 9-year-olds' performances are categorized into a higher developmental stage than Prince Edward County 9-year-olds is rejected. In fact, on Task 3, the water task, involving the graduated cylinder, inspection of Table 7 shows almost identical performance between Prince Edward County 9-year-olds and Flint, Michigan 9-year-olds.

It is interesting to note that there are significantly more Stage 3 responses on the discontinuous Tasks 4 and 5 (gum ball tasks) than on the continuous Tasks 2 and 3 (water tasks).

TABLE 6

Comparison of Prince Edward County 9 Year Olds' and
Flint 9 Year Olds' Performance on Task 2

	Stage 1 Absence of Conservation	Stage 3 Presence of Conservation	Total
Flint-9 Years	14	13	27
P.E.- 9 Years	17	9	26
Total	31	22	53

χ^2 : $\chi^2 = 1.26$ with 1 df; $p = .20$. Not significant
at .05 level.

TABLE 7

Comparison of Prince Edward County 9 Year Olds' and
Flint 9 Year Olds' Performance on Task 3

	Stage 1 Absence of Conservation	Stage 3 Presence of Conservation	Total
Flint-9 Years	14	14	28
P.E.- 9 Years	13	14	27
Total	27	28	55

χ^2 : $\chi^2 = .00$ with 1 df; $p = .99$. Not significant
at .05 level.

TABLE 8

Comparison of Prince Edward County 9 Year Olds' and
Flint 9 Year Olds' Performance on Task 4

	Stage 1 Absence of Conservation	Stage 3 Presence of Conservation	Total
Flint-9 Years	5	20	25
P.E.-9 Years	6	21	27
Total	11	41	52

χ^2 : $\chi^2 = .16$ with 1 df; $p = .50$. Not significant
at .05 level.

TABLE 9

Comparison of Prince Edward County 9 Year Olds' and
Flint 9 Year Olds' Performance on Task 5

	Stage 1 Absence of Conservation	Stage 3 Presence of Conservation	Total
Flint-9 Years	9	18	27
P.E.-9 Years	8	21	29
Total	17	39	56

χ^2 : $\chi^2 = .35$ with 1 df; $p = .50$. Not significant
at .05 level.

Tables 10, 11, 12 and 13 present the results on the effects of type of question on performance on the Piagetian tasks. Each child was asked on all the Piagetian tasks either Type A or Type B or Type C questions. On the Piagetian water tasks the Type A questions were, "Is the amount of water the same, more or less? Why do you think that?", whereas on the Piagetian gum ball tasks, the Type A questions were: "Is the amount or number of gum balls the same, more or less? Why do you think that?" Similarly, the Type B questions were: "Does one glass have more water? Why do you think that?" and "Does one glass have more gum balls? Why do you think that?" And, finally, the Type C questions were: "If you were thirsty, which glass would you drink? Why do you think that?" and "If you could have the gum balls to keep, which glass would you want?"

The hypothesis that phrasing of the question does not affect the performance of subjects on Piagetian tasks is confirmed for the Piagetian continuous tasks, but is rejected for the Piagetian discontinuous tasks. In particular, inspection of Tables 10 and 11 indicates that the type of question does not affect performance on continuous tasks whereas Tables 12 and 13 indicate that the type of question does affect performance on discontinuous tasks.

TABLE 10

Type A, Type B, Type C Questions and
Performance of Subjects on Task 2

	A	B	C	Total
Stage 1	29	28	28	85
Stage 3	9	10	10	29
Total	38	38	38	114

χ^2 : $\chi^2 = .14$ with 2 df; $p = .90$. Not significant at .10 level.

TABLE 11

Type A, Type B, Type C Questions and
Performance of Subjects on Task 3

	A	B	C	Total
Stage 1	25	30	30	85
Stage 3	12	10	8	30
Total	37	40	38	115

χ^2 : $\chi^2 = 1.09$ with 2 df; $p = .50$. Results not significant at .10 level.

TABLE 12

Type A, Type B, Type C Questions and
Performance of Subjects on Task 4

	A	B	C	Total
Stage 1	18	20	25	63
Stage 3	19	17	10	46
Total	37	37	35	109

χ^2 : $\chi^2 = 4.03$ with 2 df; $p = .10$. Results significant at .10 level.

