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CONSERVATION TRAINING AND READING

City University of New York PH.D. 1984

CONSERVATION TRAINING AND READING

by

Wendy D. Krevisky

A dissertation submitted to the Graduate Faculty in Educational Psychology in partial fulfillment of the requirements of Doctor of Philosophy, The City Unversity of New York.

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Abstract

Conservation Training and Reading

by

Wendy D. Krevisky

Advisor: Dr. Joseph Glick

The purpose of the present study was to ascertain the effect of conservation training on the decoding and comprehension skills of third grade children. Piaget (1970) stated that 75% of eight year olds attain conservation. The research question for the present study was as follows: would conservation training facilitate conservation and reading abilities in a sample of third grade (eight year old) children who were non-conservers, or early transitionals, and concomitantly at least one year below grade level in reading.

The present study utilized a sample consisting of 66 subjects: 33 males and 33 females, with a mean CA of 7.9. One group of subjects received conservation training utilizing procedures adapted from Inhelder's (1974) work. A second group of children received traditional reading instruction with the Barnell Loft, Level C Reading Materials (in both decoding and comprehension skills). And, finally, a third group was designated

as a control group and received no training.

Each group consisted of 22 subjects: 12 non-conservers and 10 transitionals. After a four-month period, with training consisting of five sessions per child (each lasting 30 minutes to an hour), the children were post-tested on conservation and reading measures. With PPVT-R scores as a control for Mental Age (MA), the children who received conservation training had significantly higher post-test scores on measures of conservation, reading grade equivalents, comprehension, number of paragraphs read, and story recall tasks. Further, the children in the conservation group showed significant decreases in the number of errors made.

The Gray Oral, Forms A and B, were the primary measure of reading, with two Aesop's Fables and two basal reader stories utilized to assess story recall: total score, main idea and inferences.

Conservation measures were found to correlate both positively and significantly with reading measures, with PPVT-R scores partialled out. Implications for future research and educational practice are also considered.

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CHAPTER I

Introduction

An ongoing question in educational research concerns the pre-requisite skills and abilities involved in the process of reading. Some researchers have focused primarily on the initial reading skills such as the decoding or translation of sounds (phonemes) into their written or orthographic counterparts (graphemes). Other researchers, in turn, have investigated the more advanced aspects of reading, such as the comprehension of a theme or plot, the ability to reconstruct text details, sequencing of story events, prediction of outcomes, drawing inferences, etc. In addressing such issues, the prevalent models of reading have tended to emphasize the role of linguistics (Chomsky 1957), perception (Gibson 1975), and memory/information-processing (Venezky 1970; Smith 1971; Rumelhart 1977; Kintsch 1977).

However, it is the intent of this proposal to consider an alternative model of reading, one which derives from Piagetian theory. Within this model, as will be shown, emphasis is given to stage development, structure, conflict and conservation attainment. These notions provide a view of reading that differs from the prevalent models described earlier.

Piaget and his collaborators were primarily concerned with how the child's thought processes undergo changes over time. In his view, the child progresses through a sequence of four major stages or periods of cognitive development: Sensory-motor, Pre-Operational, Concrete Operational, Formal Operational. The transition to each stage is characterized by qualitative changes, i.e., the appearance of new and increasingly complex forms or patterns of mental organization. These mental forms (relations, classes, conservations), have been designated as <u>structures</u>, and are presumed to underlie the child's capability to impose organization on any

and all situations encountered.

Consequently, the central argument being presented in this thesis is that stage development is crucial to progress or proficiency in reading (decoding and comprehension).

Within this model, the single most critical transition in the child's thought is from the Pre-Operational to Concrete Operational stage, whereby a fundamental logical concept, conservation ability, is achieved. In the former, Pre-Operational period, the child's thought is characterized by perceptual centrations, i.e., the child's attention is caught and held by the dominant aspects of the visual field. The child is unable to decenter or see ongoing relationships between parts and wholes. The ability to overcome perceptual influences and to synthesize parts or conflicting elements into a coherent whole marks the transition to Concrete Operations.

The transition to Concrete Operations leads to decentering and conservation, i.e., the understanding that changes in the physical appearance of objects do not alter their essential features. Beilin (1969) has defined conservation as the retention of a common element in the face of transformations. For example, a clay ball may be converted into a pancake (continuous change or transformation), or nine smaller pancakes (discontinuous changes), but the mass or quantity of the clay remains unchanged. Over a period of time, researchers also began to consider the child's understanding of conservation of inequalities as well (how essential features are changed by addition and subtraction).

Pinard (1981) has asserted that conservation is situated at the center of each of the logical concepts a child has to acquire. Consistent with this view, the proponents of a Piagetian-based reading

model have contended that conservation ability is a vital pre-requisite to the reading process. In a discussion of the decoding process, Elkind (1981) has pointed out that there are 44 sounds or phonemes represented by 26 letters or graphemes in some 250 possible combinations. Thus, the beginning reader must understand that one letter may represent more than one sound, and that the same sound can be represented by more than one letter. For example, a letter may be conserved across different classes of sounds: long and short vowels, regular and irregular pronunciations such as the a in mat, mate, mark. Further, a sound is conserved across different letters: the long /a/ in baby, way, rain, ate, great, or the /k/ sound across the letters c, q, and k. Further, letters and words may be conserved across different forms: upper case, lower case, print, script, or changes in size from one text to another.

Piagetian researchers in the reading field have discussed the conservation of word boundaries or words as classes or stabile units/patterns (Holden 1972; Sinclair 1974; Veatch 1975). Piaget (1956) has stated that each word has its own schema. Other researchers (Nevius 1977; Kirkland 1978) have referred to the conservation of direction (left to right) in reading, as well as the conservation of space (a space after every word). Henderson (1980) has investigated the conservation of vowel patterns (ee) across words, the conservation of certain morphemic endings such as the past tense (ed) and the plural ('s), the conservation of root words, and the conservation of prefixes (re in rewrite, rebuild), and suffixes (ful in playful, bountiful). Here, it can be argued that when a root word is conserved with prefixes and suffixes changing, this constitutes an example of conservation of equality and inequality (nation, national, nationality).

With respect to aspects of reading comprehension, Beilin (1974) and Murray (1979) have argued that meaning (semantics) is conserved across different word forms (synonyms) and different sentence forms (active and passive). Heatherly (1972) has discussed the conservation of identical words in different sentence contexts.

Other Piagetian researchers have maintained that conservation ability enables the child to synthesize individual story elements into a whole (main idea or theme). Studies conducted by Farnham-Diggory (1967), Kretschmer (1974) and McConnell (1980) have found differences between non-conservers and conservers with respect to this point. Other researchers (Heatherly 1972; Macomber 1972) have suggested that conservation is implicated in the reader's ability to coordinate the perspectives of the different characters in a story, to ascertain cause-effect relationships, and to arrange story events in appropriate temporal sequence. Going a step further, Lawson (1975) has argued that conservation is involved in the reader's ability to go beyond the obvious aspects of a story and to discern inferences (ideas not directly stated) from text. Here, Lawson obtained significant relationships between conservation and subjects' ability to analyze character motivations, recall propositions, and draw inferences on the Sequential Tests of Educational Progress (STEP).

Over the past decade, numerous studies have documented positive and significant relationships between conservation and a variety of reading measures, as well as differences between non-conservers and conservers with respect to a variety of reading skills (reviews by Waller 1977; Murray 1979; Barnes 1980).

Because conservation denotes an important stage transition, and a critical shift in the child's thought, much experimental research has

been conducted on the efficacy of conservation training. The empirical evidence, to date, indicates that some form of training in conservation ability does appear to facilitate stage transition and re-organization in the child's thought (reviews by Sigel and Hooper 1968; Beilin 1971; Pinard 1981).

These results point to an important next step in the research. If conservation training has a facilitative effect on the child's conservation abilities, then what are the potential effects of conservation training on the child's reading abilities? A major issue to both developmentalists and learning theorists is that of generalizability or transfer of conservation ability beyond the training tasks themselves to other domains, namely reading. On this point, Murray (1979) has stated,

> "It would be reasonable to train children on the cognitive operations related to reading."

And, Wohlwill (1973) has argued that experimental research is necessary in order to test the pedagogic value of the theory.

In testing for this generalizability, Landry (1980) documented the positive effects of conservation training on a sample of beginning readers. He compared training on Piagetian tasks (which included conservation) adapted from the Lavatelli Curriculum to a group that received training on DISTAR Phonics, and a control group. The Piagetian-trained group, after a six month training period, had significantly higher post-test scores on Piagetian tasks, The Boehm Language Tests, the Botel Test of Word Opposites, and the Spache Reading Test. The Spache is a measure of initial reading skills such as letter/sound recognition, letter and word blends, word recognition, etc. Thus, Landry's study

lent some initial support to the notion that conservation ability is important in the reading process.

While the bulk of reading research has generally focused on the characteristics of the beginning and/or early reader, the present study will address a variation on this question. If conservation training has a facilitative effect on the abilities of beginning readers, as suggested by Landry's work, would this premise also apply to the older or middle grade child who is non-conserving, and concomitantly below grade level in reading? While a wide body of research has suggested that children attain conservation concepts anywhere from age 6 to 11, Piaget (1970) has stated that "75% of eight year olds attain conservation." Thus, the present study chose to investigate a sample of eight year old/third grade children who were found to be non-conserving and reading 1-2 years below grade level. The present study hypothesized that conservation training would facilitate stage transition with consequent gains in conservation and reading.

The present study, in elaborating upon Landry's paradigm, paid more explicit attention to the specific types of reading errors or miscues made by children, as well as reading comprehension; areas that were lacking in Landry's study. Further, a more stringent criteria for conservation than Landry's was developed for the present study.

Because Piagetian investigations of the reading process derive their hypotheses from his larger overview of the relationships between thought and language, what follows will be a brief discussion of this issue on an historical level, and how it led to the present study.

Thought and Language

Olson (1977) has pointed out that the two rival assumptions about the thought-language relationship, i.e., whether meaning is intrinsic or extrinsic to language, have generated different implications for theories about reading and learning to read. The first and more prevalent view across the disciplines of anthropology (Whorf 1941), linguistics (Chomsky 1957), and psychology (Watson 1913; Vygotsky 1934; Bruner 1966), was one of linguistic determinism. The proponents of this view argued that language was the foundation of thought, and that linguistic forms were imbued with meaning. For example, Whorf-Sapir (1925), in their cross-cultural investigations of the Hebrew, Mayan, and American Indian alphabets, argued that letter and letter patterns contained ideas. Vygotsky (1934) argued that words were concepts, and Chomsky (1957) maintained that sentences were units of meaning.

With respect to reading models, Olson argued that this view contributed to the notion that meaning is in the text and that the reader's goal is to decode that meaning. Thus, facilitating or teaching reading should involve teaching the language elements directly; letter recognition, word recognition, to ultimately deciphering meaning. Olson further stated that the majority of reading programs are based upon the mastery of these sub-skills.

In sharp contrast to linguistic determinism, it was the contention of Piaget (1965 1972) and Furth (1966), as well as Inhelder, Sinclair and Bovet (1974) that thinking precedes and is independent of language (verbal signs). Piaget has consistently stated that the essential aspect of thought is its "operative" aspect, or operativity (previously referred to as structure, or the organizing capabilities of the individual).

Piaget designated perception, images, and verbal signs and symbols as figurative or representational functions. These functions were considered momentary and static; i.e., their purpose was to copy or assimilate external events (the immediate experience) as such, but without analysis (such as grouping, classifying, etc.). The word "figurative" derives from the configuration or physical appearance of objects. According to Piaget, these figurative functions are mediated by or contingent upon the operative or structural levels. These developmental levels arise from the child's actions and coordinations of actions.

Empirical support for this figurative-operative distinction has been demonstrated in studies by Smedslund (1961) and Elkind (1961), who documented that the word same will not have meaning for the child until the child has an apriori concept of equivalence or equality.

In elaborating upon this figurative-operative distinction, Piaget (1972) has stated the following:

> "Linguistic progress is not responsible for logical or operational progress. It is rather the other way around. The logical or operational level is responsible for more sophisticated language (p. 14)."

This causal relationship was subsequently demonstrated in a milestone study by Sinclair (1967), who attempted to teach a sample of non-conservers relational terms such as more, less, etc., and found that this language or linguistic method did not facilitate conservation in the non-conservers. Sinclair's study was replicated by Holland and Palermo (1975) and McLaughlin (1982).

Sinclair's work suggested the possibility that if language pre-supposed the development of cognitive structures, then the same premise could also apply to reading. Thus, Piaget's position pointed to an alternative conceptualization of reading, i.e., the presence of structure (specifically, conservation), as a requisite or mediating factor. Therefore, the present study sought to compare Piagetian conservation training with a traditional reading method that emphasized teaching the language elements only.

CHAPTER II

Overview of the Literature

The overview of the literature will discuss four areas relevant to the present investigation. The first area will be a review of the prevalent reading models and how they compare to a Piagetian-based model. The second area will cover Piagetian stages and reading. The third area of discussion will be the empirical literature on Piagetian theory and reading. And, finally, a discussion of conservation training paradigms will follow.

Reading Models

To provide a basis for comparison with Piaget's views, a number of prevalent reading models will be discussed in this section. These models have generally assigned a pivotal role to linguistics, perception, and memory/information-processing. In a Piagetian-based model, these functions are considered to be representational or figurative in function and are dependent upon the operative or structural levels.

These models will be discussed in terms of how they address the acquisition of initial reading skills, as well as comprehension, and training considerations.

Linguistics

The first reading model to be discussed will be based on Chomsky's (1957) formulations concerning language acquisition, and the respective implications for the reading process. Chomsky (1957) has argued that all languages possess certain universal features or linguistic forms (noun and verb phrases). These forms are stored at a level of deep structure (internalized meanings) and are converted to surface structures or utterances via a mechanism called a Language Acquisition Device (LAD). He has

contended that individuals possess an innate capacity to acquire language and consequently generate the rules of language in novel situations. Chomsky has posited a competence-performance distinction, whereby an individual understands the rules of language but does not necessarily apply these rules in utterances or vocalizations.

In comparing Chomsky's position to a Piagetian view, the following argument has been made. Elkind (1981) has pointed out that the irregularities of the sound-symbol relationships may constitute difficulty for the beginning reader. Chomsky, on the other hand, has maintained that English orthography is optimal for its purposes. He has argued that the beginning reader discovers a theory about language from small amounts of available data. That is, the beginning reader, through repeated exposure to written words, internalizes enough information about similarly spelled words that have different pronunciations, and links similar words through lexical (deep structure) representations. For example, the child may derive the meaning of the words elevator and elevation from the word elevate, the latter being stored at the lexical level. Chomsky contends that the pronunciation of these three words is a more superficial concern.

Chomsky's model has led to analyses of deep and surface structures in text, with an emphasis on noun and verb phrases. With respect to training considerations, a number of researchers have attempted to improve children's reading comprehension by training in linguistic-related skills: syntactic manipulations, sentence structuring, and sentence recombining. Such attempts at training have met with somewhat negligible results (Stotsky 1975; Combs 1979). However, the linguistic underpinnings of the reading process have continued to be emphasized in the majority of reading curriculums today (Olson 1979).

Perception

Gibson and Levin (1975) propose a reading model which is based upon the child's ability to detect or perceive the distinctive features of language elements; sounds, letters, words, etc. They have argued that with increasing mental age, there is an increased capacity on the part of the child to discover organization in printed material. The child perceives distinctive features by a method known as contrastive analyses. These analyses may involve graphic, syntactic, and semantic comparisons. Graphic analyses are based upon closed vs. open curves, vertical vs. horizontal lines, etc. Syntactic analyses may involve comparing noun words to verb words, etc. Semantic analyses may involve distinguishing words that denote mother vs. words that denote father.

Norberg (1978), in evaluating Gibson's model, has referred to it as a theory of "information pick-up," and has argued that the model assumes that perception is determined by the stimulus information made available to the perceiver. This point is emphasized in Gibson's (1970) work, where she stated that the natural environment provides "affordances" or stimulus information which is perceived directly by the observer.

Gibson has argued that reading is an adaptive process which involves a motivational component on the part of the reader to reduce uncertainty and increase efficiency. Reading becomes more efficient as the child focuses on larger and larger units or print; LMU or Largest Manageable Unit. For example, words, which are patterns of letters, constitute higher order patterns than the letters themselves. They further maintain that efficient reading involves tending to relevant features and ignoring irrelevant features. They further indicate that the differences between

fluent and non-fluent readers lie in their ability to detect the largest manageable units in order to gain meaning from the text.

It should be noted that Calfee (1978), in his review of the different reading models has argued that Gibson's model is more concerned with the end products of perception than the processes of perception. Further, he has pointed out that attempts to improve reading skills via perceptual training have met with negligible results; a point receiving empirical support from a number of investigators (Rouch 1968; Hedges 1972; Seaton 1972; Thomas 1974). Gibson and Levin's perceptual model has prompted other questions. For example, how does the reader perceive or detect inferences? What units of text would be involved? And, what are the role of other sensory functions, besides the visual, in reading?

On this point, Birch and Belmont (1965) attempted to investigate inter-sensory (auditory-visual) functioning with respect to reading in a sample of children, aged 5-11. They reported that the children had reading difficulties because of an inability to match rhythmic patterns with visual representations. They concluded that their sample had reading difficulties because of problems with auditory-visual or cross-modal integration.

Other researchers such as Vellutino (1977) have contended that beginning readers may have difficulty in verbally labelling or phonologically recording information received visually. Vellutino has argued that in silent reading, each unit of visual stimuli must be sub-vocally labelled before meaning can be accessed.

Information-Processing

Another reading model which elaborates upon perception and considers the role of memory and attentional factors, is the generic

information-processing model delineated by Atkinson and Shiffrin (1968). This model is a componential model whereby stimuli pass through three compartments: iconic or sensory storage, short-term memory (STM) and long-term memory (LTM). An image enters iconic storage and remains on display for several seconds. The image may disappear or it may enter STM where it is encoded according to the graphic, syntactic, or semantic feature analyses previously described. The images, once encoded, are stored in LTM via processes of labelling, grouping, chunking, practice and rehearsal.

