CONSERVATION IN SECOND-GRADE CHILDREN WITH AND WITHOUT LEARNING DISABILITIES

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CHAPTER I

INTRODUCTION

Children with learning disabilities have had many labels attached to them. The most popular labels have been minimally brain-damaged or perceptually handicapped. Despite these different labels, there is a common element in each learning disabled child. All seem to have problems in perceiving, processing, and interpreting information in academic subject areas. With this in mind, the implications for the learning disabled child derived from Piaget's theory of conservation, which involves perception and the processes of logical thought, should be obvious.

According to Piaget, the child's ability to comprehend the principle of conservation as it applies to matter and quantity is a landmark in the development of logical thinking. Prior to this achievement, the child's thoughts tend to be dominated by his perceptions. He may follow two different lines of reasoning to conflicting conclusions and be unaware of the contradiction. Beyond the attainment of conservation, thought becomes more conceptual. The child is less likely to be deceived by the appearance of stimuli. He can deal with more complex relationships, not only taking into account the immediate situation, but

mentally making comparisons and relating them to previous experience (Almy, 1966). If Piaget's theory of conservation is viable for the learning disabled child, that is, if it may be shown that this type of child is actually in a pre-logical stage of thinking, then several issues relating to the field of learning disabilities may be seen.

Currently, research in learning disabilities is primarily concentrated on perceptual difficulties and on the training and strengthening of perceptual problem areas. The success of these perceptual training programs is generally measured by either improvement on the same tasks originally used to test the children, or by administering achievement tests over a period of time to see if improvement in perceptual areas has carried over to improvement in the classroom. The results from these programs are equivocal, and it seems that what may be needed is a new approach to measuring the effect of learning disability programs.

Is it possible that Piaget's conservation tasks may be an adequate measure of the effectiveness of perceptual training and, or, learning disability programs? Perhaps conservation training may be an essential step in the instructional programs for the learning disabled. If this were so, then how would different conservation training procedures affect the learning disabled? To answer such questions, background studies on the learning disabled and conservation abilities are needed. A review of such literature reveals that nothing has been done in this area. The

present study deals with the relationship of learning disabilities to conservation abilities by comparing a learning disabled group with a non-learning disabled group on two tasks involving conservation of continuous quantity and of substance. In addition, descriptive information concerning the stimulus dimensions attended to and their relation to the level of conservation among these children will be examined.

Statement of the Problem

Many studies have replicated Piaget's findings and have confirmed the existence of the non-conservation phenomena. Such replications are a needed step in the verification of Piaget's findings. These studies primarily deal with normal populations and, or, mental defectives. They correlate intellectual ability, readiness, achievement, and reading with conservation, and deal with the effects of training in conservation using perceptual illusion and conflict (Almy, 1966). However, no studies deal directly with children diagnosed as having learning disabilities. The problem of inadequate knowledge of learning disabilities as related to conservation abilities is the basis of the present study.

Purpose

The purpose of this study is to compare a group of second-grade children who have been diagnosed as having

learning disabilities with a matched group of non-learning disabled children on two conservation tasks including conservation of continuous quantity and conservation of substance. The relationship of learning disabilities to conservation abilities is examined by providing statistical and descriptive information concerning the performance of these two groups of children on the above-mentioned conservation tasks. This information may serve as a base for further studies concerning conservation abilities of the learning disabled and the effect of conservation training on the learning disabled.

Basic to this study are these questions: 1) Do learning disabled children display abilities to conserve which are similar to those displayed by children without such disabilities in conservation of continuous quantity and conservation of substance? 2) Do learning disabled children attend to similar stimulus dimensions as do children without such disabilities in conservation of substance and continuous quantity? 3) Is there a relationship between the stimulus dimension that is most salient for the child and his level of conservation?

Clarification of Terminology

Learning Disabled

To assure that the learning disabled are not confused with slow learners or mentally retarded, an IQ cut-off of 90 or above is used. The operational definition utilized

in this study is as follows: The learning disabled are defined as those children with IQ's of 90 or above on the Wechsler Intelligence Scale for Children who exhibit below-grade placement achievement in school. This low achievement is considered a performance on the Metropolitan Achievement Test of at least four months below grade level in one of the major academic areas of reading, spelling, and arithmetic and achievement in all other areas that is at least one to three months below grade equivalence.

Non-Learning Disabled

In relation to the above definition of the learning disabled and achievement, the non-learning disabled group is defined as those children with IQ's of 90 or above who show average or above achievement on the Metropolitan Achievement Test. This average or above achievement ranges from (but does not include) minus four months of grade equivalence to no maximum limit.

Conservation

The definition of conservation utilized here is based on Piaget's definition (Ginsburg and Opper, 1969): Conservation is the idea that quantity and substance do not change when they are transformed in shape or appearance.

