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ABSTRACT

In this study it was hypothesized that those students classified as conservers would score significantly higher on cloze passages related to the concepts of number, quantity, and volume than would those students classified as non-conservers. The subjects consisted of a group of 42 sixth grade urban public school students judged to be of low socio economic background. On the basis of performance on the volume task, students were classified as either non-conservers or conservers. For each of the conservation task areas, noun-deletion cloze comprehension passages were administered. T-tests were run using the scores of conservers and non-conservers to determine the interrelationship of cloze one (number), cloze two (quantity), cloze three (volume), total intelligence, verbal intelligence, non-verbal intelligence, total reading, and reading comprehension. Pearson Product-Moment correlations were used to investigate the relationships between total conservation task scores and each of these variables. The results indicated that the students classified as conservers performed significantly better than those classified as non-conservers. Also, it appeared that intelligence played a more significant role in cloze comprehension that did conservation performance. (WR)

CONSERVATION AND READING COMPREHENSION

AN ABSTRACT OF A THESIS

SUBMITTED TO THE FACULTY

OF THE GRADUATE SCHOOL OF EDUCATION

OF

RUTGERS UNIVERSITY

THE STATE UNIVERSITY OF NEW JERSEY

BY

MARY GIAFAGLEONE BACKUS

IN PARTIAL FULFILLMENT OF THE

REQUIREMENTS FOR THE DEGREE

OF

MASTER OF EDUCATION

COMMITTEE CHAIRPERSON: ALBERT MONTARE, Ph.D.

NEW BRUNSWICK, NEW JERSEY OCTOBER, 1974

ABSTRACT

This study sought to explore the relationship between conservation on a given Piagetian task and cloze comprehension of a written passage concerning the related concept. Piaget's theories concerning the child's conceptual stages of development and resultant cognitive structures may further our understanding of student difficulty in comprehending written materials related to specific scientific concepts. In this study, it was hypothesized that those students who were classified as Conservers would score significantly higher on cloze passages related to the concepts of number, quantity, and volume than would those students classified as Non-conservers. It was hoped that conclusions based on this research could be usefully applied to the more effective writing of science textbooks.

Procedure and Sample

The subjects were a group of 42 sixth grade urban public school students, who were judged to be of low socio-economic background. Conservation performance was assessed for the areas of number, quantity, and volume. On the basis of performance on the volume task (the only one which discriminated for this

population), students were classified as either Conservers or Non-conservers. For each of the conservation task areas, noun-deletion cloze comprehension passages were administered. T-tests were run using the scores of Conservers and Non-conservers to determine the inter-relationship of Cloze I (number), Cloze II (quantity), Cloze III (volume), Total intelligence, Verbal intelligence, Non-verbal intelligence, Total reading, and Reading comprehension. Pearson Product-Moment correlations were used to investigate the relationship between Total conservation task scores and each of the variables listed above.

Results

All t-test analyses were significant at better than the .05 level. Correlation coefficients were low, but positive and significant in all areas except for those between Total conservation task scores and Cloze I (number) and Total conservation task scores and Cloze III (volume).

As was hypothesized, those students who were classified as Conservers performed significantly better on each of the cloze passages than did those classified as Non-conservers. The variable of intelligence was assessed because of its relationship to both conservation and reading. From subsequent indirect analysis, it appeared that intelligence played a more significant role in cloze comprehension than did conservation performance.

An attempt was then made to control for the variable of intelligence by dividing the population into high, middle, and low intelligence groups. Using this division, t-test analysis revealed that a significant relationship between conservation and cloze comprehension scores which went beyond the effects of intelligence existed for the high intelligence group only.

Conclusions and Implications

Further research in which the effects of intelligence are controlled is suggested. For now, reading comprehension seems to be more closely related to intelligence than to conservation performance. It also seems that conservation is simply an outgrowth of intelligence, as is reading ability.

Until more positive research data is collected, application of Piaget's theories of conservation to a specific subject area, such as science, seems limited. While Conservers did outperform Non-conservers in all areas of analysis, intelligence and not cognitive level appears to be the most important variable in predicting cloze comprehension.

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APPROVED: ______________________

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CHAPTER I

BACKGROUND OF THE STUDY

For those involved in the field of reading, the study of factors which influence the comprehension of written materials has, naturally enough, occupied much research time. It has long been realized that reading must be defined as more than the purely mechanical act of encoding. Mere parroting of sound-to-letter relationships with no comprehension of the relationship between sounds and words and the interrelationship of words, sentences, and paragraphs, cannot be termed reading. Mental linkage of these relationships is a necessary part of the total reading process.

Factors which aid or impede comprehension have been researched extensively in efforts to identify those variables which influence a reader's understanding of what is read. Recently the role of cognitive level, as defined within the Piagetian framework, has received attention as another of the variables which may well contribute to reading comprehension. Cognitive level is determined through a person's ability to perform various conservation tasks which, in turn, reflect stages of cognitive development. A fuller knowledge of the relationship between comprehension and cognitive level will enable the reading specialist to apply these findings directly to the development of various curriculum areas.

One such area which could certainly benefit from new directions of research is science curriculum. Judging from the conclusions of those who have investigated the relationship between the readability of science textbooks and the reading levels of students for whom the books were intended (Mallinson, 1963; Janz, 1972; Newport, 19[illegible]; Gilbert, 1972), the complexities of these texts can only be creating frustration for the students who must use them.

The solution most often proposed to alleviate these discrepancies is material simplification (Williams, 1968; Guthrie, 1972; Wilson, 1944). For science texts, the procedure usually runs as follows: (1) simplify nontechnical vocabulary by substitution; (2) amplify technical vocabulary through the addition of phrases or complete sentences; and (3) rephrase and shorten sentences. Using just such a technique to rewrite a sixth grade chapter on resources of the sea to third grade level, Williams (1968) found that low, average, and above average readers all performed better in both speed and comprehension as compared with performance of the control group on the unaltered passage. However, the assumption that this technique will work for all scientific concepts is yet to be proved.

The developmental theories of Jean Piaget may help to elucidate the problems associated with a child's comprehension of science materials. Piaget has received much attention in the areas of mathematics and science, as he has sought to unravel the cognitive processes of children and adolescents. For the educator, Piaget's most significant contribution is the idea that the child's level of cognitive development should dictate subject matter sequencing. The educational ideal should not be the simplification of the material to be taught, but rather the structuring of that material so that it accurately reflects the child's cognitive development.

One of the more commonly held views of educators is that development is the sum of discrete learning experiences. Piaget, in contrast, feels that "development is the essential process and each element of learning occurs as a function of total development [1964, p. 177]." For Piaget, "development explains learning [p. 177]."

Learning is thus viewed as an internal response to external stimuli, such as a teacher's presentation of new material. In such a situation there may be nothing within the child's structure of knowledge which would permit him to internalize this externally presented information in such a way as to be applicable in more than that single instance. In other words, though he may be capable to understanding the specific phenomenon presented to him he is not yet able to extend that understanding to the level of generalization.