The information-processing model is also concerned with reduction of uncertainty and increased efficiency in reading. Efficient reading is achieved when the reader is able to chunk or detect the largest possible units, and integrate these units with what has been previously stored. With respect to beginning reading, Venezky (1970) has proposed that information-processing is a serial process; letter pairs must be processed prior to word pairs, words prior to sentences, etc.

Smith (1971), varying on this point, has argued that processing for letters, words, and sentences can occur independently of each other. Rumelhart (1977) has built upon Smith's arguments and has proposed an interactive-compensatory model of reading/information-processing. Rumelhart has proposed a six-level model; letters, letter clusters, lexical level, syntax, semantics. He proposes that the reader may utilize a combination of levels, or utilize word recognition to facilitate comprehension or vice-versa. Rumelhart's model more directly addresses the issue of individual differences in reading, to a greater extent than some of the earlier information-processing models.

Within the information-processing paradigm, LaBerge and Samuels (1974)

have proposed an automaticity hypothesis, i.e., the ability to decode words automatically frees capacity for higher level semantic processing. Thus, when the reader has difficulty with decoding, this creates a bottleneck which intereferes with the time and capacity which the child has to think about what he/she has read. They maintain that decoding becomes automatized by third grade.

Goodman (1980) has argued for a "top-down" version of the information-processing model with respect to the reading process. In his model, reading is depicted as a psycho-linguistic guessing game, where the reader brings certain meanings and expectations to the text, generates hypotheses and attempts to confirm them. According to Goodman, the text provides the reader with graphic or visual information. The reader in turn utilizes syntactic and semantic information to decode this visual information. Goodman has develped a qualitative coding system or taxonomy for analyzing children's reading errors. He has referred to these errors as miscues (alterations or variations from the text). His miscue taxonomy includes insertions, ommissions, substitutions, reversals, and regressions (repetitions). Goodman has stated that as the reader scans toward the middle of a passage, his/her attention may get caught in the far visual peripheral field, thus resulting in inserting or repeating words while reading. Goodman has conducted research to demonstrate the the reading errors made by children during silent reading, are similar to the miscues of oral readers. He has also suggested that oral reading may involve more of a communicative intent than silent readers. Goodman has argued that the more proficient reader relies less and less on graphic or visual information and more on context. Goodman's miscue analyses have become widely used as diagnostic tools with both normal and disabled readers.

Schema Theory

Historically, one of the earliest reading models which was based upon the experiences which the reader brings to the text, stems from Bartlett's work on schema theory. Bartlett (1932) asserted that the reader brings meaning to the text in the form of a schema, which is an accumulation of prior knowledge and experience. This notion, evolved in part, from the philosopher Kant's view that there were apriori structures of knowledge within people (as contrasted with Piaget, where structures are constructed by the individual). A reader, according to Bartlett, might possess a schema for business, and sub-schemata for buying, selling, money, stores, etc. Bartlett contended that these experientally-based schemas mediate a person's text recall. Bartlett proceeded to test his hypotheses with a group of subjects who were asked to read stories that contained familar vs. novel content. He argued that the responses of subjects (normalizations and exaggerations) suggested that text recall is not a direct one-to-one process, but involves reconstruction. A number of criticisms have been raised with respect to Bartlett's work. For example, where do the schema derive from? How does one know what schema to apply in a given situation? Is it possible for a person to possess a schema for every situation encountered? And, what is involved in combining and integrating various schema?

Building upon the initial insights of Bartlett, and drawing upon the linguistic and information-processing models, a number of researchers have attempted to consider how experiental factors affect a person's ability to organize and recall important aspects of text.

One such researcher, Spiro (1977) has considered the notion of ideational scaffolding, i.e, the reader must be sensitive to the relative importance of various concepts. Central ideas must be identified first. Less important ideas are added in proper relation to the central theme. Finally, irrelevant or superficial information must be discarded. Spiro indicated that sensitivity to gradations in the importance of ideational units is poor among beginning readers, but increases with reading experience.

Kintsch (1976) has argued that the higher level propositions recalled from a story revolve around the main idea, character's goals, actions that lead to goals, and results or outcomes. Kintsch has defined construction as the ability to summarize a set of actions. For example, Peter has a dog and cat, is summarized as Peter has pets. This latter statement represents the higher level summary. Schank and Abelson (1977) have identified an episode schema which a person might apply to a story. This schema includes four parts: (P) Protagonist, (I) Initiating Event, (G) Goal to be achieved, and (O)Outcome.

Frederiksen (1977) has argued that the main ideas or important elements of a story are more deeply encoded and remembered for longer periods of time than the less important or peripheral aspects of a story. In Frederiksen's story schema, the protagonist, goal, and outcome constitute the major thematic or organizing content. The method used to obtain the goal, initiating event, and causal statements are lower down on his schema hierarchy. Thorndyke (1977) has similarly indicated that the important elements in a story revolve around the main character and the extent to which he/she achieves his/her goal. He indicated that when goal structure is clearest in a

story, recall is improved considerably.

In general, numerous investigations have been conducted in the area of story recall, generally involving manipulations of story content. Brown (1975) reported that a sample of six year old children could identify the main features of a simple pictorial scene, but could not identify the main idea when that scene was converted into an orally told story. She reported that children were influenced by peripheral aspects or details of the story. Otto and Barrett (1969) reported that only 29% of a sample of second graders could identify the main idea from orally told stories consisting of a few lines of prose.

Other researchers have attempted to manipulate story content and its effect on story recall. For example. Gomulicki (1956) investigated recall of passages which ranged from 15-200 words in length. He reported that with the shorter passages, the subjects tended to report the events verbatim, but with the longer passages, the subjects generates summaries which contained the main ideas only. Kintsch (1975 1977) compared subjects' recall on conventional vs. unconventional story content and found that recall appeared to be better on the former passages because the content matched the readers' prior expectations and knowledge.

Other researchers (Dooling 1971; Lawton 1977) have shown that stories involving famous persons or television characters influenced story recall. That is, the subjects tended to interject ideas associated with the characters that were not present in the text. Mandler and Johnson (1977) have argued that stories with a high

degree of structure will be recalled with more accuracy than stories with less structure. Kintsch (1975) also compared story recall on passages with scrambled vs. unscrambled content, and reported that the summaries made on both types of passages could not be distinguished.

Other investigations have also attempted to identify the priming questions asked of the subject with respect to story content. Such studies have attempted to determine whether the asking of questions should occur before the passage is read, or during or after the passage has been read. While numerous studies have been done with respect to this area, the most prominent were conducted by Frase (1967) who reported that recall is superior when questions are asked after reading the passage, and when the questions tend to be general rather than specific.

In general, the investigations tend to support the idea that the important aspects of a story revolve around a "holistic," summary, which may include the protagonist, goal, and outcomes. The ability to read for inferences is an area which has come under investigation more recently by the information-processing researchers, some of whom have developed elaborate hierarchies for readers' ability to discern inferences in stories (Kintsch 1977,etc.).

Summary The prevalent reading models have emphasized the role of linguistics, perception, and memory/information-processing, in terms of how the child becomes a more proficient reader. These models have indicated that with increasing age, the child becomes more proficient in decoding, relies increasingly less on the physical appearance of words, relies more on context in reading, and becomes more proficient in integrating story details. Again, in stressing the comparison with a Piagetian model, these functions serve a figurative role, and in his model, are guided or contingent upon the operative or structural level of development.

Piagetian Stages and Reading

As indicated in the introduction, the proponents of a Piagetian-based reading model have contended that stage development is crucial to progress or proficiency in reading, with particular emphasis on the conservation concept. The purpose of this section will be to map out Piagetian stages of development in relation to the reading process.

Sensory-Motor Period

The Sensory-Motor Period of infancy spans the period of approximately birth to age two. This stage has been characterized as pre-symbolic or pre-representational, as the infant's perception is tied to the immediate time and space, and the infant is unable to evoke absent objects, events or persons via images or verbal signs (language). The pre-cursory symbolic forms that start to emerge during this period take the form of indices, where a part of an object represents a whole (finger/hand, toe/foot,etc.). During this phase, recognition memory is evident in that the immediate presence of objects evoke a response in the infant.

The infant's gradual differentiation of signifiers from the objects they signify or represent is accomplished by a progression of activities; reaching outward, call sounds, touching objects at a distance, turning and looking toward objects, and, finally, pointing. The infant begins to employ vocal denotatives such as the word da, but will use this word in an undifferentiated fashion, i.e., to all persons present.

Piaget (1969) has stated that articulate language makes its appearance after a phase of spontaneous vocalization (6-10 months), and a phase of differentiation of phonemes (11-12 months), at the end of the Sensory-Motor Period, with one word sentences or holophrases (Stern 1914). The infant's "structures" of this period are referred to

as schemes (combinations of individual reflexes such as vision and grasping). These schemes are described as lacking reversible characteristics. That is, the infant is unable to make comparisons between an initial and subsequent event; the infant cannot trace an action from its origin to a conclusion and back to the origin, such as retrieving a missing object. Sinclair (1974) in evaluating the child's language of this period, has suggested that the holophrases or one-word sentences reflect these unidirectional schemes.

It is through a gradual interplay of assimilation and accomodation, that the infant's schemes become more refined and capable of sustaining actions, and extending and generalizing familar actions to new situations. The repetition of actions (circular reactions) serve this purpose. Piaget has suggested that progress or development occurs when the infant becomes cognizant of perturbations, disturbances, or conflict between the visual appearance of objects and the internal schemes (conflict between perception and thought). The presumed desire to resolve conflict and create a balance or equilibrium is what motivates or energizes the infant to sustain rather than interrupt an activity. Thus, toward the end of this period, the infant will attempt to search for a missing object. However, this rudimentary form of object permanence or conservation is not internalizes; it is carried out on a plane of action and represents an extension of the infant's immediate play activities.

Pre-Operational Stage

The appearance of object permanence signifies the transition into the next, Pre-Operational Period, lasting from approximately age two to age seven/eight. The child now begins to sustain actions by imitating

events shortly after their occurrence. This activity has been referred to as deferred imitation. This represents the second stage of memory (reconstructive memory), where the child uses actions to represent events that have just occurred. The third memory level, recall, is when the child uses symbols and signs to represent events (by Concrete Operations).

The Pre-Operational child's language is personalized, idiosyncratic, and lacks a social or communicative intent. The child uses symbols or personalized language, such as saying the word "bum" to designate an object which has dropped. At age 3 or 4, the child's use of language is said to be pre-conceptual. The child may learn the word dog in an imitative context, but will proceed to apply this word to all animals. While a sight word vocabulary begins to develop during this period, Sinclair (1974) has indicated that the child fails to understand that words have identities that are separate from the objects themselves.

According to Piaget (1969) and Elkind (1974), the child's thought processes of this period are dominated by perception and the physical appearance of objects. The child's perception is said to be centered, i.e., the child's attention is caught and held by the dominant aspects of the visual field. These centrations constitute attention to individual elements in a display. Further, these centrations have also been referred to as alpha behaviors or field effects; proximity, closure, continuity, etc. Element centered upon tend to be overestimated or underestimated, such as the comparison of a vertical to a horizontal line. The child has difficulty reversing figure from ground, scanning figures in precise and systematic ways, and integrating parts and wholes. In one study, Elkind (1964) demonstrated that on a measure called the Picture

Integration Test (PIT), kindergarten children could only identify parts, whereas by age eight or nine, the children were able to identify both parts and wholes.

The child's thought of this period is also characterized as transductive; going from the particular to the particular. Henderson (1980) gives an example of this behavior in reading, i.e., the child reads the word cat as c-a-t. Sinclair (1974) has argued that the child does not yet have a concept of words as stabile objects or units. Elkind, in his investigations of beginning readers, has indicated that mispronunciations of words may be due to centration tendencies; the child focuses on a part of a word rather than the whole. Further, the child does not yet understand that words are classes or units which contain elements (vowels and consonants), and that these units have meaning in isolation as well as when blended into the whole. He has contended that when a child makes a reading error such as reading the word where for when, this is not an error of visual discrimination, but rather an inferential error. The child is attempting to infer the whole from the part (wh-). Kirkland (1978) has argued that the child's inability to distinguish word pairs (cat/cut, wish/wash, came/come, etc.) is a conceptual rather than perceptual error. That is, the child cannot simultaneously attend to similarities and differences.

A number of studies have attempted to address the question of the child's centrations with respect to decoding and comprehension. One researcher, Jenkins (1979) with a sample of 46 children, aged 6-9, reported significant differences between non-conservers, transitionals, and conservers with respect to number of errors or mispronunciations made.

The subjects in his study were asked to read a 100-word selection of prose entitled the Three Dollar Mule. The non-conservers (n=13) missed an average of 45.5 words. The transitionals (n=21) missed an average of 11.4 words, and the conservers (n=12) missed an average of .3 words. Jenkins further reported a significant correlation of .61 between conservation (number, mass) and total reading score.

Kretschmer (1974) analyzed centration tendencies in the responses of second grade children to the Gates MacGinitie Reading Tests. In evaluating 500 responses distributed over 115 test items, he reported that 75% of the children's responses reflected centrations. That is, when the child was asked to select one of four pictures which identified the main idea or theme of a story, the children chose pictures that emphasized a part of the story, rather than the whole.

Farnham-Diggory (1967), using a measure of liquid conservation, with a sample of children aged 6.4 to 7.8, found differences between non-conservers and conservers in terms of their ability to read and enact sentences which were composed of individual logographs (non-alphabetic symbols). The non-conservers could only decode and enact an average of two of the sentences. The conservers could enact the maximum, i.e., eight. Further, she reported a correlation of .70 between reading and liquid conservation.

Piaget (1956) in his investigations of children's comprehension of narratives such as Niobe the Fairy and Epaminodas and the Four Swans, concluded that the Pre-Operational children had a tendency to justapose the characters, could not order events in the correct temporal sequences, and failed to delineate cause-effect relationships. He argued that centration renders the child incapable of making a coherent whole

out of a story, but instead makes the child break up the story into a series of fragmentary and often incoherent statements.

Concrete Operations

By the age of about seven or eight, the child approaches the beginning of Concrete Operations. At the outset of this period, three important groupings emerge. One is that of relational thinking or seriation. That is, the child begins to systematically arrange objects in size order, going from smallest to largest to smallest. Thus, the child is able to think in terms of comparisons. A second important ability that emerges during this period is that of classification, whereby the child is able to form classes and sub-classes based on the defining attributes of objects. The child, rather than focusing or centrating on only one dimension, begins to coordinate or covary two dimensions; i.e., that a woman can be both a mother and a teacher at the same time. With respect to the reading process, Elkind (1981) has stated that a child will understand that a word such as dog can be both a word and a noun at the same time.

The third ability, conservation, suggests a synthesis of relations and classes. Initially, the non-conserving child fails to coordinate the competing or antagonistic dimensions of a task such as height or width. According to Piaget, the child, through a phase of successive probabilities, begins to attend more and more to the transformed characteristics and gradually discovers that changes in one dimension compensate for changes in another dimension. Piaget has identified three properties of thought that make conservation possible: identity (nothing has been added or subtracted), reversibility (restoration or recombination

of the object to its original state), and compensation (height compensates for width, etc.).

Conservation ability has thus been designated as a reversible mental operation because the child must understand (mentally) without dependence on the immediate presence of the objects themselves, that different arrangements of parts do not alter the "whole." The conservation literature has prompted two major questions. One pertains to the age of the appearance of the conservation concept. The second question pertains to the appearance of the conservation concept across a wide range of domains.

On the first question, the appearance of conservation has been documented as early as age four (Dasen 1978). It was found that a sample of Mexican children were conservers on conservation of mass tasks, because of experiences which they had in physical manipulations of clay and other materials found in their natural environment. While the cross-cultural literature cited by Dasen (1978) suggests that conservation has appeared between the ages of 4 and 10 or 11, a number of questions emerge. For example, is the criteria for conservation in these studies as stringent as the criteria advocated in Piaget's original investigations? And, is conflict the primary source of movement toward the conservation concept? What is the role of other factors in the attainment of conservation?

Piaget has continually stressed that four factors play a crucial role in development: maturation, social interaction (including language), physical experience, and equilibration (conflict). Generally, Piaget has reported the appearance of conservation by age 7 or 8, and has posited that conflict or equilibration coordinates the other three factors of development. Thus conflict is still seen as the primary catalyst in inducing conservation and Concrete Operational thought.

The second important question in the conservation literature is the extent to which conservation appears for all properties simultaneously, or whether it develops in a particular sequence or decalage. Flavell (1963) has discussed two types of decalages: vertical and horizontal. In vertical decalage, the conservation concept first emerges in the form of object permanence, then as deferred imitation, and finally, by Concrete Operations, as an internalized mental operation.

The second type of decalage, horizontal decalage, has been defined by Flavell (1963) as:

> "A repetition that takes place within a single period of development; the cognitive operations employed by the child on one task will be repeated on subsequent tasks (p. 520)."

Horizontal decalages have been subject to extensive investigations in the literature. The sequence of number and length appearing by age 7 or 8, followed by mass and weight appearing by age 8 or 9, and then conservation of area appearing between age 9-11 has generally been confirmed by (Almy 1967; Uzgiris 1967; Elkind 1961; Brainerd 1972; Gruen 1972, etc.). Piaget (1960), in his own investigations on children's geometric concepts has reported that topology (closed figures, embeddedness) precedes Euclidean figures (vertical vs. horizontal lines, etc.). Decalages have also been reported with respect to acquisition of equality vs. inequality items, and continuous vs. discontinuous items (Smedslund 1961).

Piaget, in discussing these horizontal decalages, has maintained that children are more "resistant" to some properties than to others (i.e., number appearing prior to mass). He has defined the non-conserver

as the child who fails to conserve across all domains, the transitional as the child who fluctuates between correct and incorrect responses across domains, and the conserver as the child who generates correct responses across all domains.