Stimulus Dimension

Stimulus dimensions are those characteristics that

children attend to when objects are exposed in their visual field. As an example, in conservation of continuous quantity, these dimensions may be height of water in a glass, the width of a column of water, or the quantity or amount in a glass, regardless of height or width. For conservation of substance, the dimensions may be size or shape of a piece of clay or the substance or amount regardless of size or shape.

Level of Conservation

The levels of conservation prescribed to in this study are based on Piaget's research (Ginsburg and Opper, 1969) and on a modification of this research into a scoring criteria reported by Achenbach (1969). These levels are thus outlined: 1) Non-conservation is defined by the child's inability to recognize that amounts have not changed even though they may appear different. His judgement is tied to only one dimension, such as height or shape. 2) The transitional child vacillates in his response to the conservation problems, responding to different stimulus dimensions at different times. In addition, his explanation may be borderline; that is, it is based on perceptual judgements and an incomplete or partially logical explanation. 3) The conserving child will give at least one rational reason when asked why the amounts do not change after the change in appearance. One such response is that if the liquid or mass were returned to its original con-

tainer or shape, then the two original containers or masses would be of equal amount. This is the negation argument. A second reason is the identity argument: The child reasons that the amount is the same; nothing has been added or taken away. A third argument, involving compensation, involves the recognition that a decrease in one dimension results in an increase in another dimension (Ginsburg and Opper, 1969).

CHAPTER II

REVIEW OF SELECTED LITERATURE

Introduction

Piaget's theories on the development of logical thinking, and particularly the central concept of conservation, continue to be the focus of vigorous explorations and discussions. However, within this realm of exploration, the field of learning disabilities is overlooked. This gap in research necessitates a review of literature containing some, but not all, of the variables found in this study. That is, in each study reviewed, the intelligence level, the age, or the grade of the subjects may not have been the same as the present study, but each study does deal with either conservation of continuous quantity or conservation of substance.

This chapter is divided into three sections. These sections provide a framework for Chapters III, IV, and V. The first section includes a brief review of Piaget's conservation theory, replications of Piaget's experiments, and controversial issues that are relevant to conservation of continuous quantity and conservation of substance. The second section includes research that concerns attention to stimulus dimensions as related to conservation abilities.

The third section is a summary of the research and its implications for the present study.

Piaget's Theory of Conservation, Replications, and Research

In Piaget's theory of cognitive development, the concept of conservation, which may be defined as the ability to recognize invariant properties of an object despite physical transformation, marks the transition from preoperational to logical thought. Piaget feels that from four to seven years of age, the child's thinking depends upon his perception. During this period, the child centers on one dimension or element of a situation, ignoring all others; but from seven to eight years of age, he is able to break away from the influence of perception and is increasingly able to apply logical thought to practical problems and situations (Lovell and Ogilvie, 1960). Piaget believes that the acquisition of conservation proceeds through an unvarying developmental sequence, through which each child must pass. For example, the conservation of quantity, substance, weight, and volume are all similar and follow a similar course of development. These types of conservation involve a first phase in which the child must recognize that two amounts are equal. A second phase involves a visible transformation which may be done by either the child or the experimenter. The child must once again judge whether the amount in question is still the same.

These types of conservation involve a sequence of development in which the children begin by failing to conserve, and require a period of development before they are able to succeed at the task. Piaget has postulated approximate age norms for this sequence of development. For example, in the case of continuous quantity, in the first phase (two identical glasses, each filled with an equal amount of liquid), the youngest child, around four or five years of age, will correctly conclude that the amounts of liquid are equal. However, if a transformation is performed by pouring the liquid into a differently shaped beaker, the child will maintain that the amounts are not equal. When asked to explain his answer, he says that the glass with the taller column of liquid has the greater amount. His judgement of amount is centered exclusively on the heights of columns of liquid. In the second phase, the child of five or six years varies in his response to conservation, sometimes concentrating on height of the columns of liquid, and sometimes on the width of the column of liquid. During the third phase, at six or seven years of age, the child is capable of conservation. He may attend to several dimensions and to the transformation, and be able to logically explain why the amounts are still the same. In the case of conservation of substance, a progression similar to that of quantity appears.

While all conservations follow a similar course of development, Piaget claims that there is no transfer be-

tween tasks. For example, the child may master conservation of quantity and substance at about six or seven years of age, but does not conserve weight until nine or ten, and will not understand volume until eleven or twelve. There is a lack of generalization from one substantive area to another. To Piaget, this illustrates how concrete the thinking of a child aged seven to eleven is. This child's reasoning is tied to particular situations and objects; his mental operations in one area are not transferred to another, no matter how useful it might be (Ginsburg and Opper, 1969). A number of studies have replicated Piaget's findings regarding this invariant developmental sequence and have tended to confirm his findings (Hooper and Sigel, 1969), but they have not confirmed his ages for the acquisition of conservation. Indeed, more recent studies by Piaget himself have pointed up to the flexibility of these age norms.