A study by Smedslund (in Wallace, 1965) offers a pertinent argument for the view that cognitive development, rather than external reinforcement, is the true basis of learning. In this study, Smedslund was readily able to teach conservation of weight to five and six year old children through the use of external learning techniques. The children were shown balls of clay transformed into various shapes, such as sausages, small pieces, or pancakes. They were directed to weigh the various shapes of clay and were thus shown that although the shape of the mass changed the weight remained the same. However, at one point Smedslund removed a bit of clay from one ball before the first transformation. After the ball had been transformed into another shape and then weighed, the children, who had been led to expect equal weights even though the shape of one ball of clay had been changed, were confused. Many resorted to earlier non-conserving explanations of this change in weight. They thus revealed a faulty learning base which had been created through externally provoked learning. In this case, although training for conservation was effective on a superficial level, the underlying cognitive structure of some children seems not to have been affected. Smedslund concluded that

> The possibility of inducing a cognitive reorganization depends on the subject's already available schemata. If he has a structure which already approaches the given notion, the possibility of the desired reorganization is high, whereas if he is still far from the notion, the chances are small that he will change sufficiently during a limited series of experimental sessions [p. 88].

The role of training in cognitive development is minimal; it is the existence of underlying total development which provides the basis for true assimilation of knowledge.

Another of Piaget's contentions is that children follow set developmental patterns. This sequence is fixed, although sequential manifestations may appear at different ages depending on the individual and his cultural environment. The important point is that the order of sequencing is constant. As a pertinent example, the child will first conserve mass, then weight, and only then volume.

One may thus conclude that once the child has reached the appropriate developmental stage, simplification of materials will not be necessary so long as learning activities are adequately organized to reflect his level of cognitive development. The structuring of an effective science curriculum should be intimately related to that concept.

Statement of the Problem and Hypothesis

Specialists in the field of reading have generally recognized that reading ability is related to IQ, although high IQ does not guarantee successful reading achievement (Vernon, 1971). Reading involves not only perception and memorization of visual shapes and sounds, but also more complex cognitive processes including conceptual reasoning. Applying Piaget's premises as outlined above to a consideration of a child's comprehension of written scientific concepts, one might postulate that the child's cognitive level is a factor, beyond general reading ability, which contributes to his comprehension of written science materials.

It was the purpose of this study to investigate the relationship that exists between cognitive level, defined in Piagetian terms, and comprehension. This study sought to answer the following experimental question: Does cognitive level, as measured by Piagetian conservation tasks concerning number, quantity, and volume, play a role in the comprehension of written science related material, as measured by a noun-deletion cloze procedure that covers the same subject matter as that of the related Piagetian tasks? It was hypothesized that those students who were classified as Conservers would score significantly higher on cloze passages related to the concepts of number, quantity, and volume than would those students who were defined as Non-conservers. It was further hypothesized that Conservers would show a statistically significant advantage over Non-conservers in the areas of intelligence (total, verbal, and non-verbal), general reading ability, and reading comprehension.

For the total of 42 subjects in this study, the following eleven measures were taken in order to assess the general hypothesis:

A. Performance on Piagetian conservation tasks
   1. Number
   2. Quantity
   3. Volume

B. Cloze comprehension
   4. Cloze I--Number
   5. Cloze II--Quantity
   6. Cloze III-Volume

C. California Mental Maturity Test
   7. Total intelligence score
   8. Verbal intelligence score
   9. Non-verbal intelligence score

D. California Achievement Test
   10. Total reading score
   11. Reading comprehension

Importance of the Study

A review of the literature indicates that both Almy (1966) and Mertz (1970) have correlated conservation and general reading ability using a standardized reading test and one or more conservation tasks assumed to be within the developmental level of their respective populations. This study sought to be more specific and examined one facet of this problem, namely the relationship between reading comprehension of a textbook-type passage concerning specific concepts--volume, number, and quantity--and student cognitive level as judged by a series of conservation tasks dealing with those concepts.

It might be hypothesized that conservation and intelligence are intimately related and in fact cannot be meaningfully differentiated. This, in turn, could have an effect on the relationship between reading ability and performance on conservation tasks. However, the literature does not support this hypothesis. In a study of 469 junior high students, Elkind (1961c) found a correlation of .31 between intelligence and performance on a volume conservation task. This was significant at the .01 level but the correlation was low. In another study, Elkind (1961a) found a significant correlation between conservation of quantity and verbal intelligence; yet the comprehension subtest yielded an insignificant correlation of only .19 and the vocabulary subtest a correlation of only .31. Additionally, Dawson (1973) found a significant relationship between reading ability and conservation at the third grade level but not at the fourth grade level. Since there are only a limited number of studies dealing with reading ability and conservation, a need still exists for more research in this area.

Because of Elkind's findings which show a positive relationship between a conservation task and intelligence, the variable of intelligence test performance has been included in the present study. This was done in order to assess the effects of the variable of intelligence upon both the cloze comprehension scores and the conservation task scores.

Definition of Terms

The first eleven terms are operational definitions for the eleven variables listed above. The last two terms, based on subject performance, are operational definitions used in the analysis of results.

Conservation of number was operationally defined as the ability to verbalize that the spatial arrangement of equal numbers of red and white chips does not affect the total number of chips when that total number remains the same.

Conservation of quantity was operationally defined as the ability to verbalize that a set quantity of a liquid is not changed if it is poured into a container or containers of a different size from its original container.

Conservation of volume was operationally defined as the ability to verbalize that the amount of water displaced by a piece of clay rolled into different shapes does not depend on the shape of that object but on its mass.

Cloze I comprehension score was operationally defined as the score obtained on the cloze passage dealing with the concept of number. This passage was adopted especially for this study.

Cloze II comprehension score was operationally defined as the score obtained on the cloze passage dealing with the concept of quantity which was written especially for this study.

Cloze III comprehension score was operationally defined as the score obtained on the cloze passage dealing with the concept of volume which was adopted especially for this study.

Total intelligence score was operationally defined as the average of the subject's Verbal and Non-verbal scores on the California Mental Maturity Test.

Verbal intelligence was operationally defined as the score obtained on the "Verbal" subtest of the California Mental Maturity Test.

Non-verbal intelligence was operationally defined as the score obtained on the "Non-verbal" subtest of the California Mental Maturity Test.

Total reading score was operationally defined as the score obtained on the California Achievement Test administered by the cooperating school district in May of 1973, one year earlier than the date of this study.

Reading comprehension was operationally defined as the score obtained on the "Comprehension" subtest of the California Achievement Test.

A Conserver was a subject who gave both a correct verbal response to the conservation task itself and a correct verbal justification for that response. Correct verbal justification fell into the following categories: invariant quantity, compensation, and reversibility.

A Non-conserver was a subject who gave neither verbal response nor the correct justification on the volume conservation task. (Only the volume conservation task discriminated between Conservers and Non-conservers.) A non-conserving response was one which did not conform to the conserving responses listed above. The subject may have given a magical response, a perceptual response, a simple description of part of the procedure, or no explanation at all.

Limitations of the Study

One limitation of this study is its narrow scope, as it deals only with conservation of number, quantity, and volume on passages related to each of these tasks. This design was intended to test more specifically for possible relationships between reading comprehension and cognitive level in the area of science.

According to Piagetian theory, in a subject population ranging in age as this one did from eleven years two months to thirteen years six months, the expectation is that a high percentage of the subjects would be Conservers. Piaget places the full acquisition of the concept of volume, the most difficult task included in this study, at the age of eleven to twelve years (Wallace, 1965, p. 109). However, in this study only fifty percent of the subjects exhibited conserving responses on the volume task. This may be a reflection of the low socio-economic background which predominated among the subject population. That the subject population was predominantly of low socio-economic background is itself a further limitation of this study. The generalizability of the findings of the acquisition of volume by this population to more representative socio-economic levels within the total United States population is thus limited.

Additionally, the subjects tested were in a transitional stage of development, between the levels of concrete operations and formal operations. Thus, generalizing results upward or downward to other cognitive stages would have extremely limited value.