The horizontal decalages raise a number of questions. Why is the conservation concept initially restricted, and only gradually generalizes to a wider and more diverse range of domains. And, further, what are the implications of these decalages for the reading process when the correlational and comparative evidence (forthcoming) has indicated that the child who conserves on a greater number of tasks is one who is a better reader/ has a higher reading score.

With respect to the first question, a number of interpretations have been invoked for the decalages. Most critically, Flavell and Wohlwill (1969) have discussed the possibility that each conservation domain may in effect represent a sub-stage, and that there are phases within each domain or sub-stage that represent oscillations in thought or intermediate forms of reasoning. Thus, the child who is "transitional," and eventually conservers across a more diverse range of tasks, is exhibiting a structure which has become more stabile, more generalizable, and less subject to resistances or centrations.

The second question, i.e., the relationship of conservation decalages to reading, begs the question of quantitative vs. qualitative changes. Is the better conserver a better reader simply because he/she reads more words correctly, or is the more advanced conserver able to read words irrespective of their length, words of greater complexity and

novelty or unfamilarity, as well as stories that have greater plot and character complexity, as well as inferences. These latter are examples of qualitative changes. For example, with respect to conservation of root words, when the child can generalize the root word national to nationalism, nationality, etc., this is not merely an accumulation of more information (quantitative change), but an operative or generalizing ability where the child is able to use information in new and unfamilar situations.

Empirical Research

The studies previously cited constitute only a part of the growing body of literature that substantiates the emprical relationships between conservation and reading. Additional findings from correlational, predictive, and comparative studies will be reviewed in this section.

Correlational Studies

A number of reviews (Barnes 1980; Murray 1979; Waller 1977) indicate that more than 25 studies have been conducted in the last decade to support significant and positive relationships between measures of conservation and measures of reading. The correlations have generally fallen into the range of .4 to .7. Most of the studies to be cited controlled for likely covariates such as Mental Age (MA), Chronological Age (CA), SES, and sex. Further, the majority of studies with respect to Piagetian theory and reading, have not reported sex differences or minority differences. While some researchers limited reports of their correlational findings to reading and total conservation scores, others reported differential predictions among conservation tasks with respect to reading. Thus again, the issue of whether conservation is unitary or domain specific has emerged in these studies.

The first major correlational study was conducted by Almy (1967), who obtained a significant correlation (r=.53) between conservation (number, liquid) and scores on the New York Tests of Reading Readiness, in a sample of 72 kindergarten and first grade children. Signficant correlations between conservation and the Gates MacGinitie Reading Tests were reported by Heatherly (1972),Rauscher (1974), and Henderson and Beers (1980). These correlations ranged from .38 to .51.

A number of researchers utilized the Concept Assessment Kit (CAK), developed by Goldschmid and Bentler (1968). The CAK is a measure of several conservation tasks: space, number, mass, weight, length, and area. Canter (1975) reported a correlation of .60 between CAK scores and reading as measured by the SAT, in a sample of 128 kindergarten children, controlling for MA with the Boehm Test of Basic Concepts. Matthews (1975) reported a significant correlation between CAK and SAT scores in a sample of 226 first grade children. She reported that conservation was a better predictor of reading than either MA as measured by the California Test of Mental Maturity, and a measure of perception (The Raven's Progressive Matrices).

Ayers (1974) and Caballero (1977) both reported significant correlations between conservation and reading as measured by the Metropolitan Achievement Tests (MAT). Haupt (1980) obtained significant correlations between conservation (length, area) and reading as measured by the Wide Range Achievement Tests (WRAT). The correlation for conservation of length and reading was .56. Brekke (1974), in a study conducted with 38 second grade children, obtained significant correlations between conservation (number, mass) and children's frustration, instructional, and independent reading levels as measured by the Classroom Reading Inventory. The highest correlation obtained was between conservation of number and independent reading level (r=.57). Stafford (1976) reported a significant correlation between conservation (number, length) and the Durrell Analysis of Reading Difficulty in a sample of 54 2nd grade children.

In summary, an overview of the literature reveals a substantial body of evidence to support the relationships between conservation and reading. The one non-supportive study found was conducted by Meyers (1976) who failed to find significant relationships between conservation of liquid and reading scores on the SAT in a sample of second grade children. However, Bearison (1975) reported significant correlations between liquid conservation and SAT scores (Paragraph and Word Meaning) in a kindergarten sample whose reading was followed through third grade.

Predictive Studies

A number of investigators have attempted to look at conservation as a predictor of subsequent reading achievement. Almy (1975) tested a sample of kindergarten children on number conservation and found a significant correlation with reading (MAT) by the beginning of second grade. Within her sample, 64 out of 71 children who conserved in kindergarten, were reading on or above grade level by second grade. Kaufman (1974) in a study with 80 children, administered conservation of number and length tasks and measured reading achievement at the end of the first grade. She reported a significant correlation (r-.58) between conservation and SAT scores, with MA as measured by the Lorge-Thorndike held constant.

Tadlock (1978) measured conservation with the CAK in a sample of first grade children and then looked at their reading skills at the end of the first grade, using the Iowa Tests of Basic Skills. She reported that CAK scores were a significant predictor of later reading achievement as measured by the Iowa. Helm (1980) reported

that CAK scores were a significant predictor of reading achievement, as measured by the SAT, in a sample of first graders. It would appear from these studies that conservation has moderate predictability with respect to reading (controlling for CA, MA, SES, and sex.

Comparative Studies

Other studies have attempted to test stage assumptions with respect to reading by comparing the reading abilities of non-conservers to either transitionals or conservers. With a great deal of interest in the early reader phenomenon, Elkind and Briggs (1972 1974) proceeded to compare pre-schoolers who were early readers to those who were not. Matching their sample on CA, MA, SES, and sex, Elkind reported that conservation of number, mass, and area, discriminated the early from the non-early readers. He also reported that certain home variables were contributors to the reading process; i.e., the amount of reading done to the child by the fathers, and the amount of watching the Electric Company. These latter factors also appeared to discriminate the early conserver-readers from the non-early conserver-readers.

Generally, the role of parenting and the home environment has played a central focus in investigations on early readers. In a well known study, Durkin (1966) documented that early readers did not differ from non-early readers on measures of intelligence, creativity, perception, but in terms of home environmental factors: availability of reading materials in the home, amount of reading done by parents, and the child's motivation in learning the meanings of new words. A decade later, Fahey (1976) replicated Durkin's findings with similar results. Fahey reported that in a sample of 160 kindergarten children, differences did not exist between the early and non-early

readers with respect to measures of intelligence, creativity, language, SES, or sex, but did differ on home environment factors. These factors included the number of visits which the child made to the library, the amount of time watching Sesame Street, and the frequency of being read to by the parents.

Within the Piagetian literature, a few other studies have supported the notion that early readers were also early conservers (Polk 1980; Schantz 1981). In a study with first grade children (Polk 1980) reported that early readers differed from the non-early readers on conservation of number, mass, weight, and length, the Gates MacGinitie reading tests, and the Durkin Word lists. Using the PPVT as a control for MA, she further reported that PPVT scores did not correlate with reading. Similarly, Schantz (1981), in a study with kindergarten and first grade children, also found that early readers differed from non-early readers on conservation (total CAK score), the Gates MacGinitie, and the Durkin Word Lists. Schantz also included a measure of oral reading in her study, and reported that the early conserver/readers were significantly more accurate in word recognition and phonetic analysis than the non-early conserver/readers. What is suggested in these studies is not inconsistent with Piaget's view that while the stages form an invariant sequence, children may arrive at them at varying rates.

Comparative investigations have also looked at differences between so-called "disabled" and non-disabled readers. Hurta (1972) conducted one such study with a sample of 50 children, aged 7 to 8½. She compared second graders in regular and special classrooms, some of whom were reading on or above grade level, to those who were reading at least one year below grade level.

Using the Durrell Analysis of Reading Difficulty, she reported that conservation of length discriminated the children who were reading on or above grade level from the ones who were reading below grade level.

In a comparative study with first graders, Brekke (1975) found significant differences between non-conservers and conservers on several Gates MacGinitie sub-tests: listening comprehension, visual discrimination, auditory discrimination, letter recognition, following directions, and visual coordination. The only sub-test where such differences were not reported was in the area of auditory blending.

Rozanski (1977), in a study with first graders, reported significant differences between conservers and non- conservers on subtests of the Harcourt Brace Reading Tests: visual discrimination, word recognition, vocabulary, pronoun antecedents, and comprehension. Wangberg (1979) reported significant differences between non-conservers and conservers on an oral reading measure: the Woods Moe Miscue Analysis. In doing a miscue analysis, she found that the non-conservers relied more heavily on graphic cues in reading than the conservers. Further, the conservers made significantly greater use of syntax and semantics in reading, as well as making fewer errors that interefered with meaning, and more self-corrections.

Backus (1974) reported significant differences between third grade non-conservers and conservers (number, length), on Cloze Reading Tests (where every nth word is deleted, and the child has to fill in the appropriate word).

Jackson (1980) obtained significant differences between conservers and non-conservers, using the CAK, on a series of

story recall tasks. In a study with 181 first graders, the children were divided into 134 non-conservers and 47 conservers. Jackson proceeded to analyze a total of 362 story recall protocols and found that the conservers generated stories with greater linguistic complexity, longer lengths, greater number of words, as well as greater complexity in plot and character structure. McConnell (1980), in comparing the story recall protocols of conservers and non-conservers (CAK scores), found that the non-conservers could summarize the beginning and final sentences of a story, whereas the conservers could organize the material into a main idea.

Heatherly (1972) in a study with 132 first and second grade children, found significant differences between non-conservers and conservers in terms of the latters' ability to sequence story events and ascertain cause and effect, and predict story outcomes. McCabe (1980) compared story recall protocols of first grade non-conservers to conservers, using Fillmore's case grammar model. He reported that the conservers produced language with more dynamic features as well as more process-patient relationships than the non-conservers.

In summary, the sum total of the above studies suggest that conservation ability is related to reading (decoding, comprehension, story recall). Thus, the next question becomes whether conservation training will have a facilitative effect on the reading process. An overview of the literature in this area yielded only two studies which will be briefly discussed here, prior to the section on conservation training paradigms.

Conservation Training and Reading. In the first such study, Bearison (1975) trained a sample of kindergarten children on liquid-conservation, providing the children with opportunities to combine and recombine

materials. Using the Otis-Lennon as a control for MA, he reported that conservation was positively and significantly related to reading achievement when the subjects reached third grade (r=.51). His measure of reading consisted of SAT Word and Paragraph Meaning Tests. His sample included a group of transitional conservers who had received no training. He reported that this group had significantly higher reading scores than the trained non-conservers. However, without pre-test reading data on the children, it was not established how much growth or progress occurred. If the transitionals had had higher pre-test scores in reading to begin with, then it would be expected that they would maintain their respective ranks by third grade. In contrast to these findings, Brekke (1974) reported significant differences between non-conservers and conservers on the Gates MacGinitie Tests of Reading Readiness, but failed to obtain differenes between the non-conservers and the transitionals in her sample.

A more recent training study was conducted by Landry (1980). A sample of beginning first grade readers were assigned to one of three treatments; conservation training and training on other Piagetian tasks from the Lavatelli Curriculum, DISTAR Phonics, and a control group who received no training. MA was controlled for with the Vane Test. The children in both training groups received a total of 88 training sessions conducted within a six month period.

The children in the Piaget group received training on seriation, classification, and conservation (number, mass, weight, area, length, and volume). The children in the DISTAR group received training on vowel sounds, consonants, compound words, pre-fixes, suffixes, etc. At the end of a six month period, the children were post-tested

on the Spache Reading Test, the Botel Test of Word Opposites, and the Boehm Language Test. The Piagetian group had significantly higher scores on all of these measures than either the reading or control groups. Landry also reported that out of the 13 non-conservers in the Piagetian group, 9 shifted to conservation on the post-test. However, in the reading group, only 2 out of 13 non-conservers shifted to conservation from pre to post-testing.

While Landry's study was an important step in extending Piagetian theory into education and reading, a number of limitations can be cited. He failed to include measures of reading comprehension, such as reading for a main idea, story sequences, etc. He did not establish the relative contributions of seriation, classification or conservation to the reading process. His training methods on Piagetian tasks lacked a clearcut theoretical rationale; i.e., did the children attain conservation via rules, conflict methods, physical manipulations of objects, etc.

The present study attempted to correct some of these limitations. Because the issues involved in conservation training are so complex, the next section will discuss these issues and how they provide the rationale for the present study.

Conservation Training

Training studies in conservation have been conducted over a twenty year period in an attempt to delineate the mechanisms involved in stage transition. As indicated in the introduction, reviews by a number of researchers (Sigel and Hooper 1968; Beilin 1971 1978; Pinard 1981) have generally indicated that conservation training has had a facilitative effect on both non-conservers and transitionals. The theoretical rationale for the success of conservation training is indicated in a statement made by Smedslund (1961);

> "If the child has a structure which approaches the given notion, then the possibility of desired re-organization is high."

However, the sum total of training studies in conservation have given rise to a number of theoretical and methodological issues. These issues, which perhaps still remain open, will be discussed briefly here, followed by an overview of some of the more prominent training studies.

The first and major issue, central to Piagetian theory, is that of cognitive conflict. This has been defined within the theory as the child's internal oscillations or fluctuations between competing attributes and dimensions, and the eventual synthesis of these competing properties into a coherent whole. Flavell (1963) has consistently contended that the essential condition for the development of conservation is a state of cognitive conflict in the subject. Cognitive conflict induces a re-organization of the subject's intellectual actions. Following this line of thought, numerous Piagetian researchers have attempted to identify experiences that would provoke or induce internal conflict in the child.

However, other researchers such as Zimmerman (1972) working primarily from a learning paradigm, have argued that conservation ability can be acquired through a process of rule acquisition. That is, the child can be taught a correct rule in one situation (for example, conservation of number), and will then apply this rule in a new situation (liquid or mass, etc.). This has been referred to as the principle of transfer. While Piagetians argue that a child needs the structure in order to assimilate or take in the rule, the learning theorist would challenge this contention as well as the contention that conflict is implicated in the attainment of conservation. Implied in the view of the learning theorists is that conservation attainment is "continuous" rather than stage-like or categorical; the concept can be acquired through an accumulation of rules or conceptual categories, rather than a re-organization or synthesis or parts into a coherent and stabile whole.

The implications of this argument are somewhat historical in nature. That is, in Piaget's view, learning is contingent upon development and the particular stage or level. In the view of the learning theorists, learning determines or steers development, and development is seen as age and grade related.

A second major issue in the conservation literature is whether or not the conservation concept is unitary (consistent across domains). Researchers have attempted to test hypotheses about the unitary nature of conservation by training samples of non-conservers on one domain and measuring the extent to which it generalizes to other domains. The results of these studies have shown that children make optimal progress on the specific domains on which they have been trained, and

that transfer to other domains is less optimal. Given Flavell's (1963) argument that there are sub-stages or phases of intermediate reasoning or fluctuations, it would appear that training on one domain provides an incomplete picture as to why the child conserves on some tasks and not on others. The important question is how training on one domain affects the child's trainability on subsequent domains (are the same operations employed from one task to another?).

A final issue relates to the engagement or activity on the part of the subject. Piaget (1974) stated:

> "It is absolutely necessary that learners have at their disposal material experiences, form their own hypotheses, and verify them through their own active manipulations."

While Inhelder (1974) has concurred with Piaget on this point and has incorporated this aspect into her own training studies, some researchers (Hamel 1971;Rattan 1974) have reported no differences between active and passive participation on the part of subjects in training studies. However, this issue continues to be investigated actively.

What follows will be a discussion of a number of prominent paradigms that have been used in conservation training procedures; *task analysis, modeling, feedback, addition and subtraction,* reversibility training, social interaction, counter-suggestion, etc.

Learning Paradigms

Gelman (1969) employed a discrimination learning procedure in attempting to train non-conservers (age 5) number and length. The subjects were presented with 192 trials of number and length tasks

and were reinforced to tend to relevant stimuli and ignore irrelevent stimuli. The stimuli were varied in size, shape, color, texture, etc. Gelman reported that her training methods facilitated gains for 90% of her sample on post-tests of number and length. However, only 50-55% of her sample demonstrated transfer to conservation of mass and liquid. Eull and Silverman (1970), in replicating Gelman's study reported less successful results.

Kinglsey and Hall (1967) utilized task analytic techniques in attempting to teach a sample of five and six year old non-conservers conservation of length skills. These skills involved learning relational terms, using a ruler, and addition and subtraction rules. About 50% of their sample showed transfer to post-tests of conservation of length and quantity. Rothenberg and Orost (1969) demonstrated that non-conservers could learn principles of number conservation, with task analytic procedures. They taught the children counting skills, relational terms and addition and subtraction. About 50% of their sample demonstrated gains on post-tests conducted three months later, as well as transfer to conservation of length. However, Wohlwill (1962) in attempting to teach non-conserving children counting skills, found that counting did not have a facilitative effect in inducing conservation ability.

Bearison (1969) attempted to train a sample of kindergarten children who were non-conservers using procedures that involved counting and measurement activities. The children had to combine and recombine a quantity of liquid into beakers of various sizes and shapes. Post-test data revealed that 71% of the sample conserved on post-test measures of continuous quantity.

65% of the sample showed transfer to discontinuous quantity. 53% of the sample showed transfer to number, mass, and length. And, 47% of the sample showed transfer to conservation of area. While these gains were maintained over a seven month period, no explanation was offered as to why such an uneven pattern of transfer occurred.

Researchers such as Zimmerman (1972 1974 1983) and Beilin (1965), have attempted to teach conservation skills using rule acquisition. Beilin (1965) trained a sample of 175 kindergarten children on number and length. In his study, the experimenter would demonstrate a transformation of the materials, and then provide the child with a rule. Beilin argued that a rule was an algorithm or problem-solving tool. Beilin reported that this training technique was more successful with the transitionals than the non-conservers, and generally argued that training is most effective when the children possess a rudimentary or constituent understanding of the phenomenon.