However, within this general framework of conservation, there are several issues that need further analysis, which are directly related to the procedures involved in conservation of quantity and of substance. The first concerns a controversy over what is actually being measured in the standard conservation task. In a study reported in Sigel and Hooper (1969), Elkind (1967) expresses a belief that although Piaget's analysis of conservation rests on identity conservation, his assessment format is exclusively equivalence. Elkind views identity conservation as the

realization that a single stimulus transformation does not alter the fundamental property of quantity. This may be illustrated in the following manner. The subject agrees A=B, then B is transformed into C; thus B=C. In equivalence conservation, the subject must realize that the quantity does not vary although one of the factors involved in the transformation has changed; thus, he must recognize that A=B, then B is transformed into C; thus A=C (Hooper, 1969). The above equivalence task is utilized by Piaget to measure both identity and equivalence conservation, based on the assumption that these two types of conservation develop simultaneously. Elkind disagrees with Piaget on this assumption and concludes that identity conservation precedes equivalence conservation and is a necessary, but not a sufficient, condition for the attainment of equivalence conservation. Studies investigating Elkind's conceptual distinction vary in their findings. Hooper (1969) concludes that identity conservation precedes equivalence conservation, and that this makes the use of Piaget's standard conservation task questionable. Papalia and Hooper (1971) also cite evidence as to the developmental priority of identity conservation. However, Papalia and Hooper (1971) note several studies which fail to find this priority in first-grade, second-grade, and third-grade children. They conclude that the developmental priority of identity to equivalence conservation is found only in the younger age levels and not in older first, second, and

third-grade children. This finding is significant to the present study because the convergence of identity and equivalence conservation appears to be supported in the case of second-grade children, who are the subjects of this study; thus, Piaget's standard conservation tasks appear to be valid for the second-grade age level.

Another issue in question is the controversy over the use of chronological age in Piaget's studies. The use of chronological age in Piaget's studies is justified by the assumption that it equates subjects for background experience and knowledge and for physical and mental development. According to Sigel and Hooper (1969), studies have shown that there are different behaviors attributed to different chronological ages, which seems to attest to the value of chronological age as a control variable. However, the fact that some younger children are able to perform comparably to older children points out the need of a more valid method of equating experience and maturity. With this in mind, recent studies have looked at the relation between chronological age, mental age, and intelligence quotient, as it pertains to conservation performance.

Achenbach (1969) examined mental age and chronological age in normals and retardates and concluded that chronological age is meaningless without reference to mental age. He found that the mental age levels at which a majority of subjects made conservation responses corresponded more closely to Piaget's chronological age norms. However,

Brown (1973) has raised serious methodological objections to Achenbach's study. The issue lies in the concept of the mental age score itself. Heal (1970) and Weir (1967), as reported in Brown (1973), say that the mental age can be seen as a measure of level and rate of development. Thus, retarded children would be expected to perform well on tasks reflecting experiential factors, but poorly on speed of learning tasks. Consequently, it seems that the performance of mental age-matched groups on conservation tasks would reflect the degree to which mental age and the conservation task measure experiential factors. On the basis of this, Brown feels that a minimally acceptable method for comparing normal and retarded children is to match the retarded group with a normal chronological age group and mental age group comparison as Denny (1964) did. Brown used this method in comparing normal, bright and retarded children and found that retarded children performed like normal subjects of the same mental age but less well than their normal chronological age peers on continuous quantity and number, while bright children did not perform as efficiently as their normal mental age peers, but more like their normal chronological age peers. Brown concluded that experiential and intellectual factors are involved in both the mental age score itself and conservation performance. From these results, it may be seen that both the mental age and chronological age scores are valuable only insofar as they measure experience in the group being measured.

Brown's study reveals that the mental age score may be fine for the retarded, but the chronological age score is adequate for the non-retarded.

This study will use chronological age as a control variable assuming that it is a viable measure for the groups in question and that the mental age score has not really added much to the methodology of Piaget's experiments. In addition, it is felt that because Piaget's was a clinical methodology, and chronological age was adequate for him, then an experiment based on Piaget's theory and procedures should also be concerned with chronological age.

Research on Stimulus Dimensions which Receive Attention on Conservation Tasks

According to Piaget, the non-conserving child of four to five years centers on the dimension of height for judging amount, and he is unlikely to pay attention to the actual transformation or other dimensions involved. In order for the non-conserving child to acquire conservation abilities, it is necessary for him to de-center; that is, he must be able to attend to the transformation itself as well as the dimensions involved (Ginsburg and Opper, 1969).