TABLE 13

Type A, Type B, Type C Questions and
Performance of Subjects on Task 5

	A	B	C	Total
Stage 1	21	20	28	69
Stage 3	18	15	10	43
Total	39	35	38	112

χ^2 : $\chi^2 = 3.28$ with 2 df; $p = .10$. Results significant at .10 level.

Table 14 presents the results of those 6-year-old and 9-year-old subjects that passed Task 1 "only" and Task 4 "only." Passing Task 1 "only" means that a child is categorized in Stage 3 on Task 1 and in Stage 1 on Task 4. Task 4 responses were the combined results of the gum ball Tasks 4 and 5. On the other hand, passing Task 4 "only" means that a child is categorized in Stage 3 on Task 4 and in Stage 1 on Task 1. Selection of subjects that passed Task 1 "only" and Task 4 "only" insured independence of tasks. Since the tasks were independent, the Binomial test was employed. The results confirm the hypothesis for both 6 and 9-year-old subjects that the proportion of subjects passing Task 1 "only" is significantly greater than the proportion of subjects passing Task 4 only.

TABLE 14

Number of Subjects Passing Task 1 Only and Task 4 Only

	Passing Task 1 Only	Passing Task 4 Only	Total Passing One Task
6 Year Olds	13	1	14
9 Year Olds	13	3	16

Binomial Test, 6 Years Old: $P(X = 1) = .001$;
Results significant at .01 level.

Binomial Test: $P(X = 3) = .011$; Results significant at .05 level.

Table 15 presents the distribution into particular stages of development of all the 6- and 9-year olds on Tasks 1, 2, 3, 4 and 5. The tasks are described in terms of the non-verbal or verbal dimension and the continuous or discontinuous dimension. Inspection of the data indicates that Task 1, the non-verbal task, had the most Stage 3 responses and Tasks 2 and 3 had the fewest Stage 3 responses for 6- and 9-year-olds. It is also worth noting that on all tasks significantly more 9-year-olds were categorized into Stage 3 than 6-year-olds. In addition, the tasks appeared to have the following order of difficulty for both 6- and 9-year-olds: The non-verbal, continuous magic experiment, the discontinuous verbal tasks and the continuous verbal tasks.

TABLE 15

The Number of 6 Year Olds and 9 Year Olds Categorized
Into Stages of Development on Tasks 1, 2, 3, 4 and 5

		Non- Verbal		Verbal		
		Continuous		Discontinuous		
		Task 1	Task 2	Task 3	Task 4	Task 5
6 Year Olds	Stage 1 Absence of Conservation	40	53	56	50	52
	Stage 2 Transition	5	1	0	0	2
	Stage 3 Presence of Conservation	15	6	4	10	5
9 Year Olds	Stage 1 Absence of Conservation	6	31	27	11	17
	Stage 2 Transition	5	7	5	8	4
	Stage 3 Presence of Conservation	49	22	28	41	39

DISCUSSION AND CONCLUSIONS

Interpretation of Results

Failure to reject the hypothesis of no difference in performance between Prince Edward County, Virginia 6-year-olds and Flint, Michigan 6-year-olds on both the non-verbal and verbal tasks suggests a minimal influence of geographic location on performance. The similar performances on the non-verbal task by Prince Edward County 9-year-olds and Flint, Michigan 9-year-olds are consistent with the theory espoused in this study. Tables 6, 7, 8 and 9 lead us to reject the hypothesis that Flint 9-year-olds perform at a higher level than Prince Edward County 9-year-olds on Piagetian tasks.

Prince Edward County children's eight months of formal schooling prior to our testing might provide one possible explanation for the results of no differences in performances among 9-year-old subjects. The difference in language facility between Prince Edward County and Flint children might have been reduced during this period. The investigator should like to emphasize that even if this were the case, the ensuing argument that the children might have mastered the conservation tasks as a result of the school experiences is ill-founded. Smedslund (14) and Wohwill (17)

have demonstrated that providing children with specific training in conservation of substance tasks does not insure acquisition of the concept of conservation.