Zimmerman conducted a number of studies to determine the effectiveness of modeling, rule learning and feedback (verbal praise). In his earlier studies of 1972 and 1974, he reported that a combination of praise and presentation of a rule were jointly more effective than modeling alone. In a later study (Zimmerman and Blom 1983), he attempted to test hypotheses about conflict training by having samples of non-conservers exposed to video models who stated correct and incorrect conservation rules. He reported that the non-conservers who were exposed to the models who stated correct explanations, made the most progress on post-tests of conservation of weight. While Zimmerman has consistently argued that conflict is not implicated in conservation attainment, a Piagetian

interpretation of his results is plausible. That is, the non-conservers may have been in conflict with the video model's correct responses, and thus alternative viewpoints had to be reconciled by the child.

Conflict Models in Conservation Training

Some of the earliest training studies utilizing conflict methods were employed by Smedslund (1961). He argued that with respect to conservation of weight problems, if the child is asked to convert a ball of clay into a sausage and then remove a piece from the sausage, then two schemata would be in conflict (less vs. elongation). Smedslund proceeded to train a sample of five year old non-conservers using trials of addition and subtraction, but found that only 5 out of 28 subjects shifted from non-conservation to conservation on the post-test. Later investigations achieved a higher degree of success (1964). However, other researchers (Wallach 1967; Smith 1968) attempted to replicate his results and did so with little success. However, the general finding that children may conserve on equality items but revert to non-conservation on inequality items (piece added or subtracted), became an important methodological consideration in later training studies. That is, inequality items were include to control for a response set or bias on the part of the child.

Smedslund (1961) also found differences between children's ability to conserve on materials with continuous properties vs. discontinuous. With a sample of 154 children, aged 4.9 to 7.3, he reported that conservation on discontinuous materials precedes conservation on materials with continuous or uninterrupted properties.

Gelman and Wang (1972) attempted to train a sample of non-conservers using methods of compensation. That is, they attempted to have subjects consider the competing attributes of height vs. width in a liquid conservation task. The subjects had to pour water from tall/narrow beakers to short/wide beakers. They reported that 30 subjects could neither conserve nor anticipate the height the poured water would reach. 22 of the subjects could anticipate heights but did not conserve, and 5 of the subjects could conserve but could not anticipate the height the water might reach.

Wallach and Spott (1964) utilized reversibility training with a sample of kindergarten non-conservers. The children were presented with a row of dolls and beds. They would remove the dolls from the beds and spread them out, and then return them back to the beds. They reported that 13 out of 15 children went from non-conservation to conservation on the post-test. A number of researchers replicated Wallach and Spott's study with similar results (Carey 1968; Roll 1970). However, the results of reversibility studies became an important methodological consideration in later training studies. According to Piaget, the child must understand mentally without reliance on the appearance of the objects that they can be restored to their original positions. Thus, training studies attempted to control for reversibility cues in pre and post-testing of conservation, by not allowing the child to see the objects restored to their original positions.

Another group of studies tempted to test hypotheses about socio-conflict and how the child reconciles exposure to alternative viewpoints. Studies by Murray (1972) Doise (1975) and Perre-Clermont (1980) have

attempted to test the hypotheses that peer interaction has a facilitative effect on cognitive growth and the attainment of conservation. These researchers have generally demonstrated that pairs of children (dyads) make greater progress than individuals on post-test measures of conservation. Since the dyads consisted of one child who was a non-conserver and a second child who was a transitional or conserver, the researchers concluded that conflict was the mechanism that led to conservation attainment by the post-test period. While the subjects in these studies have demonstrated cognitive gains, it is not entirely clear what aspect of the training led to growth; language, interaction, communication, physical manipulation of the objects, compliance, etc. are all confounded in these designs.

A more refined training procedure is offered by Inhelder, Sinclair and Bovet (1974) who utilized a series of questions, probes, counter-suggestions ranging from the most abstract to more concrete. They trained non-conservers and transitionals on tasks of class inclusion, conservation of number, mass, weight, length, etc. In these studies, they sought to delineate what level of training a child responds to; questions, counter-suggestions, empirical return, or physical recombination of the materials. These techniques have been adapted for the present study and will be described in the procedure section later.

In summary, the sum total of conservation training studies have demonstrated more than moderate success in the training of non-conservers and transitionals. While some of the issues in conservation training continue to remain unresolved, such as the role of conflict vs. rules, etc., the important step in the research is to look beyond conservation training to see the effect on other domains, namely reading.

CHAPTER III

Statement of the Problem

The central argument that has been presented throughout this thesis is that stage development, as defined by Piagetian research, is crucial to progress or proficiency in the reading process (decoding and comprehension). In particular, the role of conservation has been investigated with respect to both aspects of reading.

An overview of the literature reveals more than moderate support for the hypothesis that conservation relates to reading. Significant correlations ranging from .4 to .7 have been reported, and in most cases, have controlled for other variables such as CA, MA, SES, and sex. Comparative studies have demonstrated significant differences between non-conservers, transitionals and conservers with respect to both decoding and comprehension skills (Waller 1977; Murray 1979, etc.).

However, correlation does not imply causality. The one training study that attempted to establish a causal link between conservation and reading (Landry 1980) had a number of limitations. As pointed out earlier, reading comprehension was not considered in his study. A conflict training method was not used for conservation, And, finally, the assessment for conservation ability was not stringent enough from a Piagetian perspective to warrant the conclusion that "true" stage transition had been facilitated.

While the bulk of reading research has focused on the abilities of the beginning reader and the early reader, the present study was interested in a variation on this question. Piaget (1970) has indicated that 75% of eight year olds can conserve. Thus, if a sample of third grade/eight year old children are found to be

non-conserving, and concomitantly below grade level in reading, then would conservation training facilitate stage transition with subsequent gains in both conservation and reading?

As the majority of previous studies cited have utilized standardized reading measures with their multiple-choice content, the present study employed an oral measure of reading in an attempt to delineate with greater specificity some of the processes involved in reading, including children's errors or miscues. Further, the children's reading abilities were assessed on a more open-ended version of reading; i.e., story recall tasks.

It was hoped that the present study would be able to establish with greater specificity than the previous studies, the specific relationships between various conservation tasks and reading skills.

Experimental Hypotheses

With regard to the objectives of the present study, the following experimental hypotheses were formulated.

Hypothesis 1

Subjects who receive conservation training have significantly higher post-test scores than subjects in either the reading or control groups. Further, transitional subjects have significantly higher conservation post-test scores than the non-conservers.

Hypothesis 2

Subjects who receive conservation training have significantly higher post-test scores on all measures of reading (grade equivalents, comprehension, number of paragraphs read, story recall) than either the subjects in the reading or control groups. Further, the transitionals have significantly higher post-test reading scores than the non-conservers.

Hypothesis 3

There are positive and significant relationships between conservation and reading measures (grade equivalents, comprehension, number of paragraphs read, story recall), with MA held constant. Significant relationships are hypothesized for pre-test measures of conservation with reading, post-test measures of conservation and reading, and pre-test conservation measures with post-test reading measures.

CHAPTER IV

Method

The present study was conducted over a four month period of time (September 1983- January 1984). There were four phases involved: a pre-testing phase, a treatment phase, an immediate post-testing phase, and a delayed post-testing phase. A white female, in her twenties served as the experimenter throughout the study.

Subjects

The sample was composed of 33 female and 33 male third grade children who were selected from three parochial schools in Manhattan. The sample was a middle-class, predominately white group of children. The ethnic composition of the sample included children who were Irish, Italian, English, Polish, and from other Eastern European countries. The small number of black children in the study did not speak with non-standard dialects; thus no potential problems existed for the scoring of the reading measure (Gray Oral). Initially 89 children were pre-tested, but because of a pre-determined criteria for conservation and reading, only 66 children were retained for the training/treatment phase of the study. The mean CA for the sample was 7.9, and the mean MA (as measured by PPVT-R scores) was 102. Parental permission for the children's participation in the study was obtained. After pre-testing, children were randomly assigned to one of three treatment groups: (1) conservation training, (2) traditional reading, and (3) a control group. Each group was composed of 22 subjects: 12 non-conservers and 10 transitionals.

Measures

In order to establish the contribution of conservation to reading ability, independently of MA, the Peabody Picture Vocabulary Test-Revised (PPVT-R) , Dunn (1981) was used as the measure of MA.

The PPVT-R (Form L) is an individually-administered intelligence test consisting of 175 plates. Each plate consists of four black and white illustrations. The experimenter says a word aloud, and the child must point to the picture designating that word. An eight year old begins with item # 65 and continues until making six errors within eight consecutive responses. Mental age (MA) is computed from a multiplicative of total number correct (raw score) and chronological age (CA). The PPVT-R was normed on a representative sample of 4,200 children selected from 1970 Census Data. The Manual reports extensive reliability and validity data: the PPVT-R correlated significantly with the WISC-R ($r = .91$), the Stanford-Binet ($r = .88$), and the Slosson ($r = .86$). The range for "normal" (-1 to +1 SD) for the PPVT-R is 85 to 115. For the present study, seven children who scored below 85, were not retained for the training phase of the study.

The dependent variable for the present study, i.e., reading was assessed using the Gray Oral Reading Tests, Forms A and B (Gray and Robinson 1963), and four story recall measures. Form A was used for pre-testing, and Form B was used for post-testing. The Gray Oral is an individually administered norm and criterion-referenced reading test. It is used for grades 1-12. The child reads each passage/paragraph aloud to the experimenter, and is then asked a series of four comprehension questions per passage, generally pertaining to main character or main idea. The child is timed while reading. A reading grade equivalent is determined based upon the child's time per passage, and number of errors. The child receives one point for each comprehension response. The comprehension and grade equivalents are thus separate scores. A 3rd grade child begins reading on

passage #2. If he/she makes no errors then he/she goes on and reads until making seven errors in two consecutive paragraphs. If a child makes errors on paragraph #2, then they move backward and read until they have made no errors. The Gray Oral includes eight error categories: partial mispronunciations (part of a word is mispronounced), total mispronunciations, substitutions (one word is substituted for another, but the meaning is retained), omissions (deletion of a word), insertions (inserting an extra word not in the text), reversals (reversing word order), inversions (was for saw, etc.), and aids (hesitation for 7 seconds or asks for help).

The Manual for the Gray Oral reports norms according to grade and sex. The test was initially constructed using procedures of item analyses. Vocabulary items were selected from 11 Basal Reader Series. After item analyses, inappropriate words were deleted and replaced. The paragraphs increase in word length, sentence length, and word difficulty. The equivalent form reliabilities across Forms A,B,C,D are reported as being higher than .95.

A number of investigations have been conducted to confirm the construct validity for this measure (Buros Mental Measurements Yearbook, 1983). Kirby (1971) reported significant correlations between the Gray Oral, the Gilmore Oral, a Cloze test, and the Gates MacGinitie. The correlations were significant for grades 1-4, but dropped after grade four. Powell (1971) reported significant correlations between error ratios (number and type of errors) between the Gray Oral, the Gilmore Oral, the Spache, and the Durrell Analysis of Reading Difficulty.

For the purposes of measuring story recall/integration abilities, four narratives have been selected (Appendix A,B,C,D). The pre-testing

included: (1) The Dog and His Shadow (Aesop's Fables)
(2) Grumble and The Elf (Scott Foresman 1976)

The two post-test measures included:

(3) The Boy Who Cried Wolf (Aesop's Fables)
(4) The Gold Dust (Scott Foresman 1976)

The Spache Readibility Scale (Spache 1974) was used to equate the four measures so that a 3.0 grade equivalent was obtained. The Spache utilizes number of words, number of sentences, and word difficulty (based on the Dale List of 769 Easy Words) to determine the level of a passage. The four stories were piloted to test for memory and attentional considerations and to insure that vocabulary words such as shepherd, flock, etc. did not impede the children's understanding.

Each story was read aloud to the children on an individual basis. The order was reversed during pre and post-testing to control for order effects. After each story, one priming question was asked (Can You Tell Me What Happened in This Story?). A series of four prompts were used if necessary (can you tell me anything more? etc.).

The children received one score for pre-test and one for post-test. Each score consisted of a point for generating the main idea and one point for any inferences generated. An inference was defined as an idea, or complete thought not directly stated in the text; inferences could pertain to character motivations, violations of the Golden Rule, etc.

Inter-rater reliability was computed for pre-test scores, post-test scores, main idea scores, and inference scores. A random sampling of 15 protocols was selected for each reliability rating. Pearson correlations were: $r\ (15) = .79$, $p < .05$ for total pre-test score, $r\ (15) = .82$, $p < .05$, for main idea, $r\ (15) .73$, $p < 05$, inference $r\ (15) = .77$, $p < .001$.

The conservation measures (Appendices E, F, G) were derived from primary sources which included The Child's Conception of Geometry (Piaget 1960), The Child's Conception of Number (Piaget 1967), and Learning and the Development of Cognition (Inhelder 1974). Five conservation domains were involved in each phase of the study (number, length, mass, weight, area). Each domain consisted of three tasks: two equality items and one inequality item to serve as a control for response bias. Within each domain, one transformation was continuous (ball into pancake), and another was discontinuous (ball into 3 pancakes). The children received one point for generating a correct explanation for each item: thus a total of 15 points for pre-testing, 15 for training, and 15 for post-testing. Three explanations were accepted: (1) identity - nothing was added or taken away, (2) reversibility - returning the object to its initial state, and (3) compensation - one feature compensates for another.

For the present study, a non-conserver was one who received a zero on all 15 pre-test tasks, and a transitional was defined as one who received a score of 1-5. During each phase of the study, the experimenter would transform one of two equal objects, and ask the child if both were still the "same" after the transformation. Instructions were counter-balanced with more and less, in order to control for order effects. Further, the conservation tasks were presented in random sequence, in order to control for order effects. There were task variations from pre-testing to training to post-testing.

Procedure

All of the children in the sample were individually pre-tested

on the PPVT-R, the Gray Oral, story recall and conservation tasks. After the pre-testing phase, which lasted approximately one month, children who were reading one year below on the Gray Oral, and who were either non-conservers and transitionals were retained for the treatment/training phase of the study.

Treatment Phase

Conservation Training The children in this group received training on five conservation domains: number, mass, weight, area, length. The procedures were adapted from Inhelder (1974) and involved four phases or levels. Each child had a total of five individual training sessions.

Phase I: After being presented with two sets of equal or unequal stimuli, the child was asked to transform one of the stimuli. The child was then asked if both were the same, or if one was more/less, etc. If the child provided a correct judgement and explanation at this point, the child receives a score of one, and training is discontinued on this particular task.

Phase II: If the child had been previously incorrect, the child was then posed with a counter-suggestion. The purpose of the counter-suggestion was to draw the child's attention to the competing attributes. If the counter-suggestion enabled the child to arrive at a correct judgement and explanation, then the child received one point, and the training for this task discontinued. If the child persisted with an incorrect response, the experimenter would move to Phase III.

Phase III: The experimenter then asked the child a question of empirical return. For example, supposing you made the ball back into a pancake, would both still be the same? If the child answered

correctly, then he/she receives a point, and training is discontinued. If not, the experimenter proceeded to the last phase.

Phase IV: Physical recombination of the materials. If the child gave incorrect explanations at each previous phase, then the child was asked to recombine the transformed object into its original shape. The child was then asked if both objects were still the same. If at this point, the child can explain the process, the child received a point, If not, the child received a zero on this particular task. Thus, to reiterate, for the 15 conservation training tasks, the child was given four possible phases per task in order to arrive at an understanding of the correct judgement/explanations.

These levels, in effect, represent a test of vertical decalage. For example, physical recombination of the materials represented a motoric enactment of conflict, whereas integration of a counter-suggestion represents a more internalized level of conflict.

Training in Traditional Reading The 22 subjects in this group received a series of five individualized sessions each lasting approximately 30 minutes to an hour. The materials used for the reading training were adapted from the Barnell-Loft Supportive Reading Skills Series (Level C, Third Grade). These materials were developed in conjunction with 17 major Basal Reader Series, and were subjected to numerous investigations concerning reliability and validity. Appendix H contains the materials and specific training procedures used. Each training session involved the experimenter stating a rule, asking the child for examples, and then proceeding to have the child read the exercises chosen for that selection. If the child made an error, then the experimenter provided a clue or prompt, rather than providing the correct response per se.

For the purposes of the reading training, a mastery of 80% (Bloom 1973) was set. However, on training for the main idea, this criteria was not necessarily met. The five training sessions are outlined here as follows. Session 1 consisted of word elements (Dipthongs and Digraphs, and Compound Words). Session 2 consisted of nouns, verbs, adjectives, and adverbs, and synonyms and antonyms. Session 3 involved training on story sequencing and reading for facts. Session 4 concentrated on reading for the main idea. And, finally, Session 6 consisted of predicting story outcomes and inferences.

Immediate Post-Testing

The children in the conservation training group were scored during the five training phases. The children in the traditional reading group received a sixth session consisting of a selection of 20 random skills from the training sessions. The children were given one point for each correct reponse.

Delayed Post-Testing

After the training phase, which lasted approximately 6 weeks, the children were all individually post-tested on measures of conservation, the Gray Oral Form B, and the two post-test story recall tasks

Prior to the present investigation, two pilot studies were conducted with small samples. The first study (Spring 1982) involved 8 male and 8 female children from a third grade class of a Manhattan parochial school. The children were assessed on MA (PPVT-R), conservation (number and mass), the Gray Oral (Forms A and B, and two poems which were used as story recall tasks. The children were one year below reading on the Gray Oral, as well as school-administered SAT tests in reading. There were 10 non-conservers and 6 transitionals in the sample.

The subjects, after random assignment to either a conservation training or reading training group, received four individualized sessions. The conservation training procedures were adapted from Inhelder's (1974) work. The reading exercises were from Barnell-Loft, Level C materials in decoding and comprehension. T-Tests revealed significant differences between the conservation and reading groups with respect to conservation, reading, and story recall scores.