Several studies deal with dimensional preferences and have found that children are more likely to master the concepts that are related to the dimensions that they find most salient. Using this as a basis, Gelman (1969a) exam-

ined the relationship of stimulus dimension preference to conservation performance. He hypothesizes that non-conservers, as measured on standard conservation tasks, differ in their attention to stimulus dimensions from conservers. Gelman uses a three dimensional preference task and measures attention to height, width, and quantity independently of a conservation of liquid quantity task. His subjects are kindergarten non-conservers and conservers. Gelman concludes that kindergarten non-conservers fail the conservation task because they attend to dimensions that are prominent but irrelevant to conservation. In contrast, kindergarten conservers attend to dimensions related to conservation, such as quantity, and ignore the irrelevant dimensions (Miller, 1973).

A study by Miller (1973) examines Gelman's hypothesis and suggests that both kindergarten conservers and non-conservers attend to a dimension (usually height) that is irrelevant for conservation. However, third-grade conservers attended to the relevant dimension of quantity which suggests that for this age level, quantity has become an important dimension. In short, a kindergarten child's attention to a stimulus dimension does not predict whether he will be a non-conserver or a conserver, while for third-grade conservers, the opposite may be true.

Miller also attempts to answer the question of why non-conservers attend to height rather than width. She suggests that height may either be the outstanding

perceptual feature or that a cognitive belief may underlie this. For example, height may be more prominent because as water is poured into a container, its width is immediately covered while the height gradually increases until the container is full. This vertical movement of the water may be quite compelling; thus, one way of helping a child to de-center from height may be to conceal the container behind a screen during the transformation. If the non-conserver is reflecting a cognitive belief, then he may view height as indicating amount; thus, he interprets conservation in terms of prominence and quantity as he understands it -- as liquid height.

The previous studies have found equivocal results as far as attention to relevant and irrelevant stimulus dimensions and their relation to conservation in kindergarten children. Miller explains these differences by modifying Gelman's original hypothesis. She says that when a child first begins to develop conservation in the form of a concept of quantity, he can demonstrate it only when trained to ignore irrelevant dimensions. Otherwise, he attends to the most prominent dimension such as height. However, at the kindergarten age, unless this training is very strong and direct, then the child will still pay attention to only the prominent dimension.

The increased relevance of the dimension of quantity seen by third-graders is explained by Miller in terms of their ability to switch attention to several dimensions

including quantity, which seems to reflect a developmental trend toward the facility of switching attention from dimension to dimension.

These findings are important to the present study in terms of background and in the development of hypotheses. If conservers and non-conservers attend to different stimulus dimensions as Gelman (1969a) says, or to similar stimulus dimensions as Miller (1973) says, then one or the other will hold true for second-grade children who are learning disabled or non-learning disabled. Furthermore, if there is a developmental trend in ability to switch from one dimension to another, then such a trend will be evident in second-grade students who are learning disabled and in those who are non-learning disabled.

Summary

A brief review of Piaget's theory of conservation has been given. More extensive treatments of this topic may be found in Hooper and Sigel (1968), Ginsburg and Opper (1969), and Almy (1966). Piaget's studies have been replicated many times and in a large number of studies, the findings remain equivocal. However, several issues may be related directly to the present study. Studies at odds with the standard conservation task and what it measures have generally concluded that Piaget's tasks measure two separate conservations: identity and equivalence. However, all such studies agree that this developmental sequence is not found

in children in the first and second-grade level. This finding supports the use of the standard Piagetian quantity and substance task for second-grade students.

Studies examining the relationship of chronological age and mental age to conservation performance have found that the mental age actually adds little to Piaget's methodology. It seems that the utility of both chronological age and mental age depends on how adequate a measure of experience they may be. With regard to the efficacy of both measures, the findings are equivocal. Thus, it appears that it may be up to the researcher as to which he wants to use: chronological age, mental age, or both together. Because Piaget's was a clinical methodology, these problems were of no concern to him, and chronological age was adequate. Consequently, a replication of Piaget's tasks would probably more appropriately use chronological age to represent the child's level of conservation. In addition, it should be noted that our public schools rely on the use of chronological age for placement which would again suggest the appropriateness of chronological age as a control variable.

The research dealing with perceptual salience is also equivocal as to relevant and irrelevant stimulus dimensions and conservation. With this in mind, the present study investigates this area in terms of perceptual salience, its relation to the conservation level of the child and will look for any apparent developmental trends dealing with increased facility for dealing with different stimulus dimensions.

CHAPTER III

DESIGN

Introduction

This chapter presents hypotheses and research questions developed from Chapters I and II, a description of the sample, methodology, including materials and procedures, scoring and classification of data, and the procedures for analyzing the data. Research limitations are stated so as to define the boundaries of this study.