Perhaps the syncretic nature of child language, espoused earlier, offers another explanation for these results. If all 6- and 9-year-old children emphasize the events of questions rather than the relationships to the events, perhaps this may account for the similarity in performances of the Prince Edward County 9-year-olds and the Flint, Michigan 9-year-olds. Conceivably, just as specific training in conservation tasks does not insure conservation (14) so too, specific training in language does not insure understanding of questions prior to 9 years of age. Indeed, certain types of questions at a particular age may be equally incomprehensible to all children regardless of their environment. The rejection of the hypothesis that, due to their academically enhanced language facility, the Flint sample is superior to the Prince Edward County sample on verbal tasks seems to suggest that school experience affects number performance only minimally.

Variations in question phrasing, however, appear to influence significantly performance on certain number tasks. The hypothesis of no difference in performance is supported for the Piagetian continuous tasks (water tasks) but not for the Piagetian discontinuous tasks (gum ball

tasks). Inspection of Tables 12 and 13 indicates that the proportion of Stage 1 and Stage 3 responses to Type C questions differs markedly from the proportion of Stage 1 and Stage 3 responses on Type A and Type B questions. One possible explanation for the difference in results on the continuous and discontinuous tasks may be that Type C questions, "If you could take the gum balls home, which one would you take" did not stress the event "amount" but rather either some other or additional event such as color of gum balls or shape of gum balls in the glass. Further, if this were not the case, how could one explain the similarity in proportions of Stage 1 and Stage 3 responses on the Type A and Type B questions. The present investigator feels that Type A and Type B questions stressed "amount" primarily and that the Type C question stressed "amount" and/or color or shape of gum balls. Questions which stress more than one event may be defined as ambiguous. Zimiles (19) supports this when he maintains that one of the ambiguities inherent in verbal tasks is the inability of a verbal test or a question to delineate specifically the kind of response, spatial or numerical, that is desired.

An analysis of the chi-square technique provides yet another possible interpretation of the data.. The statistical technique chi-square is conservative for

small N (20). That is, it masks a difference if one exists. The N in Tables 12 and 13 are 109 and 112 respectively; a reasonable size N for chi-square is about 40. If phrasing of the question does, in fact, make a difference, then one might expect differences for $N = 40$. In addition, if there is a true difference, then for large N, a significant difference should be readily detected. Furthermore, if, in fact, there is a small difference as a result of questioning, then for all practical purposes we may treat it as no difference.

But if the data do suggest that the type of question can affect performance, this implies a criticism of Piaget's techniques of assessment. In other words, acquisition of the concept of conservation of substances appears to be sensitive to the manner in which the question is posed. The present investigator feels, however, that Piaget's clinical method utilizes many "rephrased" questions. It is conceivable that even if one question stresses two events, the remaining questions would stress the event in question and minimize the possibility of confusion of events. In other words, the employment of many "rephrased" questions helps to reduce the ambiguity of a particular question. In fact, Piaget implies this when he states that only through such a method can one get to the child's cognitive structure and describe it as

it really is. On the other hand, this suggests that the standardized questioning approach, because of its inflexibility, would not reduce the possibility of confusion of events. Consequently, between the two approaches, the clinical approach appears to influence performance less.

Even though the results are significant on the discontinuous tasks, they are not of sufficient magnitude because of non-significant results on continuous tasks, and Zimiles argument, mentioned earlier, to accept the claim that phrasing of the question affects performance in general. On the other hand, the absence of language or the minimal use of language appears to affect performance significantly.

The findings in Table 14 confirm the hypothesis that the proportion of subjects passing Task 1 "only," the non-verbal task, is significantly greater than the proportion of subjects passing Task 4 "only," the gum ball task. An inspection of Table 15 of all 6-year-olds' and 9-year-olds' performances indicates that more children are categorized at Stage 3 on Task 1 than on any other task. In addition, Table 14 indicates that next to Task 1, Tasks 4 and 5 elicited the most Stage 3 responses for 9-year-olds. Moreover, the results of Table 14 are in agreement with Piaget's finding that continuous conservation tasks involving language have a higher mean acquisition age than dis-

continuous conservation tasks involving language. In light of this, it seems reasonable to say that Tasks 2, 3, 4 and 5 have a higher mean acquisition age than Task 1.