The second pilot (Summer 1983) was used to expand the range and complexity of conservation tasks, and to replace poems with narratives as story recall tasks. Six third grade children were selected from a Manhattan parochial school. The conservation tasks and narratives were piloted in order to further refine administration and scoring of these measures. The children's responses on the narratives led to a scoring system which involved crediting the children for the correct main idea in each story, as well as a point for any correct inferences. Inter-rater reliabilities were subsequently computed for the story recall protocols for the dissertation sample.

CHAPTER V

Results

The model of analysis for the present study was a three (treatment) by two (group) factorial design. The three treatment levels were conservation training, training in traditional reading, and a control group. The two groups were non-conservers (n=36) and transitionals (n=30). The sample consisted of 66 subjects, with 22 subjects participating in each treatment.

A series of univariate analysis of variance (ANOVAS) and analysis of covariance (ANCOVAS) were performed on the data. The PPVT-R scores served as the covariate, in order to establish the contribution of conservation to reading scores, independently of MA. Analyses performed on the Gray Oral Reading Tests (Form A and B) included grade equivalents, comprehension scores, number of paragraphs read, number and type of reading errors made, and in each case gain scores (differences between pre and post-testing).

ANOVAS were performed on Chronological Age (CA) and PPVT-R scores, and revealed no significant differences between the three treatments. Table 1 reports the means and standard deviations for CA and PPVT-R for the total sample. An Anova revealed significant differences between transitionals ($\underline{M}$ = 104.93) and non-conservers ($\underline{M}$ = 100.58), with respect to PPVT-R scores, $\underline{F}$ (1, 59) = 3.98, $p<.05$.

ANCOVAS were performed on pre and post-test measures of conservation, reading grade equivalents, reading comprehension, number of paragraphs read, number and type of errors made, and story recall scores. ANCOVAS were also performed on gain scores (differences between pre and post-tests)

Table 1

Means and Standard Deviations for Chronological Age (CA) and PPVT-R Scores

Condition	n	CA		PPVT-R	
		Mean	SD	Mean	SD
Conservation Training					
Total Sample	22	7.91	.27	102.56	8.4
Non-Conservers	12	7.93	.26	100.41	7.8
Transitionals	10	7.92	.28	104.40	8.9
Traditional Reading					
Total Sample	22	7.93	.26	102.95	9.1
Non-Conservers	12	7.88	.26	100.41	7.8
Transitionals	10	7.92	.28	105.20	10.8
Control Group					
Total Sample	22	7.89	.31	102.50	9.0
Non-Conservers	12	7.86	.29	100.25	7.4
Transitionals	10	7.92	.28	105.45	10.4
Non-Conservers					
Total Sample	36	7.91	.27	100.58	8.8
Transitionals					
Total Sample	30	7.92	.29	104.93	9.4

for these measures. While significant differences did not exist between the three treatment levels for any measure of conservation or reading, significant differences were obtained between transitionals and non-conservers with respect to both conservation and reading measures.

This section will report the results as follows. The results pertaining to the effects of conservation training on conservation will be discussed first, followed by the effects of conservation training on reading. Correlational analyses between conservation and reading measures will then be reported. And, finally, specific data concerning the results of the conservation/reading training will be reported.

Conservation Table 2 reports adjusted means, and standard deviations for conservation pre-test, post-test, and gain scores. Table 3 reports the adjusted pre and post-test means across five conservation domains. On pre-test scores, the transitionals had significantly higher total scores than the non-conservers, F (1, 59) = 15.86, $p < .001$, as well as on conservation of number, F (1, 59) = 14.03, $p < .001$, and conservation of length, F (1, 59) = 13.22, $p < .001$.

The first major hypothesis for the present study, i.e., that conservation training would have a facilitative effect on conservation post-test scores, was supported. Table 4 reports the ANCOVA on conservation post-test scores, and Table 5 reports the ANCOVA on conservation gain scores. On both ANCOVAS, significant main effects were obtained for group and treatment. An interaction effect was almost significant ($p < .06$) for post-test and gain scores.

Table 2

Adjusted Means and Standard Deviations for Conservation Pre-Test, Post-Test and Gain Scores

Condition	n	Pre-Test Mean	Pre-Test SD	Post-Test Mean	Post-Test SD	Gain Mean	Gain SD
Conservation Training							
Total Sample	22	1.55	0.75	8.44	2.76	6.90	2.55
Non-Conservers	12	0.00	0.00	4.23	2.57	4.23	2.57
Transitionals	10	3.10	1.50	12.66	2.98	9.55	2.50
Traditional Reading							
Total Sample	22	1.50	0.74	4.34	2.88	2.82	2.35
Non-Conservers	12	0.00	0.00	1.68	2.09	1.68	2.09
Transitionals	10	3.00	1.50	7.00	3.60	4.00	2.72
Control Group							
Total Sample	22	1.50	0.65	2.83	2.15	1.33	2.10
Non-Conservers	12	0.00	0.00	1.47	1.67	1.47	1.67
Transitionals	10	3.00	1.10	4.21	2.76	1.21	2.64
Non-Conservers							
Total Sample	36	0.00	0.00	2.56	3.05	2.47	2.03
Transitionals							
Total Sample	30	3.03	1.36	7.95	3.09	4.90	2.66

Note. Maximum Score = 15

Table 3

Adjusted Pre and Post-Test Means Across Five Conservation Domains

Condition	n	Number		Length		Mass		Weight		Area	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Conservation Training											
Total Sample	22	1.05	2.59	0.23	1.91	0.00	1.27	0.05	1.09	0.09	1.27
Non-Conservers	12	0.00	2.25	0.00	1.00	0.00	0.00	0.00	0.25	0.00	0.33
Transitionals	10	2.30	3.00	0.50	3.00	0.00	2.40	0.10	2.10	0.20	2.40
Traditional Reading											
Total Sample	22	1.05	2.09	0.32	0.59	0.00	0.36	0.00	0.32	0.50	0.18
Non-Conservers	12	0.00	1.33	0.00	0.33	0.00	0.08	0.00	0.00	0.00	0.09
Transitionals	10	2.28	3.00	0.70	0.90	0.00	0.70	0.00	0.70	0.10	0.30
Control Group											
Total Sample	22	1.09	1.50	0.18	0.68	0.09	0.27	0.00	0.14	0.05	0.05
Non-Conservers	12	0.00	0.83	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00
Transitionals	10	2.40	2.30	0.40	1.20	0.20	0.60	0.03	0.30	0.10	0.10
Non-Conservers (Total)	36	0.00	1.47	0.00	0.53	0.00	0.14	0.00	0.08	0.00	0.14
Transitionals (Total)	30	2.33	2.77	0.53	1.70	0.07	1.23	0.03	1.03	0.10	0.93

Note. Maximum Score in Each Domain = 3

Table 4

ANCOVA on Conservation Post-Test Scores

Source	SS	df	MS	F
Covariate	4.11	1	4.11	.44
Treatment	339.34	2	169.67	24.41**
Group	464.95	1	464.95	68.89**
TRT x Group	89.11	2	44.55	6.41
Error	410.06	59	6.95	

*$p < .05$

**$p < .01$

Table 5

ANCOVA on Conservation Gain Scores

Source	SS	df	MS	F
Covariate	.38	1	.38	.06
Treatment	333.49	2	166.74	29.61**
Group	91.70	1	91.70	16.27**
TRT x Group	86.12	2	43.06	7.64
Error	332.34	59	5.63	

*$p < .05$

**$p < .01$

On post-test conservation scores and post-test gain scores, Newman Keuls post hoc tests revealed that the conservation group had significantly higher scores than either the reading or control group, and that the reading group was significantly higher than the control group, $ps < .05$.

ANCOVAS performed on the five individual conservation domains revealed significant main effects for both treatment and group. The main effects for treatment are reported as follows: number conservation, F (2, 59) = 7.64, $p < .001$, length conservation, $F(2, 59) = 12.67$, $p < .001$, mass conservation, F (2, 59) = 10.30, $p < .001$, weight conservation, F (2, 59) = 11.38, $p < .001$, and area conservation F (2, 59) = 25.68, $p < .001$. For each of these domains, Newman Keuls tests revealed that the reading group had significantly higher scores than the control group, $ps < .05$.

ANCOVAS on the post-tests also revealed that the transitionals had significantly higher scores than the non-conservers across all five conservation domains: number, F (1, 59) = 31.39, $p < .001$, length, F (1, 59) = 22.69, $p < .001$, mass, F (1, 59) = 30.61, $p < .001$, weight, F (1, 59) = 30.60, $p < .001$. and conservation of area, F (1, 59) = 24.08, $p < .001$.

Table 6 reports the percentages of subjects conserving in each domain on the pre and post-tests, and table 7 reports the number of non-conservers in each domain who shifted to conservation on the post-test.

Table 6

Percentages of Sample Conserving on Pre-Tests and Post-Tests

Condition	Pre-Test	Post-Test
Number Conservation	45%	81%
Length Conservation	15%	51%
Mass Conservation	9%	31%
Weight Conservation	5%	25%
Area Conservation	4%	22%

Note. Number of Conservers on Pre-tests = 36

Note. Number of Conservers on Post-tests = 47

Table 7

Number of Non-Conservers from Each Treatment Who Shifted to Conservation on the Post-Tests

Condition	n	Pre-Test	Post-Test
Conservation Training	12	12	9
Traditional Reading	12	12	5
Control Group	12	12	3

Conservation Training and Reading The second major hypothesis for the present study, i.e., that conservation training would have a facilitative effect on reading skills (both decoding and comprehension), was supported. The first analysis to be reported will be on the reading grade equivalents on the Gray Oral, Forms A and B, which are reported in Table 8. On the pre-test (Form A) grade equivalents, the transitionals were found to have significantly higher pre-test scores than the non-conservers, F (1, 59) = 11.81, $p < .001$.

The ANCOVA performed on post-test (Form B) grade equivalents is found in Table 9. A significant main effect was obtained for both treatment and group. Table 10 reports the ANCOVA on gain scores, also with a main effect for treatment and group.

For both ANCOVAS, Newman Keuls tests revealed that the conservation group had significantly higher scores than either the reading or control groups. Further, the reading group was found to be significantly higher than the control group, $ps < .05$.

Gray Oral Comprehension Table 11 reports the adjusted means, and standard deviations for comprehension scores on Form A and B, as well as gain scores. An ANCOVA on pre-test (Form A) scores, revealed significant differences between the transitionals and non-conservers, F (1, 59) = 9.01, $p < .004$.

ANCOVAS were performed on post-test comprehension scores and gain scores, and significant main effects were obtained for both treatment and group. Table 12 and 13 report these ANCOVAS.

Table 8

Adjusted Means, Standard Deviations for Grade Equivalents on the Gray Oral Forms A and B, and Gain Scores

Condition	n	Form A Mean	Form A SD	Form B Mean	Form B SD	Gain Mean	Gain SD
Conservation Training							
Total Sample	22	2.07	.17	3.11	.66	1.04	.58
Non-Conservers	12	2.00	.17	2.38	.29	.38	.20
Transitionals	10	2.15	.15	3.85	1.09	1.70	.96
Traditional Reading							
Total Sample	22	2.07	.14	2.84	.60	.77	.60
Non-Conservers	12	2.00	.14	2.35	.41	.35	.39
Transitionals	10	2.14	.14	3.33	.80	1.19	.81
Control Group							
Total Sample	22	2.05	.13	2.47	.33	.42	.30
Non-Conservers	12	1.99	.11	2.23	.31	.24	.28
Transitionals	10	2.12	.16	2.73	.36	.61	.33
Non-Conservers							
Total Sample	36	2.01	.15	2.33	.70	.32	.29
Transitionals							
Total Sample	30	2.13	.16	3.31	.73	1.18	.70

Table 9

ANCOVA on Post-Test (Form B) Grade Equivalents

Source	SS	df	MS	F
Covariate	.71	1	.71	2.04
Treatment	3.74	2	1.87	5.35*
Group	14.94	1	14.94	42.73**
TRT x Group	2.50	2	1.25	3.64
Error	20.63	59	.35	

*$p < .05$

**$p < .01$

Table 10

ANCOVA on Gain Scores for Grade Equivalents

Source	SS	df	MS	F
Covariate	.57	1	.57	1.81
Treatment	3.51	2	1.75	5.58*
Group	11.16	1	11.16	35.52**
TRT x Group	2.44	2	1.22	3.88
Error	18.54	59	0.31	

*$p < .05$

**$p < .01$

Table 11

Adjusted Means and Standard Deviations for Comprehension Scores on the Gray Oral Forms A and B, and Gain Scores

Condition	n	Form A		Form B		Gain	
		Mean	SD	Mean	SD	Mean	SD
Conservation Training							
Total Sample	22	17.9	4.4	23.5	3.9	5.6	4.2
Non-Conservers	12	16.0	4.0	20.8	2.7	4.8	3.6
Transitionals	10	19.8	4.9	26.5	3.2	6.7	5.4
Traditional Reading							
Total Sample	22	17.4	4.3	20.4	5.6	3.0	5.7
Non-Conservers	12	16.3	4.6	16.5	3.9	0.2	4.5
Transitionals	10	18.5	4.1	24.3	4.7	5.7	6.6
Control Group							
Total Sample	22	17.1	4.0	18.7	5.2	1.6	5.9
Non-Conservers	12	15.3	3.9	15.4	3.7	0.1	4.6
Transitionals	10	19.0	4.1	22.1	4.1	3.1	5.9
Non-Conservers							
Total Sample	36	16.7	3.9	18.4	3.4	1.7	4.2
Transitionals							
Total Sample	30	19.2	4.3	25.1	4.0	5.9	5.7

Table 12

ANCOVA on Gray Oral Form B Comprehension Scores

Source	SS	df	MS	F
Covariate	3.94	1	3.94	.62
Treatment	184.89	2	92.44	5.82*
Group	736.50	1	736.50	46.39**
TRT x Group	9.87	2	4.93	.31
Error	936.57	59	15.87	

*$p < .05$

**$p < .01$

Table 13

ANCOVA on Gray Oral Comprehension Gain Scores

Source	SS	df	MS	F
Covariate	1.04	1	1.04	.04
Treatment	216.73	2	108.63	4.08*
Group	194.00	1	194.00	7.31**
TRT x Group	37.35	2	18.67	.70
Error	1565.91	59	26.54	

*$p < .05$

**$p < .01$

Newman Keuls post hoc tests performed on comprehension post test scores and comprehension gain scores, revealed that the conservation training group had significantly higher scores and made greater gains than either the reading or control groups. Further, the reading group differed significantly from the control group, $ps < .05$.

Paragraphs Read Table 14 reports the adjusted means for the number of paragraphs read on the Gray Oral Forms A and B, as well as gain scores. An ANCOVA performed on the pre-test scores indicated that the transitionals read a significantly greater number of paragraphs than the non-conservers, F (1, 59) = 10.64, $p < .001$.

Table 15 and 16 report the results of the ANCOVAS performed on number of paragraphs read on the post-tests (Form B), and gain scores. For both analyses, significant main effects were obtained for group and treatment. Further, with respect to both analyses, Newman Keuls tests indicated that the conservation training group read significantly more paragraphs and made significantly greater gains than either the reading or control groups. Further, the reading group differed significantly from the control group, $ps < .05$.

Table 14

Adjusted Means and Standard Deviations for Number of Paragraphs Read on Gray Oral Forms A and B, and Gain Scores

Condition	n	Form A Mean	Form A SD	Form B Mean	Form B SD	Gain Mean	Gain SD
Conservation Training							
Total Sample	22	5.97	.5	6.95	.8	.98	.6
Non-Conservers	12	5.75	.4	6.41	.9	.66	.8
Transitionals	10	6.19	.6	7.50	.8	1.31	.4
Traditional Reading							
Total Sample	22	5.81	.6	6.45	.6	.64	.8
Non-Conservers	12	5.50	.9	5.90	.6	.40	.9
Transitionals	10	6.19	.4	7.00	.6	.81	.6
Control Group							
Total Sample	22	5.65	.6	5.96	.7	.31	.6
Non-Conservers	12	5.42	.5	5.51	.6	.09	.3
Transitionals	10	5.89	.7	6.43	.9	.54	.9
Non-Conservers							
Total Sample	36	5.67	.6	5.93	.8	.26	.9
Transitionals							
Total Sample	30	6.14	.5	7.18	.7	1.04	.6

Table 15

ANCOVA on Paragraphs Read on Form B

Source	SS	df	MS	F
Covariate	.03	1	.03	.05
Treatment	9.03	2	4.51	8.10*
Group	20.16	1	20.16	36.14**
TRT x Group	0.00	2	0.00	0.00
Error	32.91	59	.55	

*$p < .05$

**$p < .01$

Table 16

ANCOVA on Gain Scores for Paragraphs Read on Forms A and B

Source	SS	df	MS	F
Covariate	0.26	1	0.26	.46
Treatment	3.83	2	1.91	3.88*
Group	5.75	1	5.75	11.65**
TRT x Group	0.22	2	0.11	0.22
Error	29.15	59	.49	

*$p < .05$

**$p < .01$

Reading Errors Table 17 reports the adjusted means for the reading errors made up to paragraph five, the total number of reading errors, and gain scores. Table 18 reports the adjusted means for (total) reading errors across the eight categories on the Gray Oral Form A. And, table 19 reports the adjusted means for (total) reading errors across the eight categories on the Gray Oral Form B.

On pre-test scores, ANCOVAS revealed no significant differences between the three treatment levels with respect to reading errors. Nor were there significant differences between the transitionals and non-conservers with respect to reading errors made on the pre-tests.

On post-test reading errors, four ANCOVAS were performed. The first two ANCOVAS were performed on reading errors made up to paragraph five, and differences between errors up to paragraph five on Forms A and B. This was done in order to create an equitable comparison, as the subjects read up to different paragraph numbers, thus making different amounts of errors. Table 20 and 21 report the results of these two ANCOVAS. For post-test scores on errors made up to paragraph five, a main effect was obtained for treatment and group. Newman Keuls tests revealed significant differences between the conservation, control and reading groups, respectively, in regard to errors made up to paragraph five.