Hypotheses

Hypothesis I. There is no significant difference in performance between the learning disabled children and the non-learning disabled children on tasks of conservation of continuous quantity.

Hypothesis II. There is no significant difference in performance between the learning disabled children and the non-learning disabled children on tasks of conservation of substance.

Research Questions

Research Question I. Do learning disabled children display abilities to conserve which are similar to those

displayed by children without learning disabilities on tasks of conservation of continuous quantity?

Research Question II. Do learning disabled children attend to similar stimulus dimensions as do children without learning disabilities on tasks of conservation of continuous quantity?

Research Question III. Is there a relationship between the stimulus dimension that is most salient for the learning disabled child and the stimulus dimension that is most salient for the non-learning disabled child and the children's level of conservation of tasks of continuous quantity?

Research Question IV. Is there an observable developmental trend for the learning disabled children which is similar to the observable developmental trend for the non-learning disabled children, involving the ability to use different stimulus dimensions in a conservation of quantity task?

Research Question V. Do learning disabled children display abilities to conserve which are similar to those displayed by children without learning disabilities on tasks of conservation of substance?

Research Question VI. Do learning disabled children attend to similar stimulus dimensions as do children without learning disabilities on tasks of conservation of substance?

Research Question VII. Is there a relationship between

the stimulus dimension that is most salient for the learning disabled child and the stimulus dimension that is most salient for the non-learning disabled child and the children's level of conservation on tasks of substance?

Research Question VIII. Is there an observable developmental trend for the learning disabled children which is similar to the observable developmental trend for the non-learning disabled children, involving the ability to use different stimulus dimensions in a conservation of substance task?

Description of Sample

The subjects are twenty-six second-grade students (twenty-two boys and four girls) from six elementary schools in a predominantly rural community. The total enrollment of the six elementary schools is 1400 with a total second-grade enrollment of 193. Because of the small number of students who met the learning disabled criteria, it is necessary to utilize all who were available and could be matched with a non-learning disabled student.

The original plan of the study was to include an even number of males and females in the experiment. However, it was necessary to drop from the experiment four females who met the learning disabled criteria because of difficulties in matching age and intelligence quotient levels with the non-learning disabled group. In addition, there were no other females available that would fit the learning dis-

abilities criteria. Consequently, additional male subjects are utilized to bring the total number of subjects to twenty-six.

Methodology

The subjects are divided into two groups of 13 each on the basis of a classification of learning disabled and non-learning disabled. The learning disabled group meet the operational definition discussed in Chapter I. To meet the achievement criteria, scores on the Metropolitan Achievement Test, 1970 edition, form F, are utilized. The standard error of measure of grade equivalence on the Metropolitan is three-tenths of a year. Thus, students who are four or more months behind grade equivalence are considered low achievers. The learning disabled group surpasses the level of four months set in the operational definition, as all performed at least six months below grade equivalence in one of the major academic areas of reading, spelling, or arithmetic. To meet the IQ criteria, the learning disabled group must have obtained a full-scale IQ of 90 or above on the Wechsler Intelligence Scale for Children (WISC).

As shown by Table I, the two groups are matched as closely as possible regarding IQ, sex, age at the time the WISC was given, and chronological age on April 15, 1974. (The experiment was conducted between April 8 and April 22, 1974).

TABLE I

MATCHED VARIABLES

Variable	Learning Disabled (N=13)	Non-Learning Disabled (N=13)
Sex		
Male	11	11
Female	2	2
CA		
Mean	7.9	7.10
Range	7.6-9.2	7.6-9.1
WISC Test Age		
Mean	7.1	6.9
Range	6.4-8.1	6.4-7.8
IQ		
Mean	100.5	101.4
Range	90-112	90-112
Achievement		
Grade Placement	2.7	2.7
Average Achievement on Metropolitan	1.85	2.85

Materials

Table II describes the cylindrical glass beakers used in the conservation of continuous quantity task. Four ounces of water, tinted blue by one drop of food coloring, is poured into each of beakers A and B, which are of equal size, to begin the task. For the conservation of substance task, eight ounces of modeling clay are used and divided into two balls of four ounces each.

TABLE II

MEASUREMENT OF GLASS BEAKERS

Beakers	Diameter	Height	Volume
A & B	3 1/8 in.	3 7/8 in.	10 1/2 oz.
C	4 3/4 in.	3 1/8 in.	27 oz.
D	2 3/4 in.	5 7/8 in.	13 1/2 oz.
Set E	2 3/4 in.	3 3/8 in.	6 oz.

Procedure

Each child is given the quantity task first and then the substance task in an individual session with the examiner. This fixed order of presentation is used while assuming, as Piaget does, that the differences are developmentally determined and that practice effects are minimal over a brief time span (Elkind, 1961). Each session lasts approximately ten minutes and takes place in a small room at their school.