Overview of the Study

The purpose of this study was to investigate the possible relationship between performance on a given conservation task and comprehension of written science related material dealing with the appropriate concept--number, quantity, and volume. It was hypothesized that reading comprehension is to a significant degree dependent upon the child's cognitive level, *i.e.*, his ability to conserve. Findings which support this hypothesis may contribute to the development of a more effective science curriculum, particularly for those students from a low socio-economic background.

Science textbooks are still being written at levels which may be incompatible with student reading abilities. If cognitive level does indeed affect comprehension of science materials, then will students who have reached higher stages of development, as herein measured, be able to comprehend the corresponding written passages better than those students operating at lower stages of development? If so, then cognitive level would be one of the necessary factors to consider when science curriculum is structured and accompanying student texts are written.

In the following chapter, literature pertinent to this study will be reviewed. Following that, there will be a description of the procedures used in executing the study. Findings are then presented, followed by a discussion of results.

CHAPTER II

REVIEW OF RELATED LITERATURE

Written science material is often especially difficult for students to comprehend; this is a conclusion frequently encountered in studies dealing with science and readability. Various methods have been suggested which might simplify the presentation of scientific concepts. The most frequently utilized method is controlling the readability levels through the application of a readability formula. Judging from a review of the literature of readability and science related materials, the utilization of these formulas is providing little assistance in the eventual comprehension of science materials.

Guthrie (1972), in a study investigating learnability and readability, found an interesting paradox. Unfamiliar reading material was written in a more complex form than material for which general familiarity can be assumed. Thus the very material from which the most learning must be gained, he found, was written in forms which blocked easy access by the student.

A review of studies which have investigated the readability ratings of science textbooks reveals that many of these materials are written at higher levels than the students for whom they were written would be expected to be reading. Mallinson (in Klare, 1963) conducted a series of nine studies evaluating the readability ratings of science textbooks for grades four through high school. His conclusions indicate that these materials are written above the students' reading levels. This was found to be true particularly in grades four to six where evaluations indicated that "none of them amounts to easy reading [p. 238]." This same study reports that the textbooks were found to be too difficult throughout for the average fourth grade reader, too difficult throughout for slower fifth grade readers, and only moderately difficult in the sixth grade with the exception of slow readers. Newport (1965) confirmed the difficulty level of elementary science textbooks documented by Mallinson.

At the high school level, readability of science texts varies markedly. The most frequently recurring finding reported in Mallinson's studies indicated that materials varied greatly within themselves and that reading difficulty was not graded more easily in the beginning of the texts than in the concluding sections.

More recent investigations into readability and science textbooks support earlier difficulty ratings. Janz (1972) found a "practical difference" between the reading ability of 590 eighth, ninth, and tenth grade students and the readability levels of their assigned textbooks in English, science, and social studies. She concluded that over half the books assigned to these students were unsuitable. In the area of science, 13 to 63 percent of the eighth grade science texts (copyright dates 1954 to 1965) were shown to be too difficult for the population in the study. Two ninth grade earth science books (copyright 1961 and 1962) yielded readability levels of grade nine and college level. The grade nine level book was too difficult for 84 percent of the population using it. At the tenth grade level, the four biology texts yielded readability ratings of from grade eight to college level. The reading level difficulty for the population using them showed these books to be too difficult for from 26 percent to 100 percent of the students.

The discrepancy between readability ratings and the level of student reading ability in the area of science is critical. Scientific terms are often derived from Latin roots, are multi-syllabic, and represent complicated concepts which, even when defined, can remain rather nebulous and complex. Readability formulas make no such allowance for rapid increases in "uncommon" words and concepts. Present readability formulas utilize syntax difficulty (a pure word count) and vocabulary difficulty (generally a syllabic count). Because the terminology of science is often multisyllabic, the readability level of a text could easily increase, even if sentence structure were simple.

Because of difficulties experienced by students in understanding science textbooks, one is led to speculate that there might be some other factor, beyond readability level and reading ability that may be contributing to reading comprehension. An area which has not been specifically examined is the role that cognitive level plays in the comprehension of written science material. The present study was designed as an attempt to assess the possible relationship between cognitive level and comprehension. The theory and conclusions of Jean Piaget are relevant to such research.

Piaget and Education

Piaget's work and the work of educational researchers employing Piaget's principles of development have contributed much to curriculum reform, particularly in the areas of mathematics and science. The focus of this reform is that subject matter content should be adapted to that which is relevant rather than to that which is traditional (Droz, 1969a). This means reorganizing programs by placing elements within them according to objective importance; it does not mean simply increasing the volume of material and maintaining a purely receptive learning environment (Piaget, 1964). Piaget has gained recognition as the foremost educational psychologist not so much because of his own pragmatic approach to education but because educational researchers have attempted to apply his description and explanation of intellectual behavior and development to education.

Mental growth, in Piagetian terms, is composed of two processes, development and learning. In the area of learning, Piaget distinguishes between two types of experience that result in changes in behavior. Physical experience is the result of things acting upon us. Examples are the fact that Christmas is on December 25 or that a shape having three sides is called a triangle. These are facts that the learner cannot control or manipulate. The other type of experience is logio-mathematical and is a result of our actions upon things.

Examples of logio-mathematical experiences are represented by the acquisition of concepts such as quantity, or left and right.

Neither physical nor logio-mathematical concepts are innate; both must be learned. The difference lies in the fact that once physical concepts are learned they are relatively stable, whereas logio-mathematical content continues to deepen and expand as mental growth develops. Pedagogical disputes between teaching facts or processes become irrelevant because, so the implication goes, content cannot be taught without affecting process and vice-versa (Elkind, 1970). Because logio-mathematical content is the more inclusive of the two, the educational implication is that logio-mathematical content should be emphasized. It is logio-mathematical content which serves as the framework for physical learning. Thus a broader learning base is achieved.

Development, the other process of mental growth, is spontaneous, vital, and results in genuine learning. Those who hold this view are opposed to narrow learning which is provoked by situations, by a teacher, or perhaps by reading. As stated above, Piaget contends that "development explains learning [Piaget, 1964, p. 177]." He disputes what he calls the "atomistic view" of those who think that development is the sum of individual learning experiences. He further explains that "development is the essential process and each element of learning occurs as a function of total development [p. 177]." Reacting against theories of learning based on the stimulus-response schema, Piaget asserts that the stimulus-response theory is incapable of totally explaining cognitive development. For Piaget (1964), "a stimulus is a stimulus only to the extent that it is significant, and it becomes significant only to the extent that there is a structure which permits its assimilation [p. 180]."

Piaget stresses the idea of an operation, a set of actions which he thinks is central to true knowledge. An operation allows one to "modify an object, and enables the knower to get at the structures of the transformation [p. 171]." It is an interiorized action which never occurs in isolation and is reversible in the same way that joining and separating are reversible. In order to understand development fully, Piaget postulates the existence of four development stages. Through these stages the formation, organization, and functioning of operations are delineated.

The first stage, sensory-motor, is characterized by the child's boundless activity which is directed upon his environment. From this stage the child obtains practical knowledge of the world he lives in and learns how his actions affect the people and things around him. Symbolic play, imitation, and language develop during the second stage, pre-operational thought. During this stage the child learns to label things in his environment. The third stage, concrete operations, appears from the ages of seven to eleven years. During this period the child acquires and organizes a tremendous amount of knowledge and concepts. The fourth stage, formal operations, develops during the onset of adolescence. In this stage, operations center around ideas more than around real objects, and around logical truth rather than around reality (Droz, 1969b).