Table 17

Adjusted Means for Errors Up to Paragraph Five, Total Errors, and Gain Scores on Gray Oral Forms A and B

Condition	n	Errors to Par. 5 FormA	Errors to Par. 5 FormB	Errors to Par. 5 Gain	Total Errors FormA	Total Errors FormB	Total Errors Gain
Conservation Training							
Total Sample	22	14.5	7.4	-7.1	23.0	17.0	-6.0
Non-Conservers	12	15.7	10.2	-5.5	24.6	19.1	-5.5
Transitionals	10	13.5	4.1	-9.4	21.2	14.3	-6.9
Traditional Reading							
Total Sample	22	13.8	12.6	-1.2	20.4	18.9	-1.5
Non-Conservers	12	13.6	13.5	-0.1	18.3	17.0	-1.3
Transitionals	10	14.1	11.4	-2.7	22.7	23.5	-0.8
Control Group							
Total Sample	22	14.9	10.9	-4.0	21.5	15.8	-5.7
Non-Conservers	12	15.2	11.1	-4.1	22.0	14.1	-7.9
Transitionals	10	14.6	10.7	-3.9	20.0	17.8	-2.2
Non-Conservers							
Total Sample	36	14.7	11.6	-3.1	21.2	17.7	-3.5
Transitionals							
Total Sample	30	14.1	8.7	-5.4	22.1	18.5	-3.3

Table 18

Adjusted Means for Eight Error Categories on the Gray Oral Form A

Condition	n	AID	GMS	PMS	OMS	INS	SUB	REP	INV
Conservation Training									
Total Sample	22	1.9	5.1	5.2	3.6	1.9	4.1	1.0	.3
Non-Conservers	12	2.3	4.1	6.5	2.8	1.9	3.6	1.1	.3
Transitionals	10	1.4	6.3	3.6	4.7	2.0	4.8	1.0	.4
Traditional Reading									
Total Sample	22	3.6	2.8	7.4	4.5	1.1	1.5	0.8	.1
Non-Conservers	12	2.7	3.0	5.3	2.8	1.1	1.7	0.9	.0
Transitionals	10	4.7	2.6	9.9	6.5	1.2	1.3	0.7	.3
Control Group									
Total Sample	22	3.2	3.5	5.3	4.3	0.8	2.0	0.6	.2
Non-Conservers	12	3.0	3.5	5.6	4.5	0.4	1.8	0.5	.4
Transitionals	10	3.6	3.5	5.0	4.1	1.3	2.2	0.8	.0
Non-Conservers									
Total Sample	36	2.6	3.5	5.8	3.4	1.1	2.4	0.8	.2
Transitionals									
Total Sample	30	3.2	4.3	6.1	5.1	1.5	2.7	0.8	.2

Table 19

Adjusted Means for Eight Error Categories on Gray Oral Form B

Condition	n	AID	GMS	PMS	OMS	INS	SUB	REP	INV
Conservation Training									
Total Sample	22	6.3	1.5	4.2	2.9	1.5	2.9	0.2	0.1
Non-Conservers	12	5.4	1.8	4.8	2.5	1.7	2.7	0.3	0.1
Transitionals	10	7.4	1.1	3.5	3.4	1.3	3.1	0.1	0.0
Traditional Reading									
Total Sample	22	3.1	2.8	6.6	3.7	0.7	1.8	0.1	0.0
Non-Conservers	12	2.6	3.4	5.0	2.5	0.6	1.6	0.5	0.8
Transitionals	10	3.7	2.1	8.4	7.1	1.0	2.1	0.1	0.3
Control Group									
Total Sample	22	2.7	2.7	4.8	3.8	0.8	1.6	0.2	0.0
Non-Conservers	12	2.5	1.9	5.3	2.4	0.1	1.1	0.2	0.0
Transitionals	10	2.8	3.7	4.2	5.6	1.8	2.1	0.2	0.0
Non-Conservers									
Total Sample	36	3.5	2.4	5.0	5.4	0.8	1.8	0.3	0.1
Transitionals									
Total Sample	30	4.6	2.3	5.3	6.0	1.4	2.4	0.1	0.1

Table 20

ANCOVA on Reading Errors Made Up to Paragraph Five

Source	SS	df	MS	F
Covariate	7.69	1	7.69	.30
Treatment	301.88	2	150.94	5.98*
Group	127.15	1	127.15	5.04*
TRT x Group	95.17	2	47.58	1.81
Error	1487.08	59	25.20	

*$p < .05$

**$p < .01$

Table 21

ANCOVA on Differences Between Errors Made Up to Paragraph Five on Form A and B

Source	SS	df	MS	F
Covariate	102.76	1	102.76	2.11
Treatment	402.41	2	201.20	4.14*
Group	46.20	1	46.20	.95
TRT x Group	67.18	2	33.59	.69
Error	2682.81	59	48.52	

*$p < .05$

**$p < .01$

ANCOVAS were also performed on total errors made on the post-tests (Form B), and differences between total errors made on pre and post-tests. These ANCOVAS are reported in Tables 22 and 23. With respect to total errors, Newman Keuls tests revealed that the reading group made the greatest number of total errors, followed by the conservation group, and then the control group, $ps < .05$.

ANCOVAS were also performed on all individual error categories for the Gray Oral Forms A and B. On both pre and post-tests, significant differences between the three treatment levels and two groups, were for the most part, not obtained. The one exception though, was the (total) number of substitutions made on the Gray Oral Form B. Here, an ANCOVA revealed a significant main effect for treatment, F (2, 59) = 3.31, $p < .04$. Newman Keuls tests revealed that the conservation training group made a significantly greater number of substitutions (M = 2.9) than the reading (M = 1.8) or the controls (M = 1.6), $ps < .05$. Further, the reading and control groups did not differ significantly.

Table 22

ANCOVA on Total Reading Errors on Form B

Source	SS	df	MS	F
Covariate	16.81	1	16.81	.46
Treatment	214.18	2	107.09	3.92*
Group	22.36	1	22.36	.70
TRT x Group	106.88	2	53.44	1.69
Error	1862.67	59	31.57	

*p<.05

**p<.01

Table 23

ANCOVA on Differences Between Total Errors on Forms A and B

Source	SS	df	MS	F
Covariate	103.58	1	103.58	1.92
Treatment	287.03	2	143.51	2.66*
Group	22.83	1	22.83	.42
TRT x Group	352.70	2	176.35	3.26*
Error	3183.43	59	53.92	

*p<.05

**p<.01

Story Recall The analyses performed on story recall scores included total scores, and main ideas and inferences. Table 24 reports the adjusted means, and standard deviations for story recall pre-test scores, post-test scores, and gain scores. Table 25 gives a further breakdown of adjusted means for main idea and inference on pre and post-tests.

ANCOVAS on pre-test scores revealed no significant differences between the three treatment levels. However, significant differences were found between the transitionals and non-conservers with respect to (total) pre-test story recall score, F (1, 59) = 5.74, $p < .02$, and (pre-test) main idea scores, F (1, 59) = 3.91, $p < .05$.

Table 26 reports the ANCOVA done on total story recall post-test scores, and table 27 reports the ANCOVA done on total gain scores. On post-test scores, a significant main effect was obtained for group and treatment. Newman Keuls tests revealed that the conservation group had significantly higher post-test story recall scores than either the reading or control group. Further, the reading group was higher than the control group, $ps < .05$.

An ANCOVA performed on gain score for (total) story recall revealed a significant main effect for treatment, F (2, 59) = 6.25, $p < .05$. Newman Keuls tests indicated that the conservation group's means differed significantly from the reading and control groups, but that the latter two did not differ significantly.

Table 28 reports the ANCOVA performed on post-test main idea scores, and Table 29 reports the ANCOVA performed on post-test inference scores. For both ANCOVAS, significant

Table 24

Adjusted Means, Standard Deviations for Story Recall Pre-Test, Post-Test and Gain Scores

Condition	n	Pre-Test Mean	Pre-Test SD	Post-Test Mean	Post-Test SD	Gain Mean	Gain SD
Conservation Training							
Total Sample	22	1.2	.9	2.7	.7	1.5	.9
Non-Conservers	12	0.7	.8	2.3	.4	1.6	.9
Transitionals	10	1.9	.9	3.3	.8	1.4	.9
Traditional Reading							
Total Sample	22	1.2	.8	1.5	.9	0.3	.8
Non-Conservers	12	0.8	.8	1.0	.8	0.2	.8
Transitionals	10	1.7	.8	2.4	.3	0.7	.8
Control Group							
Total Sample	22	1.1	.9	1.3	.8	0.2	.7
Non-Conservers	12	1.0	.8	1.3	.8	0.3	.8
Transitionals	10	1.2	.9	1.3	.9	0.1	.8
Non-Conservers							
Total Sample	36	0.9	.9	1.4	.9	0.5	.8
Transitionals							
Total Sample	30	1.6	.9	2.3	.7	0.7	.8

Note. Maximum Score= 4/4+

Table 25

Adjusted Means for Main Idea and Inferences for Story Recall Pre and Post-Tests

Condition	n	Pre-Test Main Idea	Pre-Test Inference	Post-Test Main Idea	Post-Test Inf.
Conservation Training					
Total Sample	22	.77	.50	1.59	1.14
Non-Conservers	12	.58	.17	1.33	.92
Transitionals	10	1.00	.90	1.90	1.40
Traditional Reading					
Total Sample	22	.77	.45	1.09	.45
Non-Conservers	12	.50	.33	.75	.08
Transitionals	10	1.10	.60	1.50	.90
Control Group					
Total Sample	22	.73	.45	.77	.55
Non-Conservers	12	.58	.58	.75	.58
Transitionals	10	.90	.30	.80	.50
Non-Conservers					
Total Sample	36	.56	.36	.94	.53
Transitionals					
Total Sample	30	1.00	.60	1.40	.93

Table 26

ANCOVA on Story Recall Post-Test Scores

Source	SS	df	MS	F
Covariate	3.60	1	3.60	.11
Treatment	25.46	2	12.73	8.98*
Group	9.44	1	9.44	6.66*
TRT x Group	7.40	2	3.70	2.63
Error	83.58	59	1.41	

*$p < .05$

**$p < .01$

Table 27

ANCOVA on Story Recall Gain Scores

Source	SS	df	MS	F
Covariate	0.00	1	0.00	0.00
Treatment	22.40	2	11.20	6.25*
Group	.53	1	.53	.29
TRT x Group	2.23	2	1.11	.62
Error	106.04	59	1.79	

*$p < .05$

**$p < .01$

Table 28

ANCOVA on Main Idea Post-Test Scores

Source	SS	df	MS	F
Covariate	.88	1	.88	.20
Treatment	7.53	2	3.76	6.98*
Group	2.71	1	2.71	5.03*
TRT x Group	1.50	2	.73	1.36
Error	31.83	59	0.54	

*$p < .05$

**$p < .01$

Table 29

ANCOVA on Inference Post-Test Scores

Source	SS	df	MS	F
Covariate	.94	1	.94	.16
Treatment	6.12	2	3.06	6.43*
Group	2.02	1	2.02	4.26*
TRT x Group	2.31	2	1.16	2.41
Error	28.07	59	0.47	

*$p < .05$

**$p < .01$

main effects were obtained for treatment and group. For main idea scores, Newman Keuls tests revealed that the conservation group, reading group, and control group differed respectively. For post-test inference scores, the conservation group differed significantly from the reading and control group, but these latter groups did not differ significantly.

An ANCOVA performed on gain scores for main idea revealed a main effect for treatment, F (2, 59) = 4.48, $p < .01$. Newman Keuls tests indicated that the conservation group, reading group, and control group differed significantly. An ANCOVA on gain scores for inferences also revealed a main effect for treatment, F (2, 59) = 4.5, $p < .01$. Newman Keuls indicated that the conservation group differed significantly from the reading and control groups, but that the latter two groups did not differ significantly.

Additional Analyses. A separate set of ANCOVAS were run on all measures, with the inclusion of sex as an added independent variable. Differences were not obtained on overall conservation or reading scores. However two of the reading error categories yielded sex differences: gross mispronunciations and inversions. On the former indicate, the males were significantly higher (M = 4.0) than the females (M = 3.5), F (1, 59) = 2.08, $p < .04$. On the latter indice, the males were also higher than the females, F (1, 59) = 7.3, $p < .04$. While Piagetian studies have generally not reported sex differences, a large literature with respect to reading has been reported (Rudel 1974).

Correlational Analyses

The hypotheses that conservation measures would correlate both positively and significantly with reading measures, when MA (PPVT-R) scores are partialled out, was supported. Table 30 reports the range of intercorrelations between CA, PPVT-R, conservation and reading scores. The pre-test partial correlations between conservation and reading ranged from .38 to .58. The post-test partial correlations between conservation and reading ranged from .39 to .55. Further, pre-test conservation measures were found to correlate significantly with post-test reading measures, with a range of .17 to .65.

The relationships between chronological age (CA) and reading were non-significant, and the relationships between PPVT-R scores and reading were also found to be non-significant. Here, the one exception with respect to PPVT-R and reading was the correlation with number of paragraphs read (Form A), r (66) = .34, $p < .05$.

Total conservation scores did not correlate significantly with total number of reading errors; here one might have expected an inverse correlation. However, when total conservation scores are broken down into their respective domains, conservation of length and mass were significantly (inversely) correlated with total reading errors, on the pre-tests. On the post-tests, conservation of number had a significant inverse correlation with total number of reading errors.

Table 30

Intercorrelations of CA, PPVT-R, Conservation and Reading Scores for the Total Sample

Subscales	CA	PPVT	Pre Cons	Post Cons	Reading Measures									
					GE (A)	GE (B)	CompA	CompB	ParA	ParB	ErrA	ErrB	Story Recall	
Pearson														
CA	-	.13	.07	.16	-.10	.21	.06	.21	.19	.30	.08	-.08	.21	.22
PPVT-R	-	-	.08	.11	.06	.13	.05	.01	.34*	.22	.13	-.06	.19	.18
Partial (Controlling for PPVT-R Scores)														
Pre-Cons.	-	-	-	.62**	.47**	.65**	.38*	.55**	.44*	.58**	.17	-.19	.39*	.44*
Post Cons.	-	-	-	-	-	.39*	-	.54*	-	.45**	-	.45**	-	.55*

*p<.05

**p<.01

Table 31 reports the partial correlations between pre-test conservation and reading measures, with respect to the individual domains. This series of correlations fell into a moderate but significant range (.4 to .6). The highest correlations were between conservation and the grade equivalents for reading. Further, conservation of discontinuous quantity correlated the highest with the reading measures.

Table 32 reports the partial correlations between post-test conservation and reading measures. The range of correlations was .2 to .6. Again, the highest correlations were between conservation and grade equivalents in reading. Also, discontinuous measures correlated the most highly with reading.

Table 33 reports the partial correlations between pre-test conservation measures and post-test reading measures. These correlations fell into a range of .07 to .60. Number conservation pre-tests correlated the highest with the reading post-tests. Further, pre-test measures of conservation of equality had the highest correlations with post-test reading measures.

Table 31

Partial Correlations Between Pre-Test Conservation Domains/Tasks and Pre-Test Reading Measures, controlling for PPVT-R Scores

Pre-Test Conservation	Pre-Test Reading Measures				
	GE	Comp	Para	Errors	Story Rec.
Number	.44**	.37**	.43**	-.08	.33*
Length	.38*	.18	.35*	-.20	.30*
Mass	.18	.16	.21	-.20	.31*
Weight	.34*	.15	.21	-.11	.22
Area	.33*	.21	.25	-.01	.39*
Discontinuous	.51**	.34*	.37*	-.13	.31*
Continuous	.45**	.31*	.31*	-.07	.28*
Equality	.43**	.47**	.27*	-.04	.35*
Inequality	.39**	.36**	.21	-.11	.31*

*$p < .05$

**$p < .01$

Table 32

Partial Correlations Between Post-Test Conservation Domains/Tasks and Post-Test Reading Measures, with PPVT-R scores partialled out

Post-Test Conservation	Post-Test Reading Measures				
	GE (A)	Comp	Para	Errors	Story Rec.
Number	.57**	.55**	.61**	-.37*	.43*
Length	.56**	.48**	.49**	-.39*	.47*
Mass	.56**	.43*	.44*	-.31*	.45*
Weight	.58**	.59**	.51**	-.24*	.38*
Area	.55*	.38*	.45*	-.42*	.40*
Discontinuous	.54**	.48**	.41*	-.18	.42*
Continuous	.44*	.39*	.32*	-.12	.38*
Equality	.43*	.38*	.31*	-.07	.35*
Inequality	.41*	.34*	.28	-.04	.31*

*$p < .05$

**$p < .01$

Table 33

Partial Correlations of Pre-Test Conservation Domains/Tasks and Post Test Reading Scores, controlling for PPVT-R Scores

Pre-Test Conservation	Post-Test Reading Measures				
	GE (B)	Comp	Para	Errors	Story Rec.
Number	.60**	.50**	.44*	-.06	.33*
Length	.39*	.32*	.21	-.10	.29*
Mass	.06	.37*	.05	-.06	.01
Weight	.09	.07	.19	.11	.01
Area	.15	.27*	.32*	.09	.25*
Discontinuous	.43*	.30*	.20	-.08	.41*
Continuous	.32*	.25	.36*	-.11	.28
Equality	.31	.18	.34*	-.06	.33*
Inequality	.53*	.21	.36*	-.09	.24

*$p < .05$

**$p < .01$

Training Analyses Table 34 reports the adjusted means and standard deviations for conservation training scores, indicating a significant difference between transitionals and non-conservers. Table 35 reports the adjusted means and standard deviations for training on the reading tasks. Again, a significant difference was obtained between the transitionals and non-conservers.

Table 36 reports the subjects' involvement in the differential aspects of conservation training (responses to questions, counter-suggestions, empirical return statements, and physical manipulations of the objects. Table 37 reports the specific types of conservation responses on pre and post-test measures of conservation.