Conservation Tasks

After a brief conversation to establish rapport, the conservation tasks are introduced. Each conservation task begins with an equivalence task and ends with the question, "Why do you think so?"

Conservation of continuous quantity may be detected by

this situation. The child is presented with two identical beakers (A and B), each filled with equal amounts of liquid, and is asked whether the two glasses have the same amount or not the same amount to drink. After he agrees to the equivalence of quantities, the liquid is poured by the experimenter from beaker B into a third, dissimilarly shaped beaker C. The column of liquid in the third glass (and the glass itself) is both shorter and wider than that in the remaining original glass. The child is now asked whether the two beakers (B and C) have equal amounts. If he asserts that they do, he is asked to explain why. The liquid in C is then returned to the original beaker, and the child is again asked if A and B have identical amounts. The above manipulation is repeated, this time with a glass (D) which is taller and thinner than the original beakers. Finally, the liquid of B is poured into a set (E) of three smaller glasses, and the same questions are asked with the addition of gestures or any further explanation that is necessary to be sure the Ss understand that they should compare the amount contained in the set (E) with that in glass A.

In the case of conservation of substance, the child is presented with two identical balls of clay. He is first asked whether there is the same amount of clay in both balls. If he does not think so, he is asked to add or take away some clay to make them identical. Then, the experimenter changes one of the balls to a pancake shape while the child watches. The child must now decide whether or not the

ball and the pancake have equal amounts of substance. As in the liquid situation, the ball is changed into a variety of different shapes (pancake, sausage, and a set of three small balls). This procedure is taken from the general experiment described by Ginsburg and Opper (1969).

Scoring and Classification of Data

Scoring

During each session of the experiment, a score sheet containing the previously described procedure was used. An example of this score sheet follows.

Conservation of Continuous Quantity

		Same	Not Same
Equivalence (A & B)	1) Do these two glasses have the same or not the same amount to drink?	____	____
Conservation (A & C)	a) Now do the two glasses have the same amount or not the same amount to drink?	____	____
	b) Why do you think so?		
Equivalence (A & B)	2) Now do these two glasses have the same amount or not the same amount to drink?	____	____
Conservation (A & D)	c) Now do these two glasses have the same amount or not the same amount to drink?	____	____
	d) Why do you think so?		
Equivalence (A & B)	3) Now do these two glasses have the same amount or not the same amount to drink?	____	____

		Same	Not Same
Conservation (A & E)	e) Now do these glasses have the same or not the same amount to drink?	____	____
	f) Why do you think so?		
Conservation of Substance			
Equivalence (A & B)	1) Do these two balls have the same or not the same amount of clay?	____	____
Conservation (A & C)	a) Now do these two balls have the same or not the same amount of clay?	____	____
	b) Why do you think so?		
Equivalence (A & B)	2) Do these two balls have the same or not the same amount of clay?	____	____
Conservation (A & D)	c) Now do these two have the same or not the same amount of clay?	____	____
	d) Why do you think so?		
Equivalence (A & B)	3) Do these two balls have the same or not the same amount of clay?	____	____
Conservation (A & E)	e) Now do these have the same or not the same amount of clay?	____	____
	f) Why do you think so?		

The scoring was then based on the following criteria taken from the general principles laid down by Elkind (1961), Goldsmid (1969), and Smedslund (1964) and reported by Achenbach in 1969.

Non-Conserving Responses

Points

(0) Not same. (Subject says they are not equal.)

(1) Same. (Subject says they are the same, but with inadequate or no explanation.)

(Magical, tautological, no explanation; for example, "I dreamed it. That's the way it is.")

Transitional Responses

Points

(2) Same (Subject says they are the same, but with borderline explanation.) (Perceptual explanation: for example, "It looks like it will." "It looks the same." "It's long enough.")

Conserving Responses

Points

(3) Same. (Subject says they are the same with logical explanation, but not much inference as to what the child meant. Doubtful or borderline cases are transitional. For example, "Because it fits there." "...both the same...", and "...that's bigger...")

(a) Correct reference to the object having fit before. For example, "It fit before. I tried it."
(b) Correct reference to the preservation of the object's identity. For example, "It's the same. It hasn't changed."
(c) Correct reference to the reason for the perceptual change. For example, "It just looks different."

Classification of Data

The child is classified as to his level of conservation in the following way. Points are awarded for the child's explanation after each of the three transformations involved in each of the conservation tasks. The level of the child's conservation abilities is then based on the total number of points awarded for the three explanations in each task.

For example, if a child is awarded a total score ranging from zero to two points for all three explanations, he

is classified as a non-conserver. Thus, the least number of points corresponds with the most illogical answer, that is, the inability to recognize the equivalence of amounts; while the most number of points a non-conserver could receive and still be labelled a non-conserver is associated with one two-point borderline logical explanation out of the three possible answers.