Operations within the concrete operations and formal operations stages are most pertinent to the subjects in this study. Knowledge in these stages is drawn from the discovery that things can be assimilated to certain behavior patterns. The child works and operates with real objects, whether overtly or covertly. At this stage, "operations are still related to their content and cannot be disassociated from it [Dawson, 1973, p. 34]." Within this concrete stage certain operations appear within a rather fixed order. Piaget has set broad age levels for the appearance of specific conservation abilities. These are not to be taken as norms but rather as guidelines. For example, the appearance of the conservation of weight occurs around the age of eight or nine, and conservation of volume around ten or eleven. Yet because of personality or cultural factors, appearance of these abilities may be retarded or accelerated. The important point is the stipulation that conservation levels are attained in the following invariable order: mass, weight, and volume.

In order to operate at the highest level of intellectual functioning, the formal operations level, conservation is essential (Dawson, 1973). Furth (1969) defines conservation as

> the maintenance of a structure as invariant during physical changes of some aspects. The stability of an objective attribute is never simply given, it is constructed by the living organism. Conservation, therefore, implies an internal system of regulations that can compensate internally for external changes [p. 158].

There are three definite stages in the development of conservation, namely: (1) non-conservation; (2) an intermediate stage of hesitancy between logically right and wrong answers; and (3) definite conservation when the child is able to justify his answer logically.

In the area of science, as in mathematics, there is a need to be concerned with the logical thought processes of children. Questions asked involving comparison, whole-part relations, or hypothesizing rely on more than simple factual regurgitation. It is this area where the logico-mathematical learning discussed earlier seems most applicable. Attention must be paid to the child's ability to manipulate stored data, but care must be taken that the type of manipulation desired is within the cognitive reach of the child. There is a need for a more careful examination of the content of science curricula and its primary tool, the textbook, so that we may better understand the relation between cognitive level and the comprehension of textbook material. Most importantly, does having a completed underlying mental structure, i.e., a logico-mathematical basis, for a given concept affect comprehension? Following Piaget's theories, it would seem that without this underlying structure only physical learning could take place. In such case, the permanency, transfer, and generalization of learning which occurs in the logico-mathematical phase would not necessarily exist. The purpose of this study is to examine this question.

Reading

Bond and Tinker (1967) describe reading as that process which "involves the recognition of written symbols which serve as stimuli for the recall of meanings built up through the reader's past experience. New meanings are derived through manipulation of concepts already in his possession [p. 22]." Thus, reading is a dynamic dual process composed of an intimate interaction between the reader and the writer. Symbolic reasoning--involving the perception of relationships between letters, words and their parts, sentences, paragraphs, and entire articles--becomes a necessary part of reading, and, hence, of comprehension. Effective perceptual activity, Piaget has suggested (in Vernon, 1971), is "associated with intelligent understanding of the nature of the material, and hence appropriate direction of attention [p. 20]." This may suggest that comprehension of a passage may in some part be associated with cognitive familiarity. Thus as the child becomes more adept at word recognition, more complex demands relating to advanced visual and auditory interplays are placed upon him. His ability to reason about the relationship between printed symbols in a passage and the verbal symbols of language which indicate meaning becomes more important (Vernon, 1971).

High intelligence test scores, particularly verbal intelligence, have generally been regarded as necessary for the attainment of fluent reading (Vernon, 1971; Bond and Wagner in Bond, 1967). In contrast, the relationship between reading achievement and performance on non-verbal intelligence tasks has been less close. Vernon (p. 84) cited two studies (Douglas, 1964; Morris, 1966) which investigated reading achievement and non-verbal intelligence. His inference is that the relationship between reading and intelligence may depend heavily on the type of reasoning employed in the intelligence test. Morris' study was particularly interesting in this respect because her intelligence test was composed of pictorial analogies and similarities. She closely approximated the type of reasoning often utilized in verbal intelligence tests; yet the linguistic factor was absent. These findings may have some bearing on Piaget's feeling that

> words are probably not a short cut to a better understanding...the level of understanding seems to modify the language that is used, rather than vice versa...language serves to translate what is already understood; or else

> language may present a danger if it is used to introduce an idea which is not yet accessible [in Duckworth, 1964, p. 321].

Through factor analysis, Kohlberg and DeVries (1969), showed that Piagetian conservation tasks actually measure areas of cognitive functioning not evaluated in traditional psychometric tests. Almy reported from her study of 330 kindergarteners through second graders in the New York City area that whatever is tested by the Stencil Design Test is more closely related to conservation than to verbal ability. Thus conservation seems to be a factor separate from those factors measured by verbal intelligence test. This seems to concur with Piaget's hypothesis that the concrete operational stage, the stage at which conceptual reasoning develops, is independent of linguistic ability.

Two studies by Elkind (1961b, 1961c) investigate as additional issues the relationship between intelligence and performance on conservation tasks. Each study shows a positive but very low correlation between intelligence and measures of conceptual development. One study involved both the individual and group administration of tasks of mass, weight, and volume to 469 junior and senior high students. The point biserial coefficient for the correlation between intelligence and a passing score on the volume test was .31. In the other study by Elkind, conservation of quantity, one of the concepts used in this study, was related to scores on the WISC. The subjects were 80 children aged four to seven. Performance on the conservation tests was found to be moderately significant with the verbal scale (.47), and insignificant with the performance scale (.29). Neither comprehension (.19) nor vocabulary (.31) proved to be significantly related to performance on these tasks.

Almy's (1966) initial findings in investigating the relationship between conservation and academic success in children ages five to seven indicated a positive correlation between ability to conserve and successful performance on other tests related to mental ability and to beginning reading. However, in a subsequent longitudinal study using the same population as her original investigation, the reading growth test used to measure reading achievement "showed a considerably less close relationship with conservation [p. 106]."

Mertz (1970), in a study employing second and third graders, found a larger relationship between the ability to conserve quantity and reading in the second grade than between reading achievement and verbal mental age in that same grade. In the third grade there was no statistically significant relationship either between the ability to conserve quantity and non-verbal mental age or between conservation of quantity and verbal mental age.

Dawson's (1973) conclusions follow the same pattern as those noted in Mertz's work. Using a population of third and fourth graders, she found a positive relationship between logical thinking (as judged by four conservation tasks) and reading for her third grade subjects, yet she found no significant relationship between those two factors for her fourth grade subjects. This pattern suggests that perhaps children who can perform certain logical operations and fit within the broad age guidelines suggested by Piaget are better able to deal with the various processes involved in the mechanical act of reading which can then be generalized to comprehension than are those subjects who have not mastered these tasks.

Each of the above studies sought to unravel the relationship, if any, between logical tasks which are generally thought to be attained within a certain age range and overall reading achievement. The ages of students involved in these studies ranged from kindergarten to fourth grade. In each piece of research the general conclusion was that a positive relationship between conservation and reading ability existed at the lower grade level, but not at the next higher level. A developmental pattern seems to emerge. At the lower grade levels in each study, a significant relationship was seen between a specific conservation task or tasks used as measures of cognitive development and reading ability (either overall ability or comprehension alone). Inferences can be drawn from this information, but a lack of homogeneous research designs discourages any absolute interpretation.