Table 34

Adjusted Means and Standard Deviations for Conservation Training

Condition	n	Mean	SD	T
Non-Conservers	12	2.5	2.1	4.14*
Transitionals	10	8.6	2.7	

*$p < .05$ Note. Maximum Score = 15

Table 35

Adjusted Means and Standard Deviations for Reading Training

Condition	n	Mean	SD	T
Non-Conservers	12	11.6	3.2	5.83*
Transitionals	10	18.0	2.6	

*$p < .05$ Note. Maximum Score = 20

Table 36

Training Phases in Conservation

Condition	n	Number of Correct Responses	Questions	Counter-Suggest.	Emp. Return	Phys. Manip.
Non-Conservers	12	30	15%	26%	26%	33%
Transitionals	10	75	29%	22%	28%	21%

Note. Maximum Score for Non-Conservers = 180, for transitionals = 150.

Table 37

Types of Conservation Responses on Pre and Post-Tests

Subscale	n[a]	Identity	Reversibility	Compensation	Other
Pre-Test Conservation	91	49%	27%	13%	13%
Post-Test Conservation	328	38%	29%	25%	8%

a = total number od correct conservation responses

CHAPTER VI

Discussion

Numerous theoretical models have evolved which have attempted to explain the processes involved in reading (decoding and comprehension). The prevalent reading models have focused on the role of linguistics, perception, memory and information-processing. These models have indicated that with increasing chronological age (CA), the child progresses in both decoding and comprehension, and in time, becomes a more proficient reader.

It was the intent of the present investigation to consider the application of Piagetian theory to the reading process. An an alternative model applied to reading, Piagetian theory advances notions of stage, conflict, conservation, etc. Specifically, the attainment of conservation, according to Piaget (1966), constitutes the core of all logical or rational activity.

Over the past decade, numerous correlational studies have attempted to link conservation to reading. The one major shortcoming of these studies is that correlation does not imply causality. A major precedent in testing for causality was demonstrated in a study by Landry (1980), where beginning readers were trained on Piagetian tasks which included conservation, and consequently demonstrated gains in both conservation and reading.

The present study attempted to expand upon Landry's paradigm. The goal of this study was to ascertain the benefits of conservation training with a sample of third grade, eight year old children who were non-conserving or at an early transitional point, and concomitantly below grade level (at least one year below) in reading.

The basis for selecting this sample derived from Piaget's (1970) statement that 75% of eight year olds attain conservation.

The purpose of this section will be to examine the major findings in greater detail. Limitations of the study will be cited, as well as implications for future research and educational practice.

Conservation Results. The first major hypothesis of the present study was supported. Conservation training, utilizing Inhelder's (1974) methods did appear to facilitate conservation ability in both the non-conservers and transitionals. Significant main effects were reported for both group and treatment. With respect to group, the transitionals had significantly higher conservation post-test scores and gain scores than the non-conservers. With respect to treatment, the post hoc tests indicated that the conservation training group had significantly higher post-test and gain scores than either the reading or control group.

The consistent pattern of differences between the transitionals and non-conservers with respect to pre-test, post-test, and individual domain conservation scores, lends some support to a demarcation of abilities which would be found from one stage to another.

Further an almost significant (.06) interaction effect for conservation post-test and gain scores suggests that a joint effect of treatment and group facilitated conservation abilities. This is especially plausible with respect to the transitionals within each group and particularly in the conservation group having the highest scores. As Beilin (1974) and Inhelder (1974) have pointed out, the children who possess some "rudimentary"

understanding of the phenomenon, are more able to take in or assimilate the new concepts which are brought about by training.

In evaluating the present study, a number of questions emerge concerning the classification of subjects as non-conservers or transitionals on the pre-tests. Initially, the transitionals were defined as those who scored from 1-5 on the pre-tests, thus allowing for the possibility of one correct response in each domain. In the present study, the transitionals reached a ceiling effect on the number pre-tests. Researchers have varied as to whether a child who conserves on one domain should be characterized as either a transitional or conserving subject. Thus with respect to the present study, a question emerges as to whether the two pre-test groups were really non-conservers vs. conservers, or non-conservers vs. transitionals?

The issue of differential task performance on conservation has been referred to as horizontal decalage. The decalage question has been addressed extensively in the literature by Piaget (1967) who has argued that children are more resistant to some properties than others, and that the development of a stabile conservation concept takes place over a gradual period of time. A developmental sequence of number, length, mass, weight, and area has been confirmed by (Piaget 1960; Elkind 1967: Inhelder, et. al., 1974, etc.).

Number conservation, which builds upon the child's notions of one-to-one correspondence and sets, is the understanding that different arrangements of objects do not alter the amount or number of objects. Number conservation has been consistently reported as the beginning of

or initial understanding of the conservation concept, and has been documented as early as age 5 or 6 (Piaget, 1960). Thus, in the present study, the children who conserved on number were characterized as transitionals, because they did not yet exhibit a structure which was generalizable across the five domains. Further, in considering the learning perspectives of Zimmerman (1974) and Brainerd (1974), arguments have been made that number conservation is especially sensitive to experiential factors because children have frequent experiences with counting and measurement activities. This constituted a further rationale for designating these children as transitionals.

Given the pre-test ceiling effect of number conservation, it might be argued that progress in conservation understanding should be based on how the children did on the other four domains. The conservation scores shifted as follows: 1.5 to 8.4 for the conservation group with a further breakdown for the transitionals (3.1 - 12.6) and the non-conservers (0 - 4.2). These scores must be evaluated in light of two factors. The first point is that the tasks and materials varied from pre-testing to training to post-testing. The second factor is that each domain contained a stringent criteria for conservation assessment by including equality, inequality, continuous, discontinuous items. Thus, it could be argued that the post-test measures constituted a stringent enough criteria for the retention of the conservation concept. In considering a four-month training study, one could argue that these scores indicate that the children attained a more stabile and generalizable understanding of the conservation concept.

One might have expected more progress on the part of the non-conservers in the control group, given the view that development is not a static phenomenon. However, in evaluating

previous studies, particularly Landry's have demonstrated that a much lower percentage of non-conservers shift to conservation than transitionals.

The conservation sequences reported in the present study have been corroborated in many previous training studies. While key theoretical questions emerge concerning the boundaries of stages, i.e., where is the initial point and where is the final point?, these remain questions for future research.

A major issue concerns the influential element in the training experience. Here, we have further corroboration for Piagetian theory in the form of vertical decalage, i.e., that some form of conservation appears at each stage of development. The results of the present study indicated that a higher percentage of non-conservers responded to experiences involving physical manipulations of objects, whereas the transitionals responded more to counter-suggestions. The physical manipulations constitute a motoric and thus external conflict between parts and wholes, whereas the counter-suggestions constitute a more internalized level of conflict. The effectiveness of the counter-suggestions with the transitionals in terms of inducing conservation has been a source of major investigation by Perre- Clermont (1980) and others, who have studied the effects of dyadic interactions and pairings of children with different viewpoints and how they arrive at the conservation understanding.

Conservation Training and Reading. The second major hypothesis of the present study was supported. Conservation training appeared to have a facilitative effect on the reading grade equivalents, comprehension scores, number of paragraphs read, decrease in errors, and story recall abilities of both the non-conservers and transitionals. The conservation training group also demonstrated greater gains than either the reading or control groups in all of these areas.

ANCOVAS on both reading pre and post-test scores also revealed significant differences between the transitionals and non-conservers with respect to these measures. These differences have been consistently reported in previous studies (Rozanksi 1977; Jackson 1980; McConnell 1980).

In further evaluating subjects' progress on the reading measures, a number of points need be made. Clearly, the conservation group showed the greatest progress on grade equivalents (2.0 to 3.1) as compared to the reading (2.0 to 2.8) and the control groups (2.0 to 2.4). The grade equivalent is based upon a composite of time and number of errors made. In the area of comprehension, the conservation group was only ahead of the other two groups by a few points. However, the use of an across grades measure indicates that any improvement in comprehension is being made on increasingly complex reading material. Further, a higher number of children in the conservation group generated both main ideas and inferences on the story recall post-tests, than either the reading or control groups. Thus the conservation-reading relationship has received some support on both conventional as well as more open-ended aspects of reading.

Reading Errors. The Gray Oral yields both a total error score as well as breakdowns into eight separate error categories. Because of the nature of the scoring system of the Gray Oral, the child is likely to make more errors as he/she reads more paragraphs. Both quantitative and qualitative analyses were performed on the reading errors.

In evaluating the number of errors made up to paragraph five, as well as total errors (beyond paragraph five as well), the conservation group showed a significantly greater decrease than either the reading or control group. The conservation training group made significantly fewer errors up to paragraph five, but did not differ significantly from the reading group on total number of errors made. Again, this finding can be explained by the fact that the number of errors made by the subjects is proportionate to the number of paragraphs read.

Significant differences between transitionals and non-conservers with respect to number of errors made, occurred up to paragraph five, but not on total errors made. Again, this can be explained by the fact that the transitionals read more paragraphs than the non-conservers.

ANCOVAS were also performed on the eight individual error categories for Form A and B of the Gray Oral. Significant differences were, for the most part, not obtained. These error categories constitute a more qualitative analyses. Goodman (1980) makes a distinction between reading errors or miscues that interfere with the meaning of the text (i.e., mispronunciations or ommissions of key words) and errors that don't interefere with meaning (such as substituting words; house

for home, etc.). A question arises as to what extent these error categories can be linked to children's cognitive developmental levels? In one instance, the conservation training group did make a significantly greater increase in the number of substitutions on the post-tests when compared to the reading and control groups. This finding would represent some consistency between Goodman's (1980) and Piaget's (1967, etc.) formulations.

However, differential patterns with respect to the number and type of reading errors made by the different groups are subject to limited qualitative interpretations, because the number of errors made are proportionate to the number of paragraphs read. One might question why the conservation training group asked for more help ("aids") on Form B than on Form A? One argument might be that the children were learning and making greater use of the interactive context, and were using time and effort efficiently by asking rather than guessing at what they don't know. Another possibility is that the children read more paragraphs and were asking for help with words on the harder paragraphs.

Another interesting area is that of ommissions made by the children. Is this type of error considered to interefere or not interefere with meaning? From an information-processing perspective the children may omit the less important words in order to reduce redundancy and increase efficiency (vis a vis skimming). Thus, ommissions of unimportant words may reflect a higher cognitive level, whereas ommissions of important or key words represent a lesser cognitive level. While the Gray Oral is limited in making these distinctions. future research might utilize miscue analysis; (graphic, syntactic, semantic) word similarities, which would control for such findings.

In evaluating the reading gains made by subjects in the conservation training group, a point which must be taken into account concerns the time period involved and the limited number of training sessions.

If one looks at the results of training as advocated by the prevalent reading models, one often sees uneven or negligible results. Linguistic methods of training with respect to reading comprehension have not always been successful (Stotsky 1975; Combs 1979). Training studies employing perceptual methods have also not resulted in reading gains (Rouch 1968; Hedges 1974; Seaton 1974; Thomas 1974). Even in the realm of information-processing, Chi (1977) reported that attempts to teach children chunking, labelling, rehearsal strategies, etc., did not help children to read for the main idea. If linguistics, perception, and memory-information processing constitute the underpinnings of the reading process, the evidence remains to be seen. Again, within a Piagetian model, these functions are considered important but are contingent upon the structural or developmental levels.

Evlautions of reading programs which have built upon these reading models (phonics, Basal Readers, whole-word approaches, DISTAR, etc.), have also not necessarily resulted in facilitating children's reading abilities. Becker (1977) in discussing DISTAR, indicated that children who participated in this behaviorally oriented curriculum scored above the national norm on the WRAT, but were below the national norms on the Metropolitan Achievement Tests (MAT); the latter being a more stringent criterion of reading, particularly with respect to reading comprehension.

Another key point about evaluating reading programs comes from the work of Chall (1967), who stated that progress or gain in reading does not always manifest itself right after training or intervention, but sometimes even a year or two later.

While the present study demonstrated that conservation training helped reading, it is again important to know what specifically about the training experience helped reading? For example, while physical manipulations of objects helped some children (mainly the non-conservers) to learn about part-whole relationships, can the analogy really be made with respect to reading? While Piagetian notions of cognitive "conflict" may be involved in the child's understanding that a ball is converted into two pancakes and then back into a ball again, is this type of conflict really involved in a child putting together letters into words, words into sentences, or parts of a story into a main idea? While analyses of the children's conservation responses indicated that the majority of children utilized identity responses (addition and subtraction), again, can the analogy be made to the child's putting little words into compound words, and breaking them up again. Information-processors such as Stanovich (1980) would argue that decoding becomes automatized by the third grade. Another question is how does the conservation ability pertain to the child's reading for story inferences? Or is this a skill that might be more characteristic of formal operational thought? And, what is the role of culture or environmental or historical factors in terms of how children understand themes such as greed, revenge, violations of the Golden rule, etc.?

As to the broader implications for conservation training with respect

to reading, there has been insufficient evaluation of Piagetian-based curriculums with respect to basic skill improvement. Kuhn (1979) has pointed out that large scale evaluations of such curriculums (Lavatelli 1970; Furth 1966; Weikart 1971; DeVries 1977, etc.) appear to be lacking. While Renner and Stafford (1976) documented that the SCIS (a Piagetian-based science curriculum) helped to improve elementary school children's reading skills, there appears to be little empirical evidence beyond this study. If Piagetian curricula are to replace the so-called traditional curricula, what then would be the goals of education (i.e., reaching a particular developmental stage)? And, how are children to be grouped, and at what age should reading instruction begin? These are all questions that call for further study.

Since the children in both the reading and control groups made some progress in both conservation and reading, a question arises as to why this happened? One possible explanation is that pre-testing on the 15 conservation tasks constituted a form of training for the children (Beilin 1974). Thus the possibility existed that the training from the pre-testing of conservation interacted with the reading training and thus helped the children progress in both domains. Future studies might include experimental groups with combination treatments.

Perhaps an even more important question given the progress of the conservation and reading groups is whether or not the training techniques either directly or indirectly had certain elements in common. It might be argued that both training methods employed induction; examples were ellicited from the children and enabled the children to

form and refine their ideas further. There was clearly some degree of cognitive overlap in the reading training. For example, when the children were asked to provide examples of nouns, verbs, etc., their reasoning required them to classify and categorize. The possibility that the reading training helped the children to formulate ideas, is perhaps more consistent with Vygotsky and Luria's (1977) work, and suggests a re-appraisal of Piaget's view that language is secondary to thought.

Again, the question of the relationship of thought and language is implicated in the reading materials themselves. For example, with respect to story sequencing, is the idea that a story contains a beginning, middle and ending, a linguistic or relational(conceptual) concept?

Correlational Analyses The correlations between conservation and reading measures (with PPVT-R scores partialled out), fell into a moderate but significant range (.4 to .6). Number and length conservation were found to have the highest correlations with the reading sub-skills on both pre and post-tests. This particular finding has been corroborated in prior studies (Almy 1967; Haupt 1980; Stafford 1976). Again, the question is raised as to whether conservation is unitary (consistent across domains), or domain-specific. For example, Polk (1980) discussed the conservation of length with respect to word length, and how these two are related.

The conservation pre-tests had the highest correlations with the reading post-tests. Further conservation of equality items had

highest correlations with the reading measures.

Mental Age (MA) and Chronological Age (CA) did not correlate significantly with the reading subscales. This finding is not inconsistent with previous studies. In 1967, Almy conducted the first correlational study utilizing measures of MA (WISC-R), conservation and reading. She reported that the conservation-reading correlation was higher than the MA-reading correlation. This particular finding has been consistently replicated in Piagetian studies (Elkind 1967; Rauscher 1974; Polk 1980; Cox 1980, etc.).

The other reason that MA did not correlate significantly with reading sub-scales deals with the "range of restriction" issue with respect to the sample, i.e., that the children's abilities fell into a limited and somewhat homogeneous range. Higher correlations might have been obtained had the sample represented a wider range of abilities.

While the correlations between conservation and reading were significant, a closer look indicates that only 40% of the variance in reading is explained by conservation factors. If CA, MA, SES, and Sex were controlled for in the present study, and proved not to be contributing factors, then what factors (besides error) could account for the remaining variance in reading?

Other possibilities might include attention, memory, distractibility, self-efficacy, and even neurological impairement. Possibly one might argue that the child's ability to respond to between 60-80 plates on the PPVT-R constituted a control for attention and memory factors. However, no measure to control for neurological factors (such as the Bender-Gestalt) was included, and this might be a consideration for future research.

Even another possiblity might be

a consideration of the non-school influences on the child, as suggested by Durkin's work (1966) and even attested to by Piagetian researchers such as Elkind (1972 1974). These factors include the home environment, the frequency of being read to by parents, exposure to reading materials at an early age, and the amount of television watching. Also to be considered are the levels of the reading materials themselves. In the past, readibility formulas were based primarily on linguistic considerations: number of words, syllables, sentences, etc. Readability formulas, might in the future, be influenced by Piagetian stage notions.

It should also be mentioned that additional correlational analyses were conducted to ascertain the relationships between the conservation domains, and between the reading subscales. In both cases, the correlations proved to be significant and fell into a moderate range (.4 to .6).

Implications for Future Research

Future research with respect to conservation and reading should include a number of considerations. An across-grades study would constitute even further support for the notion of stage. Also, children's reading abilities, as influenced by conservation could be assessed on a longitudinal basis: i.e., shortly after training, one year later, two years later, etc. While the present study was limited to children who were reading below grade level, an obvious question emerges as to the progress of "good" or proficient readers.

If the so-called good readers had been included in the present study, how much progress might they have made, and what does this suggest for stage theory? Future studies should also include a wider range or variety of reading tests and reading skills. Further, more research needs to be done on the relationships between conservation ability and how a child might discern inferences from the text. It would appear that the domains of conservation and reading have moved in a more contextual direction, with both domains placing increasingly more emphasis on task, person, and situation variables. This trend has import for education in terms of combining a consideration of the child's logical abilities with notions of individualized and self-paced diagnosis and reading instruction.

Also to be considered for future research is the area of meta-cognition in reading, i.e., how aware is the child of the types of errors and/or reading strategies which he or she utilizes? And, is the ability to engage in self-correction consistent with developmental stages?