A total score of three to six points for all three explanations causes the child to be put in the transitional level of conservation. His answers on the transformations may recognize that the amounts are the same, but he is unable to logically explain why. For example, the least number of points he could obtain and still be labelled transitional is three points which could be arrived at in two ways: First, through the recognition of the equivalence of amounts alone with no explanation or an inadequate explanation on all three transformations; or secondly, he could have one inadequate one-point explanation and one two-point borderline logical explanation out of the three possible explanations. The most points he could obtain and be classified as transitional is six points. This may be arrived at in two ways: First, the child may explain all three transformations with a two-point borderline logical explanation; or he may utilize two three-point logical explanations out of the three possible explanations.

To be labelled a conserver, the child has to recognize that despite each transformation, the amounts are still the

same; and he has to be able to logically explain why on at least one of the three required explanations. For example, the least number of points he could obtain and still conserve is seven points, which could be arrived at in two ways: two three-point logical explanations and at least a one-point recognition that the amounts are the same on the other of the three explanations, or one logical explanation and two two-point borderline explanations.

As can be seen, the level of conservation of each child depends on the ability of the child to recognize that the amounts in each conservation task do not change, despite the transformation, and on his ability to logically explain why they do not change.

Data Analysis Procedures

The data analysis procedures are designed to provide comparative and descriptive information concerning the two hypotheses and the eight research questions stated at the beginning of this chapter. Each of the hypotheses and research questions are closely interrelated and information in one will help to clarify or add to the other. The two hypotheses are statements of no significant difference between the learning disabled and non-learning disabled with regard to their performance on conservation of continuous quantity and conservation of substance.

The procedures for analyzing both hypotheses are the same. The child's conservation classification is based on

the total number of points awarded, using the scoring criteria, for the three explanations in each of the tasks. Following this, the total scores again are used, but this time in a pooled variance formula *t*-test to measure the significance or non-significance of the results.

The next step in analyzing the data concerns Research Questions I and V for conservation of continuous quantity and conservation of substance, respectively. These questions concern any observable differences in ability of learning disabled and non-learning disabled children to conserve on the continuous quantity and substance tasks. This is designed to provide a non-statistical comparison of the two groups. The procedure involves a comparison of the number of children in each conservation classification. This is done by adding the number of children in each level of conservation and dividing this number by the total number in each of the two groups to get a percentage. The percentage and number in each level of conservation is paired and an analysis by inspection is made. The second and sixth research questions dealing with the continuous quantity and substance tasks involve any observable differences between the learning disabled and non-learning disabled children with regard to the stimulus dimensions they attend to. The procedure for analyzing the data is the same for both tasks.

The stimulus dimension information is compiled by noting the dimensions as they are referred to by the child in his explanations. After the experiment was completed,

on all children in each group, the different dimensions attended to are listed and the number of responses in each dimension are added together to get a total. The percentage, that this total equals, of the total number of responses possible in each dimension is found by dividing the number of responses possible into the total number in each dimension. The number in each dimension and the percentage are then paired and ranked from most salient to least salient for each group. Results obtained for both groups are then compared through an analysis by inspection. It should be mentioned that there is no attempt to limit in any way or suggest what stimulus dimension the child should attend to; rather, the purpose of this analysis is to see just what the children would attend to and then discuss it in terms of salience for both groups.

Because each individual child could have attended to as many as three different stimulus dimensions on both of the conservation tasks, the number of possible responses depended on how many different dimensions each child attended to in the task. If for example, on the first quantity-task transformation the child attended to height, and on the second quantity-task transformation he attended to width, and on the third quantity-task transformation he attended to height and width together, he would have used three different dimensions. Then if each of the thirteen children in the learning disabled group should do the same, there would be thirteen responses to each dimension. Exactly what

these children did in this respect cannot be found without analyzing the data. Due to this, the number of responses in each dimension will be discussed in the analysis of data chapter.

The third and seventh research questions for the continuous quantity and substance tasks concern any observable relationship between what a child attends to and his conservation abilities. In order to make this comparison, the salient stimulus dimension for the child is found in each conservation task by looking at the child's explanations and choosing the dimension referred to most. This would suggest a problem in determining salience if all dimensions were attended to equally; however, this is not the case as will be discussed in the next chapter. The child's previous conservation classification is then paired with his salient stimulus dimension. The next step is to find the learning disabled children who attend to each stimulus dimension and group them together. The procedure, then, for analyzing the data is to find the total number of children in each stimulus dimension group and compute that sub-group's percentage of the thirteen in the original group. This is done by dividing thirteen into the number in each dimension grouping. The same procedure is used in each group, and the results for each group are paired to facilitate an analysis by inspection.