The present study also sought to investigate the relationship between cognitive level and comprehension. However, in order to examine more closely the interaction that may exist between reading comprehension and cognitive level, specific conservation tasks were chosen and specific passages were then written which dealt with the concepts that were covered in those conservation tasks. This design permitted a more direct method of investigating the relationship between cognitive level and comprehension than did utilizing specific conservation tasks and general reading ability, as had been the pattern in previous studies.

Cloze

The cloze procedure was chosen as the measure of comprehension of the passages used in this study not only for the simplicity of its construction but also because it has generally been found that the cloze test is a very valid and highly reliable measure of the comprehension abilities of students and of the comprehension difficulty of materials (Bormuth, 1967, 1968; Rankin, 1957). The usual procedure in constructing the cloze test is to delete every 5th, 10th, or nth word from a given passage. This type of deletion is referred to as "structural" deletion. Research results have indicated that this type of deletion is closely related to intelligence scores. The second type of cloze procedure is referred to as "lexical." This type of cloze test is constructed by selectively deleting nouns, verbs, or adjectives--the meaning or concept carriers of language. It has been shown that this type of construction is less related to intelligence than is structural deletion (Rankin, 1957).

In order to minimize the effects of intelligence, which seems to bear some small but positive relationship to both cloze and reading performance, a cloze procedure utilizing lexical noun-deletion was employed in this study.

Thus, a review of the literature indicated a need for a specific investigation into the relationship between performance on a conservation task, which according to Piaget reflects certain levels of cognitive functioning, and reading comprehension. It was determined that this investigation could best be served by examining the relationship between performance on a set of conservation tasks and comprehension of noun-deletion cloze passages constructed to reflect the concept of each of those tasks. It was hoped that ultimately these experimental findings would have fresh applicability to the writing of science textbooks, for past attempts at simplification or the use of readability formulas have not produced an adequate solution to the difficulties so often observed in this category of reading.

CHAPTER III

PROCEDURE

Population

The subjects were 48 sixth grade students, 17 males and 31 females, drawn from the large, city-wide Intermediate School of New Brunswick, New Jersey. Using only the occupational scale of Hollingshead's Index of Social Position (1958), the overall socio-economic status of the students was judged to be lower class. The father's occupation was used in this determination, except in those cases where the mother was the only parent.

New Brunswick is a populous, congested urban area with a large proportion of Black, Puerto Rican, Hungarian, and other ethnic groups. Thus, in order to control for discrepancies in language backgrounds, only those children whose primary home language is English were chosen.

From a base population of 71 students made available by the school system, 26 subjects were disqualified because of absences or other factors which hindered the gathering of complete data. The 45 remaining students provided the data upon which the conclusions of this study are founded. All students were drawn from the top three reading groups of their grade level. "Top group" was defined by the school as being between one and one-half years above or below grade placement. These groups were assigned to the researcher by the school principal. The mean intelligence test score for the total population used in the final study was 100.5 in May, 1973. The mean reading score for the total population was 6.0 in May, 1973. Although the reading scores and intelligence test scores were nearly a year old at the time of this study, it was felt that these tests had been properly administered and that the basic scores would not have changed significantly for the group in so short a time.

Construction of Testing Instruments

The Conservation Tasks

The following three task areas were used to determine the subject's level of conservation: number, quantity, and volume. The number and quantity tasks used in this study were adapted from The Concept Assessment Kit--Conservation (Goldschmid and Bentler, 1969), a standardized measure of Piagetian conservation. The volume task was a replication of a task found in other studies.

The testing was executed individually. One task was administered by each of three testers set up at stations. Wording, gestures, and scoring procedures were memorized by each tester in order to produce as much uniformity as possible in these areas.

The number task was performed with two sets of six chips; one set was white, the other was red. It was established that there were as many red chips as there were white chips. The configuration of the chips was then changed so that, perceptually, there appeared to be more of one color than of the other. The question was then posed, "Now, are there as many red chips as there are white, or is there more of one color?" Then the question "Why?" was asked. The configuration was changed once more and the same questions were asked.

Conservation of quantity was established through the use of two identical containers each filled with the same amount of water. It was established that each container held the same amount as the other. The subject was asked to watch what the administrator did next. The liquid of one container was poured into six smaller containers. The following question was posed: "Now, is there as much water in this container as in all of these smaller ones together, or does one side have more?" Then again the question "Why?" was asked.

The volume task was performed with two containers filled with the same amount of colored water, and two equal-sized balls of clay. It was established that each of the clay balls was identical in size and that each container held an identical amount of water. The subject watched as one ball was inserted into one of the containers; he was then asked to observe the new water level. The shape of the remaining ball of clay was then changed into a sausage shape. The following question was posed: "If I insert this shape into this other beaker of water, will the water level rise as high as the other beaker, will it rise higher than the other beaker, or will the water level be lower than the other beaker?" The clay was not inserted into the water; only the problem was posed. Reversibility was established by asking the same question after the sausage shape had been changed once again into its original ball shape.

Scores were recorded in two categories for each task. One category was verbalization of a correct conserving response (recorded under Behavior on the score sheet); the other category was the verbal justification for that response (recorded under Reason on the score sheet). A correct response in each category was scored one point; thus a total of two points was possible for each part of a task. The number and volume tasks were each composed of two parts for a possible combined total of eight points. Quantity had only one part for a possible total of two points. Thus each individual tested could score a maximum of ten points. Correct responses included such explanations as invariant quantity, compensation, and reversibility of the procedure. (A copy of the score sheet can be found in the appendix.)

The Cloze Passages

Three cloze passages were written. Two of the passages (number and volume) were simplified versions of passages in elementary science texts. The third passage was a statement written by this researcher describing the conservation task dealing with quantity. As judged by the Fry Readability Graph (Fry, 1971), the passages ranged from grades 4 to 5 in readability.

Lexical noun-deletion was used. Beginning with a random starting point, every tenth word was counted off. The nearest noun to either the left or the right of that word was deleted. An average of thirteen nouns was deleted from each passage. Average passage length was 138 words. Exact word replacement was scored one point. (Copies of the completed passages are found in the appendix. Underscored words are those which were omitted in the cloze presentation.)

Demographic Data

Demographic data was gathered from each student by means of a questionnaire. Information was recorded under the following categories: sex, date of birth, age, grade, parents' occupations, language spoken at home, child's rank among siblings, and person with whom the subject was living. (A copy of this questionnaire may also be found in the appendix.)

Other Tests

The only group data available from the school dated back one year to May, 1973. Total reading scores and intelligence scores were used from that testing period. Reading scores were those obtained by the subject on the California Achievement Test. Intelligence test scores were those obtained by the subject on the California Mental Maturity Test.

Administration of Tests

Standardized reading and intelligence tests had been administered by the cooperating school district in May of 1973.

The three conservation tasks were administered individually, one task being conducted by each of the three examiners.

The cloze tests were group administered after the individual testing had been completed. The students were given a copy of the undeleted passage. This passage was read aloud by the tester to insure that all subjects had understood the words in the passage. The undeleted passage was then collected and the deleted cloze passage and answer sheet were distributed. Students were given unlimited time to fill in the blanks. The same procedure was followed for all three passages.

Data Analysis

From the available data, t-scores were used to compare the mean scores of those students judged to be Conservers with the mean scores of those students judged to be Non-conservers in each of the following categories: Cloze I (number); Cloze II (quantity); Cloze III (volume); Total intelligence; Verbal intelligence; Non-verbal intelligence; Total reading; and Reading comprehension. Pearson Product-Moment correlations were obtained in order to analyze the degree of covariance between group total conservation task scores and each of the variables listed in the above categories. In a final analysis, the correlation between Total cloze comprehension and Total intelligence was determined.