Flavell (4) and others mentioned earlier have argued that the concept of conservation is sensitive to task variation. Piaget states that continuous tasks have a higher mean age of acquisition than discontinuous tasks. Since the magic experiment is a continuous task, clearly the lower mean age of acquisition cannot be accounted for in terms of the task. The evidence indicates that the absence or presence of language significantly affects performance. It should be pointed out that it is not the use of linguistic approach, namely clinical or standardized that is crucial, but the absence or presence of language itself. Clearly then, Piaget's clinical approach is deficient in the sense that it does not take into account the language variable. It is entirely possible then, that children who possessed the concept of conservation, but could not verbalize it, escaped Piaget's detection.

Conclusions

It is concluded that geographic location did not influence the performance of subjects in this study who had equivalent experiences in school (6-year-olds). It is further concluded that the absence of formal schooling

has little or no effect on a child's performance on number development tasks. The results support the findings of Wohwill(17) and Hyde (5) that specific school-related experiences bear little relationship to concept acquisition. Furthermore, the results are consistent with the claim that school experiences are not of sufficient moment to alter the natural processes of adaptation which take place in the child's adjustment to his objective world (11).

It is also concluded that the type of question has little or no effect on children's performance on number development tasks unless the task introduces a source of "event ambiguity" into the situation. This seems to lend support to Piaget's use of a clinical approach. Further, it is concluded that children perform at a higher level on a non-verbal task of number development than on verbal tasks of number development. This lends support to Piaget's concept of the syncretic nature of the child's language; and it points out the importance of the language variable on performance, a factor which Piaget has apparently overlooked.

Implications for Further Research

The results of question phrasing on performance indicate that the nature of the task and the type of question posed merit further exploration. For example, to what

extent are the effects of question phrasing a function of the question and a function of the task. It should be pointed out that although different types of questions may not affect performance, this does not imply that the child understands the questions. In other words, all questions may be equally incomprehensible to the child. Perhaps one can infer that it is not what you say to the child that counts but how you say it. In other words, the tone of your voice, a non-verbal cue, and other non-verbal cues may be more influential than what you say. The superior performance on the non-verbal tasks supports the above in that children understood more readily what was expected of them than on the verbal tasks where language frequently confounded the issue. The role of language as both a facilitator and an inhibitor of concept acquisition merits further exploration; and finally to what extent language facility is a function of development needs further investigation.

Implications for Education

The findings on the effect of lack of formal schooling are at variance with the argument based on the Bruner hypothesis and consistent with the Piaget-based argument. Number development or the concept of conservation of substance appears to come about by a natural process of

adaptation by the child to his world. In this study, the striking differences between the two groups' school environments was not of sufficient moment to alter the rate of development for the acquisition of the concept of conservation. Of course, it may be argued that the Flint children were not given the proper number experiences in school; however, it cannot be denied that the Flint, Michigan children received some formal number experiences whereas the Prince Edward County children received hardly any formal number experiences. Gesell, as quoted by Tyler (15, p. 216, 217), further supports this developmental point of view when he states that, "The environment is not responsible for developmental sequences. Environmental factors support, inflect and specify; but they do not engender the basic forms and sequences of ontogenesis." Gesell's studies of identical twins stressed the importance of added maturity that comes with the passage of time and the ineffectiveness of "early" practice. Furthermore, the results of Smedslund (13) indicate that the concept of conservation of substance cannot be taught until a particular level of cognitive maturity has been reached.

The evidence appears to indicate that you cannot teach anything in some intellectually honest form to any child at any stage of development. Just as one cannot toilet-

train a child until the sphincter muscle is developed, so too, one cannot train a child to understand number, "no matter how you structure the environment," until certain mental structures are developed. This suggests that perhaps we ought to reexamine the feasibility of teaching number theory and sets to children under eight years of age.

The results also seem to support Sigel's contention that "a willingness of the teacher to accept relatively poorly articulated expressions without negative evaluation may sometimes have a positive effect, potentially providing a basis for the child to enhance his intellectual development. This may be particularly important in the education of children from culturally underprivileged groups, where verbal facility often lags considerably behind intellectual potential. Excessive demand for verbalization may bring about a withdrawal or rebellion from other aspects of learning."