Implications for Educational Practice. Generally, educators have tended to emphasize the role of grade, age, SES, and IQ in terms of predicting academic achievement, and specifically reading achievement or proficiency. Developmentalists, on the other hand, have leaned toward constructs such as stage, conflict, conservation, etc., in terms of how the child is viewed. The present study, to an extent, represented an intersection of these two areas.

The finding that conservation measures related both positively and significantly to reading skills, irrespective of mental age (as measured by PPVT-R), would suggest important applications for the reading teacher and reading curriculums.

If more extensive research efforts establish conservation as a pre-condition for reading skills, then the reading educator will be faced with the decision of whether or not to wait for the child to conserve naturally, or attempt to induce it experimentally, prior to formal reading instruction. If the latter is the case, then the teacher will have to consider whether one method of training will work for all children or whether children will benefit from different levels of training, as suggested by the present study. The reading educator will also have to consider whether curriculum materials should be at the child's level or slightly higher, as was the case with the present study.

Another important question revolves around how the children should be grouped in order to maximize reading instruction. Should they be grouped according to developmental levels, irrespective of age or grade? And, given the success of the many Piagetian interaction studies, if children are to teach each other, then should two children work together who are on the same cognitive levels, or at different levels? As peer teaching becomes an increasing part of the educational system, both methods will have to be tried out.

If the school child exhibits reading problems, it would appear that inclusion of Piagetian tasks and consideration of developmental levels be part of ongoing assessment. The use of Piagetian tasks can serve as a valuable tool for both assessment and training.

APPENDIX A

The Dog and His Shadow

Once upon a time, a dog was wandering about in the country.
Suddenly, he stumbled upon a big piece of meat.
He started to carry it home in his mouth.
On his way home, he came to a narrow bridge.
The bridge covered a running stream.
As he started to cross the bridge, he looked down and saw his own shadow reflected in the water.
Thinking it was another dog and another piece of meat, he wanted to have that also.
He snapped at the shadow.
But as he opened his mouth, the piece of meat fell out.
It dropped in the water and was lost forever.

(Aesop's Fables, Translation by V.S. Vernon, Avenel Books, NY)

APPENDIX B

Grumble and The Elf

Once upon a time, there was a mean man named Grumble.

One day, Grumble saw a tiny elf in the woods.

Grumble said, "An elf always has a huge pot of gold."

"I'll make this elf take me to his pot of gold."

Grumble took hold of the elf.

The elf shouted, "Let me go!"

Grumble said, "Take me to your pot of gold."

"Then I'll let you go!"

The elf took Grumble to a big tree.

The elf said, "The gold is buried under this tree."

"You'll have to dig very deep to get it."

Grumble said, "I'll need a shovel to dig with."

"I'll go home and get one."

"But first I'll mark the tree so that I can find it again."

Grumble took off his red scarf and put it on the branch of a tree.

He said to the elf, "Promise you won't take my scarf off the tree."

The elf said, "I promise!"

Grumble ran home to get a shovel.

When Grumble returned, he looked for the tree with the red scarf.

The elf had kept his promise.

He had not taken Grumble's scarf off the tree.

Instead, he had put a scarf on every tree.

Grumble began to yell and scream and stamp his foot.

But the elf was nowhere to be found.

So Grumble began to dig, and he may still be digging!

The Boy Who Cried Wolf

Once upon a time, there was a shepherd's boy who was tending a flock of sheep.

The boy thought it would be fun to fool the people in the nearby village, by pretending that a wolf was attacking the sheep.

So the boy cried: Wolf! Wolf!

The people from the village came running, and the boy laughed at them.

He did this a second and then a third time.

Each time, the people came running but saw no wolf.

Finally, a wolf really did come.

The boy cried Wolf as loud as he could.

But this time, the people in the village didn't pay any attention.

The wolf then ate up all the sheep.

(Aesop's Fables, Translated by V.S. Vernon, Avenel Books, NY)

APPENDIX D

The Gold Dust

Once upon a time, there was a man who owned a huge sack of gold.

One day, he had to go on a long journey, so he brought the sack to his friend.

He said to his friend, "Please watch this sack of gold dust for me until I return."

"Yes," said the friend, "It will be safe with me!"

When the man returned from his trip, he went to his friend.

"I have bad news," said the friend.

"Your gold has turned into sand."

The man was very unhappy.

But there was little he could do, so he went home.

Later, the friend came to him.

"I am going on a long journey, may I leave my little son with you?"

"Yes," said the man. "He will be safe with me!"

So the young son stayed with the man.

Then the man bought a parrot and trained him to say:

"Father, see what I've turned into!"

When the boy's father returned, he asked the man:

"Where is my son?"

"Here he is," said the man, pointing to the parrot.

"Father, see what I've turned into!" said the parrot.

The father was very angry and shouted,

"Don't be foolish, boys don't turn into parrots!"

Where is my son?"

The man replied, "In a country where gold dust turns into sand, boys can turn into parrots."

"Find my gold dust and I'll take you to your son."

So the father went and got the gold dust, and the man took him to his son.

APPENDIX E

Conservation Pre-Tests

Number Conservation (6 red chips, 6 yellow chips)

a. Top row (red) elongated, bottom row yellow remains same.

b. Top row (yellow) touching, red placed in tiny paper cup.

c. Top row (4 red) elongated, yellow bottom row remains same.

Length Conservation (red and yellow pipecleaners)

a. Red horizontal- yellow cut into three pieces placed vertically underneath

b. Yellow horizontal- red vertical

c. Red horizontal- piece cut from yellow placed on vertical

Mass Conservation (red and yellow Playdoh balls)

a. Red ball converted into sausage.

b. Yellow ball is cut into 3 sausages

c. Red ball (initially red Playdoh is added) made into 1 sausage.

Weight Conservation (Red and Yellow Playdoh balls, child initially holds in hands)

a. Yellow ball is made into 2 pancakes.

b. Red ball is made into 1 pancake

c. Yellow ball (piece initially removed) made into 2 pancakes.

Area Conservation (2 Yellow paper squares with little red squares)

a. Red square is placed in bottom right corner.

b. Red square is cut in ½, ½ then moved forward.

c. Red rectangle is placed in bottom right corner.

Conservation Training Tasks

Number Conservation (Red and blue round wooden beads)

a. String with blue beads forming a line, red beads in a circle.

b. String with red beads in line, loose blue beads form a circle.

c. Blue beads on a string forming a line, 2 red beads added to circle string.

Length Conservation (Red and blue pipe-cleaners)

a. Blue pipecleaner horizontal- red pipecleaner 45 dgree right angle

b. Red pipecleaner horizontal- blue cut in ½, 45 degree right angle

c. Blue pipecleaner horizontal- longer red pipecleaner 45 degree right angle

Mass Conservation (Red and blue Playdoh balls)

a. Blue ball is transformed into 3 rings.

b. Red ball into 1 large ring.

c. Blue ball (piece initially subtracted), then made into 3 rings

Weight Conservation (Red and blue Playdoh balls)

a. Red ball made into horseshoe, blue ball placed at one end.

b. Blue ball into horseshoe-red ball cut in ½ placed at one end

c. Red ball (initially piece added) into horseshoe, blue ball at one end.

Area Conservation (Red paper squares, smaller blue squares)

a. Blue cut in ½, then made into inverted T shape, placed on red.

b. Blue placed on diagonal.

c. Blue cut in ½, piece removed, placed on diagonal.

APPENDIX G

Conservation Post-Tests

Number Conservation (Green and yellow marbles, plastic cups)

a. Green marbles into 2 smaller containers.

b. Yellow marbles into 1 large container.

c. Green (Initially subtracted) into 2 containers.

Length Conservation (knotted strings)

a. 1 string placed in horizontal position, 2nd string cut in ½ and placed into 2 touching curves above horizontal string

b. 1 string horizontal- 2nd string placed into 2 touching curves above other.

c. 1 string horizontal- ½ cut off, smaller string made into 2 touching curves.

Mass Conservation (Beakers, cups and water)-initially presented in 2 equal cups.

a. Water is poured into large beaker.

b. Water is poured into 2 smaller beakers.

c. (Water initially added) poured into beaker.

Weight Conservation (Sand, small plastic measuring cups)

a. Sand poured into 3 smaller cups.

b. Sand poured into larger cup.

c. Sand (some is removed) and poured into 3 smaller cups.

Area Conservation (Green cardboard squares, little red houses).

a. 2 green squares, 3 houses form triangle in 1 square.

b. Green square cut in ½, houses placed in triangle in base

c. 2 green squares, red house removed, outer area larger

Appendix H

Traditional Reading Materials

Session 1:

Dipthongs and Digraphs The experimenter holds up a card with a stimulus word printed on it. The child will be asked to read the word on the card. The experimenter will then point to a part of the word on the stimulus card, for example, the ew in new, and ask the child to read the sound. The child is then asked to read 4 other words that contain the same sound as on the stimulus card. The child will be aided in reading the stimulus words only, and will receive cues or prompts in reading the other words.

Stimulus Words (Dipthongs)

New (grew, stew, flew, nephew)

boy (toy, ploy, enjoy, destroy)

book (took, shook, look, cooking)

now (plow, cow, allow, how)

out (cloud, proud, count, loud)

Stimulus Words (Digraphs)

what (why, where, when, which)

shell (ship, shake, sharp, sheet)

chair (change, check, chase, chart)

the (then, them, they, this)

phone (phony, phrase, photo, phantom)

Compound Words The experimenter explains that a compound word is a big word that contains two smaller words. The experimenter holds up a card with the word snowman, and then asks the child what two smaller words make up this word. The child is then shown ten cards with ten compound words and in each case is asked to read the two smaller words

that make up the compound word. The ten words to be displayed are: airport, rowboat, mailbox, drugstore, skyscraper, sunshine, cardboard, flashlight, barnyard, baseball).

The child will then be given a list of ten sentences containing these words, and will be asked to read the sentences aloud and then read the compound word. The ten sentences are:

The plane landed at the airport.

The girls used a rowboat to cross the lake

Put the letter in the mailbox.

We bought gum at the drugstore.

Look at the tall skyscraper.

The sunshine is very bright.

The box is made of cardboard.

I couldn't see so I got a flashlight.

There are many animals in the barnyard.

My father got tickets for the baseball game.

Session 2: (Nouns, Verbs, Adjectives, and Adverbs/ Antonyms and Synonyms)

Nouns The experimenter tells the child that a noun is the name of a person, place, or thing. The experimenter then holds up a card summarizing this rule. The experimenter provides verbal examples, and then asks the child for examples, The child is then asked to read five sentences aloud and to read/identify the noun in each sentence.

Don't forget to eat your dinner.

Bring your bike in to be fixed.

The store will open later.

The dog was hungry.

The baby was crying.

Verbs. The experimenter tells the child that a verb is an action

word, and holds up a card stating this rule. The experimenter provides examples, and then asks the child for examples. The child is then asked to identify five verbs in five sentences.

The hot sun melted the snow.

We planted flowers in the Spring.

May and Bill played a game of checkers.

You can light a candle with a match.

She did not return my book.

Adjectives. The experimenter tells the child that adjectives are words that describe nouns. A card is held up with this rule. The child is then asked to correctly identify five adjectives in five sentences.

I was happy to win first prize.

The lion made a loud noise.

There are many cold days in the winter.

Who will wash the dirty dishes?

I will take a hot bath when I get home.

Adverbs. The child is told that an adverb modifies a verb. A card is held up with this rule. The experimenter gives an example: The man walked quickly. Quickly is the word (adverb) which described how the man walked. The child is then asked to read five sentences and identify the five adverbs.

The lion roared loudly at the circus.

We worked hard to do a good job.

Please try to get home early.

It suddenly started to rain.

The mouse ran slowly across the floor.

Synonyms and Antonyms The experimenter tells the child that some words look different, but have a similar meaning, for example,

unhappy and sad. The experimenter then tells the child that some word pairs have opposite meanings, for example, up and down. The child is asked for examples of synonyms and antonyms. The child is then provided with 20 mixed cards, and asked to make correct synonym/antonym pairings.

(fast- quick, build-make, shut-close, begin-start, happy-glad, before-after, right-wrong, bottom-top, win-lose, high-low).

Session 3: (Story Sequencing and Reading for Facts)

Story Sequencing. The experimenter tells the child that all stories have a beginning, middle, and ending. For example:

Jane woke up in the morning.

Jane got her bike and went to school.

Jane came home from school at 3 o'clock.

The child is asked what happened first, next, and last. The experimenter then says to the child, I would like you to read these stories, place a 1 to what happened first, a two next to what happened second, and a three next to what happened last. (Stories are in large print on ditto sheets)

a) Cars could not go on the road.

It rained for three hours.

The road was filled with water from a storm.

b) Jane's dog jumped over the fence and ran away.

A girl down the block found Jane's dog.

Jane looked and looked for her dog.

c) Bob and his dog were very tired.

Bob played games with his dog all night.

Bob got a dog for his birthday.

d) The girls were walking along and found the money.

Money was lying on the ground.

The girls returned the money and got a reward.

e) The ship tried to sail away from the shark.

The ship sank in the water.

A shark swam into a ship.

Reading for Facts . The experimenter explains to the child that stories contain sentences or statements that are true, i.e., these are facts that can be proven and checked in the story. For example, if a story said that Mary was wearing a green hat, and I said to you that Mary was wearing a yellow hat, would that be true or false? Discuss these terms with child and make sure that they understand the meaning.

The experimenter then proceeds to say to the child, I am going to read a story to you. Afterwards I am going to ask you some questions about the story. Please tell me if each question is true or false.

Camels

A camel lives in hot countries.

He travels mostly over sandy deserts.

He can go for a long time without a drink of water.

A camel may have one humps or two.

Food and water are stored in his humps.

True/False questions

A camel stores water in his humps.

A camel lives in a cold snowy country.

He goes on sandy deserts.

Camels may have four humps.

Camels don't ever need a drink of water.

Session 4: Reading for the Main Idea

The experimenter tells that each story has a main idea. Further, a main idea answers questions pertaining to who, what, why, where, or when. Examples of each are given to the child, and then the child is told that sometimes a main idea can be found in the first or last sentence of the story.

The child is then given a practice story:

Indian children had many toys.

They used sticks, seeds, rocks, and shells.

They made toys out of the things that they found.

They had fun with their toys.

Best of all, their toys were free.

The experimenter then says to the child, supposing that you were given three possible choices for the main idea, can you pick the best one?

a) How much Indian toys cost.

b) Where Indian children bought their toys.

c) What Indian children's toys were like.

The experimenter discusses the child's answers, and asks the child to read the next five stories and pick out the main idea.

Stories for the Main Idea

a) Leo Hirsch was a scientist who loved making new kinds of candy.

In 1896, he made candy that was shaped like a roll.

When he finished, he thought of his daughter "Tootsie."

Then he had an idea, he would name his new candy, Tootsie Roll.

Leo wrapped each Tootsie Roll in a piece of paper and sold them each for one cent.

The main idea of this story is:

a) a man who loved candy
b) how a piece of candy got its name
c) what kinds of candy were eaten years ago

b) When Indiant children were born, they were given nicknames like Flat Head, Big Teeth, and No Nose. The children had to keep these names until they did a good deed or a brave thing. Then they could take a better name.

The main idea of this story is:

a) games that Indian children play

b) Indian names

c) How Indian children got better names.

c) Many years ago, people wore hats indoors. People even wore hats at meals. People had good reason, because in those days, houses were not heated. People were able to keep their heads warm by wearing hats indoors. It helped to cut down on the number of colds.

The main idea of this story is:

a) Why people wore hats indoors.

b) How people ate their meals.

c) Why people caught colds.

d) What is the smallest town in the United States? Some students in a geography class looked at many maps. They found the answer. The smallest town was Alvin, North Carolina. Only ten people live there.

a) Why a town was so small.

b) What the smallest town was?

c) Where the smallest town can be found.

e) In the early 1860's, there were no trains to carry letters across the United States.

Session 5: (Predicting Story Outcomes and Drawing Inferences)

Story Outcomes. The experimenter tells the child that all stories have an ending. The experimenter then tells the child that if the ending is left out of the story, there is enough information to guess what will happen. For example,

I was walking home.

I dropped a book.

What would happen next? The child then replies, pick up the book, or the equivalent. The experimenter then asks the child to read some stories aloud and pick the best ending for the story.

1) Bob was running down the icy street.

Suddenly, he felt his feet flying from under him.

The next moment, he was

a) flat on his back.

b) ice-skating

c) jumping up and down.

2) Mr. Smith ran out of his store.

Help! Help! he shouted, "I've been robbed."

The policeman came running around the corner.

The policeman

a) bought something in Mr. Smith's store.

b) wrote something in his notebook.

c) ran after the thief.

3) Paul was getting dressed to go to school.

He put on his mittens, heavy coat, and boots.

Don't forget your wool hat, said mom.

Paul stepped outside into the:

a) fog b) sunshine c) snow

Story Outcomes. The examiner tells the child that all stories have ideas that are not always directly stated. Sometimes you have to guess from the information given in the story. The experimenter relates this to story outcomes done the previous time.

The experimenter then says to the child, I would like you to listen to these stories, and try to use the words in the story to guess what these people do.

1) The blades of the chopper went round and round. The noise they made were music to Joe's ears. Then Joe saw the landing strip beneath him. He landed his chopter on a tall building and his passengers got off. (What kind of job did Joe have?)

2) Mary carried her bag of supplies with her as she went from one cage to another. First, she went to see a sick monkey that needed a shot. After that, she pulled a tiger's broken tooth and gave him a pill (What kind of job did Mary have?)

3) Tom put on his hard hat and stepped into the elevator. When it stopped underground, he turned on his hat lamp and got off. Then he made a hole in the rock. Soon his helper came by to help him blast the rocks loose (What kind of job did Tom have?)

4) The shop was full of furniture. Linda was dusting a clock when a customer walked in. "May I help you," said Linda. Yes, said the man, I'd like to buy this table. How much does it cost? Linda replied that it was ten dollars. The man paid for it. (What kind of job did Linda have).

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