CHAPTER IV

RESULTS

On the basis of their performance on the conservation tasks administered to them, the 45 subjects were divided into two groups, Conservers and Non-conservers. Since the volume conservation task was found to be the only one of the three tasks which discriminated, it was on the basis of his performance on that task that each student was determined to be either a Conserver or a Non-conserver. There were judged to be 25 Conservers (8 males and 17 females), while 23 were classified as Non-conservers (9 males and 14 females).

The first level of data subjected to t-test analysis supported the basic hypothesis that those students who were classified as Conservers would score significantly higher on cloze passages related to the concepts of number, quantity, and volume than would those who were classified as Non-conservers. The results were as follows. Cloze I (number) comprehension scores: $t = 2.03$, $df = 38.6$, $p < .025$; Cloze II (quantity) comprehension scores: $t = 2.03$, $df = 46$, $p < .025$;

Cloze III (volume) comprehension scores: $t = 1.84$, $df = 46$, $p < .04$.

The secondary hypothesis was also supported through t-test analysis. Conservers had a statistically significant advantage over Non-conservers in Total intelligence ($t = 2.78$, $df = 43$, $p < .004$), Verbal intelligence ($t = 1.87$, $df = 43$, $p < .03$), Non-verbal intelligence ($t = 2.66$, $df = 43$, $p < .005$), Total reading scores ($t = 2.62$, $df = 43$, $p < .006$), and Reading comprehension ($t = 2.64$, $df = 43$, $p < .006$). The null hypothesis was rejected, and a two-tailed test supported the conclusion that the mean score of the Conservers was significantly higher than that of the Non-conservers for each analysis. Therefore, as may be seen in Table 1, the initial and most important finding of the present study is the conclusion that when this group of students, who were homogeneously placed into the so-called top reading groups within their school, were divided into groups of Conservers and Non-conservers based on measures of Piagetian cognitive development, the Conservers were statistically superior to the Non-conservers in each area of analysis.

In order to investigate the relationship between conservation (as defined through total conservation task

TABLE 1

T-TEST ANALYSES OF CONSERVERS AND NON-CONSERVERS

	Conservers	Non-Conservers	t	df	p
Cloze I (number)	9.7	8.1	2.03	38.6	.025
Cloze II (quantity)	12.2	10.9	2.20	46	.025
Cloze III (volume)	8.1	7.0	1.84	46	.04
Total intelligence	104.91	95.91	2.78	43	.004
Verbal intelligence	102.87	96.41	1.87	43	.03
Non-verbal intelligence	105.22	96.05	2.66	43	.005
Total reading	6.6	5.4	2.26	43	.006
Reading comprehension	6.7	5.3	2.64	43	.006

scores) and other variables used in the present study, correlation coefficients were performed. (Data from these correlations is presented in Table 2.) All correlations were run using the total group of subjects. The results are as follows. Cloze I (number) comprehension scores: $r = .18$, p NS; Cloze II (quantity) comprehension scores: $r = .27$, $p < .05$; Cloze III (volume) comprehension scores: $r = .15$, p NS; Total intelligence: $r = .34$, $p < .025$; Verbal intelligence: $r = .25$, $p < .05$; Non-verbal intelligence: $r = .27$, $p < .05$; Total reading: $r = .31$, $p < .025$; and Reading comprehension: $r = .32$, $p < .025$.

As may be seen from reviewing the results presented in Table 2, all correlations were positive but of relatively low magnitude. In addition, all correlations were statistically significant at greater than zero, except those in which Cloze I and Cloze III were correlated with total conservation task scores. A total correlation matrix was not performed; only those analyses relevant to the investigation of the hypotheses were performed.

Since two of the cloze comprehension scores (Cloze I and Cloze III) were not significantly correlated to total conservation task scores, an investigation

TABLE 2

CORRELATION COEFFICIENTS: TOTAL CONSERVATION TASK SCORES AND CLOZE I COMPREHENSION, CLOZE II COMPREHENSION, CLOZE III COMPREHENSION, TOTAL INTELLIGENCE, VERBAL INTELLIGENCE, NON-VERBAL INTELLIGENCE, TOTAL READING, AND READING COMPREHENSION

Tests	r	p
Cloze I (number) and Total conservation task scores	.18	NS*
Cloze II (quantity) and Total conservation task scores	.27	.05
Cloze III (volume) and Total conservation task scores	.15	NS*
Total intelligence and Total conservation task scores	.34	.025
Verbal intelligence and Total conservation task scores	.25	.05
Non-verbal intelligence and Total conservation task scores	.27	.05
Total reading and Total conservation task scores	.31	.025
Total comprehension and Total conservation task scores	.32	.025

* These correlations were not significant.

of the correlational relationship among the three cloze test scores was performed. As may be seen in Table 3, the three cloze scores are significantly related to each other. It may thus be concluded that although two of the cloze tests do not correlate with overall Piagetian conservation task performance, there is nevertheless a moderate degree of internal consistency within the cloze measures utilized in the present study.

The types of statistical analyses which could be performed on the data were limited because of a lack of variance within the Conserver and Non-conserver conservation task scores. All Conservers scored perfectly on each of the three conservation tasks for a total conservation score of 10. Most Non-conservers obtained perfect scores on the number and quantity tasks, and received two of the four possible points on the volume task. Thus, the mean total conservation score for the Non-conservers was 7.55 out of a possible score of ten. The lack of variance within the Conserver category and the small amount of variance within the Non-conserver group prevented more sensitive types of analyses.

TABLE 3

CORRELATION COEFFICIENTS: TOTAL CLOZE COMPREHENSION SCORES OF CLOZE I, CLOZE II, AND CLOZE III AS COMPARED WITH EACH OTHER

Tests	r	p
Cloze I comprehension and Cloze II comprehension	.49	.001
Cloze II comprehension and Cloze III comprehension	.37	.001
Cloze III comprehension and Cloze I comprehension	.57	.05

CHAPTER V

DISCUSSION AND CONCLUSIONS

Reading, Conservation, and Intelligence

The purpose of this study was to explore the relationship between a child's performance on specific Piagetian conservation tasks and his reading comprehension on written passages dealing with those concepts. It was hoped that this study would contribute to the determination of whether conservation performance can be used to predict cloze comprehension scores.

In researching this area it became essential to assess the variable of intelligence. As indicated in the review of the literature and corroborated in the research findings presented in Table 1 and Table 2, intelligence correlates significantly with both conservation ability and general reading ability. A basic question underlying the relationship between the variables of comprehension, conservation, and intelligence is whether conservation is a factor which is not measured by traditional intelligence tests. As noted above, Kohlberg and DeVries (1969) concluded from their factor-analytic study that Piagetian tests do measure factors not measured by psychometric tests. Since it has been established that intelligence is highly correlated with reading ability (for sixth grade students at least) (Bond & Wagner, 1966), it is likely that the additional factor which is being measured is in fact the relationship between intelligence and conservation.

In a further attempt to elucidate this relationship, a correlation was run between total cloze comprehension scores and total intelligence scores. This analysis did not directly answer the question of the relationship between conservation and intelligence; yet when the relative effects of these two factors were assessed in light of cloze comprehension performance, it appeared that intelligence played a more significant role than did conservation. The Product-Moment correlation between these two factors (Total cloze and Total intelligence) was .60. As reported in Table 1, the correlation between Total intelligence and Total Piagetian task performance was .37, and the correlation between each of the three cloze measures and Total Piagetian task performance never exceeded .27. Therefore, since the correlation between Total cloze comprehension scores and Total intelligence scores was a very substantial .60 (accounting for 36.4% of the total variance between the two factors), one may conclude that intelligence was a more significant factor than was cognitive level as measured by performance on the Piagetian conservation tasks.