BIBLIOGRAPHY

1. Bruner, Jerome S., The Process of Education, New York, Vintage, 1960.
2. Dixon, J. C., "Concept Formation and Emergence of Contradictory Relations," J. Exp. Psychol., 1949, 39, 144-149.
3. Dodwell, F. C., "Children's Understanding of Number Concepts: Characteristics of an Individual and of a Group Test," Canad. J. Psychol., 1961, 15, 29-36.
4. Flavell, John H., The Developmental Psychology of Jean Piaget, New York, Van Nostrand, 1963.
5. Hyde, D. M., (1959), An Investigation of Piaget's Theories of the Development of the Concept of Number. Abstract - Unpublished PhD Thesis, London University.
6. Lovell, K., The Growth of Basic Mathematical and Scientific Concepts in Children, New York, Philosophical Library, 1961.
7. Lovell, K., and Ogilvie, E., "A Study of the Conservation of Weight in the Junior School Child," Brit. J. of Educ. Psychol., (1961), 31, 138-144.
8. Peel, E. A., The Pupils Thinking, London Oldbourne, 1960.
9. Piaget, J., The Child's Conception of Number, London, Routledge and Kegan, Paul Ltd., 1952.
10. Piaget, J., The Language and Thought of the Child, New York, Meridian, 1955.
11. Sigel, I., "The Attainment of Concepts in Children," Hoffman and Hoffman (Eds), Review of Child Development Research, Vol. I, Russell Sage Foundation, New York, 1964.
12. Smedslund, J., "The Acquisition of Conservation of Substance and Weight in Children. I. Introduction." Scand. J. Psychol., 1961, 2, 11-20.

13. Smedslund, J., "The Acquisition of Conservation of Substance and Weight in Children. II. External Reinforcement of Conservation of Weight and of the Operations of Addition and Subtraction," Scand. J. Psychol., 1961, 2, 71-84.
14. Smedslund, J., "The Acquisition of Conservation of Substance and Weight in Children. III. Extinction of Conservation of Weight Acquired "Normally" and by Means of Empirical Controls on a Balance Scale," Scand. J. Psychol., 1961, 2, 85-87.
15. Suppes, Patrick, "Modern Learning Theory and the Elementary School Curriculum," American Educational Research Journal, 1964, 1, 79-93.
16. Tyler, Fred T., "Issues Related to Readiness to Learn, Chapter IX, Theories of Learning and Instruction," The Sixty Third Yearbook of the National Society for the Study of Education, 1964, Chicago, National Society for the Study of Education.
17. Wohlwill, J. F., "A Study of the Development of the Number Concept by Scalogram Analysis," J. Genet. Psychol., 1960, 97, 345-377.
18. Wohlwill, J. F., and Lowe, R. C., "An Experimental Analysis of the Development of the Conservation of Number," Child Developm., 1962, 33, 153-167.
19. Zimiles, Herbert, "A Note on Piaget's Concept of Conservation," Child Developm., 1963, 34, 691-695.

APPENDIX I

TYPE A, TYPE B, TYPE C QUESTIONS AND PERFORMANCE OF 6 YEAR OLDS ON TASK 2, TASK 3, TASK 4 AND TASK 5

	A	B	C	Total	
Stage 1	18	18	17	53	
Stage 3	2	2	3	7	
Total	20	20	20	60	Task 2
Stage 1	18	20	17	55	
Stage 3	2	0	3	5	
Total	20	20	20	60	Task 3
Stage 1	14	17	18	49	
Stage 3	6	3	2	11	
Total	20	20	20	60	Task 4
Stage 1	18	15	19	52	
Stage 3	2	5	1	8	
Total	20	20	20	60	Task 5

APPENDIX II

TYPE A, TYPE B, TYPE C QUESTIONS AND PERFORMANCE OF 9 YEAR OLDS ON TASK 2, TASK 3, TASK 4 AND TASK 5

	A	B	C	Total	
Stage 1	10	10	10	30	
Stage 3	10	10	10	30	
Total	20	20	20	60	Task 2
Stage 1	5	10	11	26	
Stage 3	15	10	9	34	
Total	20	20	20	60	Task 3
Stage 1	2	2	6	10	
Stage 3	18	18	14	50	
Total	20	20	20	60	Task 4
Stage 1	4	4	8	16	
Stage 3	16	16	12	44	
Total	20	20	20	60	Task 5

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