In general, the results of this research support the conclusion that reading and conservation are simply outgrowths of intelligence. But further analyses revealed that conservation may in fact play a role in the comprehension of written material related to that specific conservation task.

In an effort to draw out more revealing information concerning the relationship between conservation tasks and comprehension on passages dealing with those tasks, the subjects were analyzed according to the following three IQ ranges: low (IQ 94 and below); middle (IQ 95-105); and high (IQ 106 and above). T-tests which were run using total cloze scores of Conservers and Non-conservers, when controlled for IQ, yielded substantial findings. There were no significant differences found in the low and middle IQ groups. However, a significant difference was uncovered in the high IQ group: $t = 3.81$, $df = 11$, $p < .01$. My inference is that for the cloze passages used in this study the low IQ group would seem to have an intelligence based disadvantage. For this group, being a Conserver or a Non-conserver did not affect a subject's cloze comprehension scores. For the high IQ group, on the other hand, there were factors operating beyond intelligence which influenced an individual's cloze comprehension scores.

The means of the Conservers were higher than the means of the Non-conservers within each IQ range. This suggests that given a larger population, significant differences might also be found within the low and middle IQ ranges.

This study thus confirms Elkind's findings (1961b,c) regarding the correlation between intelligence and the child's conceptual development of volume and quantity. Elkind's first study (1961b) showed a .43 correlation between intelligence and conservation of quantity. In a subsequent report (1961c) he noted a correlation of .31 between intelligence and conservation of volume. The findings of the present study confirm the correlation between intelligence and conservation on all tested tasks (number, quantity, and volume): $r = .34$, $p < .025$. As in both of Elkind's studies, this correlation is low, but positive and statistically significant.

The relationship between conservation and reading comprehension is less clear. The results of this study reveal a significant correlation ($p < .025$) between Total conservation task scores and both Total reading (.31) and Reading comprehension (.32). In contrast, Mertz (1970) found no statistical significance between either conservation of quantity and reading comprehension or conservation of weight and reading comprehension. Dawson's study (1973) reveals uneven relationships between conservation and reading performance. In her total population of third and fourth grade students analyzed as a group, she determined the existence of a significant t-score relationship ($r = .24$, $t = 1.91$, $p < .05$) between reading and the ability to conserve. However, broken down by grade levels the significance held true only for the third grade population.

As noted above, the conservation tasks for number and quantity used in this study did not discriminate between Conservers and Non-conservers. Therefore no predictions of an individual's cloze comprehension scores can be based on his performance on those two tasks. Performance on the volume conservation task, on the other hand, was a discriminating factor for this population. What is particularly interesting is that performance on this one task successfully divided the subjects into two statistically different groups, not only for Cloze III (volume) comprehension scores but also for all t-test analyses run. (Refer to Table 1.)

Perhaps a conservation task which has the capacity to challenge and divide a given population is more closely related to intelligence than a task which is well within the grasp of the majority of students. Such a task might then have potential as a method for dividing a group into two significantly different sub-groups representing both intelligence and reading ability. Research in this area may prove to be fruitful, for obviously a body of conclusive evidence is still needed in order to define more clearly the inter-relationship between conservation, intelligence, and reading ability.

Stages of Cognitive Development

The results of this study failed to confirm Piaget's 11-12 year age range for the full acquisition of the concept of volume. As noted above, while Piaget has insisted upon an invariant order for the appearance of the ability to comprehend specific conservation tasks, he does not ignore cultural factors which might accelerate or impede the appearance of these cognitive levels. In addition, there are several ranges of difficulty within each category of conservation. For the concept of volume, distinction must be made between interior volume, occupied volume, and displacement volume. Displacement volume, the most difficult of the three levels, was the conservation level tested in this study.

Elkind's studies, which also dealt with the conservation of displacement volume, revealed a much higher age range for the full acquisition of volume than that posited by Piaget. In a 1961 study using 11 and 12 year old American children, only 27% were conservers of displacement volume. In a study using another group of students aged 12 to 18 years, Elkind found that only 47% conserved displacement volume.

The results of the present study were that approximately 50% of the 11 to 13 year old students tested successfully completed the volume task. These results support Elkind's findings. The discrepancies between Piaget's age limits and those determined both in this study and in Elkind's research might be explained as the result of cultural differences between the Swiss population with which Piaget determined his norms and the American populations which were the basis of the other studies. Or perhaps socio-economic distinctions within a culture play a role in the age of acquisition of the ability to conserve on given tasks.

Socio-Economic Status and Conservation

An observed difference between cultures in the ages for the acquisition of conservation leads one to examine further the role of socio-economic status within a given culture and the influence which differences in socio-economic status might induce.

Dawson (1973) advised that a higher age range than that determined by Piaget should be selected when a research population is drawn from a predominantly lower socio-economic background. Yet the 11-12 year old population used by Elkind--in the study in which only 27% conserved volume--was drawn from a middle to upper-middle class strata. The population used in the present study (aged 11 to 13 years) was selected from a lower socio-economic background. Fifty percent of these subjects had attained conservation of volume. This higher percentage was not the result of the increased age of the subjects. The majority of the students were in the age range of 11.0 to 12.6, the same as that population used in Elkind's study. One would expect to find slower attainment of conservation in children from lower socio-economic backgrounds. Yet a comparison of

Elkind's findings with those of this study does not confirm this supposition. Both studies used subjects in the same age range and concentrated on the same conservation task; each study yielded similar conservation performance results. However, the subjects involved in the two studies came from differing socio-economic strata. Thus the present study offers no evidence to support the conclusion that socio-economic background influences the rate of attainment of conservation.

Role of Memory in Comprehension

In the experimental stage of this study, the undeleted cloze passage was read aloud to the students as they followed along. It might be objected that this mode of presentation may have had some effect on cloze comprehension scores. However, Dornbush (1960) found no significant differences between good and poor readers tested for short-term visual and auditory recall. Of significance to the present study is Dornbush's conclusion that more auditory material was recalled than visual material. Therefore, whereas the cloze scores may contain a slight biasing in favor of auditory recall, the effects across the population nevertheless remain unchanged, since short-term auditory differences are negligible for both good and poor readers.

Conclusion and Implications for Science Curriculum

One of the objectives of this study was to investigate possible causes for comprehension difficulties encountered by students when reading science textbooks. Lowering the readability rating of the cloze passages used in this study and having these passages read aloud to the students did not eradicate statistical differences between Conservers and Non-conservers. Lowered readability ratings probably affected both Conservers and Non-conservers in an equally favorable direction in terms of cloze comprehension scores. This conclusion is supported in studies by Williams (1968) and by Dornbush (1969). So it seems that some other factor is operating in the comprehension of the science related material used in this study. The specific experimental question dealt with in this study points to a more substantial explanation, i.e., that conservation on a specific task is indicative of reading performance on written material related to that task.

Within the high IQ range, as defined for this population, the Conserver does seem to have an advantage over the Non-conserver in his ability to perform better on the cloze passages presented to him. At the high

IQ range, those students who conserved on the volume task scored significantly higher on the cloze passage concerning volume than did their non-conserving counterparts. Given a larger population, this conclusion may be found to be true for other intelligence strata.

The chief implication of this study for the development of a more effective science curriculum is that more attention should be given to cognitive level in the writing of science texts. However, implications of this study for science curriculum are limited until more research is performed. Suggestions for future research designs include the following: the use of a larger population; the construction of a conservation scoring scale which would provide more variance within itself; and the selection of a younger population so that the Conserver/Non-conserver distinction can be made on more than one discriminating task.

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APPENDIX A

RAW DATA

CONSERVERS

Total Intelligence	Verbal Intelligence	Non-Verbal Intelligence	Total Reading	Reading Comprehension	Cloze I	Cloze II	Cloze III	Total Cloze
88	87	91	4.5	4.7	4	12	5	21
88	87	83	4.9	5.3	9	10	4	23
88	84	95	5.0	5.5	10	13	7	30
94	78	109	4.4	5.5	9	11	9	29
99	97	101	4.8	4.4	10	14	8	32
99	94	105	4.9	4.7	9	7	8	24
99	99	98	6.0	6.6	10	13	5	28
100	103	94	5.1	4.9	5	13	7	25
102	109	63	5.1	4.3	9	13	7	29
102	92	114	5.2	5.3	10	10	9	29
104	101	105	6.4	6.6	10	12	10	32
104	108	117	6.7	6.2	9	12	9	30
106	107	103	8.9	9.5	10	14	10	34
108	102	114	7.0	6.2	10	11	10	31
109	115	100	8.1	7.3	12	13	10	35
111	104	120	7.2	6.2	11	14	9	34
111	109	110	7.6	10.2	13	13	7	33
116	117	111	7.0	6.2	12	14	10	36
119	116	119	8.9	9.5	11	14	10	35
125	129	115	10.6	11.1	12	14	12	38
129	125	126	11.5	11.9	11	12	10	33

CONSERVERS (Continued)

Conservation Task Scores

Number		Quantity	Volume		Total
2	2	2	2	2	10
2	2	2	2	2	10
2	2	2	2	2	10
2	2	2	2	2	10
2	2	2	2	2	10
2	2	2	2	2	10
2	2	2	2	2	10
2	2	2	2	2	10
2	2	2	2	2	10
2	2	2	2	2	10
2	2	2	2	2	10
2	2	2	2	2	10
2	2	2	2	2	10
2	2	2	2	2	10
2	2	2	2	2	10
2	2	2	2	2	10
2	2	2	2	2	10
2	2	2	2	2	10
2	2	2	2	2	10
2	2	2	2	2	10
2	2	2	2	2	10

NON-CONSERVERS

Total Intelligence	Verbal Intelligence	Non-Verbal Intelligence	Total Reading	Reading Comprehension	Cloze I	Cloze II	Cloze III	Total Cloze
77	82	77	4.6	4.4	10	13	9	32
79	91	73	4.7	4.6	4	7	5	16
81	90	75	4.1	4.4	5	7	3	15
86	89	85	4.1	4.3	3	9	6	18
87	79	96	5.3	5.7	11	13	8	32
89	90	90	4.2	4.1	8	11	9	28
90	92	89	3.4	3.5	10	13	7	30
91	88	96	4.2	4.1	8	12	8	28
91	83	100	5.6	6.2	6	10	6	22
92	93	93	5.6	6.9	8	10	6	24
92	93	93	6.0	5.5	9	10	9	28
97	101	91	6.3	5.7	11	12	7	30
98	94	104	5.4	6.2	12	14	6	32
100	95	106	5.1	5.3	5	11	4	20
104	101	106	5.7	4.9	9	8	10	27
104	107	99	6.1	5.3	9	11	6	26
105	105	66	6.9	7.3	10	14	8	32
106	102	110	5.6	5.7	6	8	5	19
107	116	95	6.6	6.2	11	13	6	30
108	107	107	6.4	5.5	14	8	9	31
109	113	101	6.3	5.7	7	11	9	27

NON-CONSERVERS (Continued)

Conservation Task Scores

Number		Quantity	Volume		Total
2	2	2	0	2	8
2	2	2	0	2	8
2	2	2	0	2	8
2	2	2	0	2	8
2	2	2	0	2	8
2	2	0	0	2	6
2	2	2	0	2	8
2	2	2	0	2	8
2	2	2	0	2	8
2	2	2	0	2	8
2	2	0	0	0	4
2	2	2	0	2	8
2	0	2	0	2	6
2	2	2	0	2	8
2	2	2	0	2	8
2	2	1	0	2	7
2	2	2	0	2	8
2	2	2	0	2	8
2	2	2	0	2	8
2	2	2	0	2	8
2	2	2	0	2	8

APPENDIX B

STUDENT QUESTIONNAIRE

1. NAME__________________________ 2. HOMEROOM__________

3. GRADE_____________ 4. SEX: ___male ___female

5. DATE OF BIRTH________________________ 6. AGE________
Year Month Day

7. PARENT'S OCCUPATION: Father________________________

Mother________________________

Guardian______________________

8. LANGUAGE SPOKEN AT HOME: _____English

_____Spanish

_____Hungarian

_____Italian

_____Other________________

9. I AM THE ___1 / ___2 / ___3 / ___4 / ___5 / ___6 / ___7 / ___8 CHILD IN MY FAMILY.

10. I live with: _____both parents

_____one parent only

_____relatives________________________

_____other____________________________

APPENDIX C

CONSERVATION SCORE SHEET

NAME ______________________________ HOMEROOM __________

	TASK	NUMBER	CONTINUOUS QUANTITY	VOLUME	TOTAL
	Behavior				
	Reason				
	Total				
BEHAVIOR					
same					
a has more					
b has more					
REASON					
invariant quantity					
compensation					
reversibility					
no explanation					
magic					
described procedure					
other					

COMMENTS

APPENDIX D

CLOZE COMPREHENSION PASSAGES

SELECTION 1

The fact that mercury rises in a thermometer is explained by the movement of mercury molecules. As the temperature increases the mercury moves higher. Why? It is not because you added more molecules of mercury. Therefore the same number of molecules must be occupying more space. As the molecules get warmer they move more, bouncing off each other and taking up more space. Think of it this way. Let 10 chips represent the mercury molecules sealed into the thermometer. When the temperature is cool, the chips, or molecules, move very little. They are close together towards the bottom of the tube. As the temperature goes up, the chips move and bounce against each other more. Our molecule chips take up more space and move up the tube but the number of molecules, or chips, is still the same.

SELECTION 2

If you were offered five ounces of grape juice in five one-ounce glasses or in one five-ounce glass, which would you take? The answer is simple. In each choice the amount of juice is the same. The amount of juice if five ounces in each case. Simply by using arithmetic we could figure that out. Now suppose some-one set two large glasses in front of you. Each glass is filled with the same amount of honey. Then one large glass is emptied into six smaller glasses. Now which would you say contains more honey? Does the one large glass that is left contain as much as the six smaller glasses? Once again the answer is that both contain the same amount. We can prove this. Pour the contents of the six smaller glasses back into the larger glass. The two large glasses once again contain the same amount.

SELECTION 3

The amount of space that something occupies is its volume. Some people think that the volume of an object depends on its weight. But this is not so. The volume of a one-inch cube of styrofoam and a one-inch cube of lead is the same. The weight of these two equal cubes is not important to volume. The important point is that the space each occupies is the same.

If the shape of these cubes were changed, their volume would still be equal. Roll one cube into the shape of a ball. Now roll the other cube into a sausage shape. Their volumes are still the same. The amount of space occupied is still the same. The only difference is the shape of that equal amount of space.