Research Questions IV and VIII deal with whether or not there are developmental trends evident in the performances

of the learning disabled children and non-learning disabled children on the continuous quantity and substance tasks. To answer these last two research questions, it is necessary to bring the data in the previous review of literature together with the results concerning dimensional salience and its relationship to conservation abilities as discussed in previous research questions. It was noted in Chapter II that Piaget regards the use of a single dimension, such as height, as representing the lower end of the developmental sequence associated with the acquisition of conservation. The ability to use several dimensions is a slightly higher transitional stage in conservation development, and the ability to attend to several dimensions and explain in some logical way the transformation of these dimensions results in conservation. Gelman (1969a), in a dimensional preference study on kindergarten children, agrees with Piaget's sequence and concludes that height is irrelevant to conservation abilities in a quantity task, while if the child has an adequate concept of quantity, he will attend to it and conserve. Miller (1973) raises some questions about Gelman's study and concludes that at the kindergarten age, both conservers and non-conservers will attend to the irrelevant but salient dimension of height, while third-grade conservers attend to the relevant dimension of quantity. This data suggests a developmental trend for conservers involving an increased facility to utilize the dimension of quantity.

With this information in mind, the procedure for analyzing the data on this last research question is to rank the stimulus dimensions and conservation classifications of each group in a hierarchy starting with the lowest end of Piaget's developmental sequence and proceding through the transitional stage to the conservation stage. An additional step for this particualr question involved finding ages or age ranges for the children previously grouped in terms of stimulus dimensions attended to. The purpose of this was to clarify the developmental trend in terms of age and ability. The last step was to pair the results from each group and discuss them based on the use of an analysis by inspection.

It should be emphasized that the analysis by inspection, in each of the hypotheses and eight research questions, included comparison between children within a group and between groups of children.

Limitations of Study

The limitations of the present study will be inherent in the procedures and methodology used in the study. Limitations are as follows: 1) The significance of the findings will be dependent on the reliability of the procedures used in determining conservation abilities in learning disabled and non-learning disabled children and in the reliability of administration procedures. 2) Due to the small group of second-grade learning disabled children available for this study, it was not possible to use randomization in the

selection procedures. Because of this, it may be questionable to generalize the findings of this study to any other group.

CHAPTER IV

ANALYSIS AND DISCUSSION OF DATA

Introduction

The analysis and discussion of data are based on procedures described in Chapter III. The format of this chapter will be to state each of the hypotheses and research questions and then analyze and discuss the data. As mentioned in Chapter III, all of the hypotheses and research questions are interrelated. With this in mind, in order to get a clear picture of the data on each conservation task, the hypothesis and research questions dealing with conservation of continuous quantity will be presented first, and then the hypothesis and research questions that deal with conservation of substance will be presented.

Conservation of Continuous Quantity

Hypothesis I. There is no significant difference in performance between the learning disabled children and the non-learning disabled children on tasks of conservation of continuous quantity.

The difference in total scores between the learning disabled children and non-learning disabled children on the continuous quantity task are examined through the use

of a t-test of significance. Using a one-tailed test at the .05 level of confidence, and a pooled variance t-formula with 24 degrees of freedom, the required t-value is 1.708. The obtained t-score on the conservation of continuous quantity task is 1.5. The results of this t-test are non-significant at the .05 level. This information is summarized in Table III.

TABLE III

STATISTICAL DATA

Variable	df	t-score	significance level
Continuous Quantity	24	1.5	< .05

Although the performance of learning disabled children and the performance of non-learning disabled children are not significantly different statistically, a difference is approached. The most probable explanation for this finding is that there are a few of the learning disabled children who are capable in the continuous quantity task. This is somewhat supported by the observable differences found in the way the learning disabled and non-learning disabled children are classified. These observable differences are

emphasized in the process of answering Research Question I.

Research Question I. Do learning disabled children display abilities to conserve which are similar to those displayed by children without learning disabilities on tasks of conservation of continuous quantity?

To determine each child's level of conservation, the procedures described in Chapter III are used. Each child is classified with respect to his level of conservation by using the total score obtained by him on the three explanations required in the quantity task. The average age of the learning disabled children is 7.9; and of these children, eleven are classified as non-conservers, one as transitional, and one as a conserver. The average age of the non-learning disabled children is 7.10; and of these children, six are classified as non-conservers, five as transitional, and two as conservers. The most important observable difference found in this data is in the learning disabled children and non-learning disabled children who are classified as non-conservers or transitional. The difference is slight between the children who are classified as conservers. This may be easily seen when percentages of the total learning disabled and non-learning disabled children who are in each classification are computed.

The largest difference is in the percentage of non-conservers found in the learning disabled and non-learning disabled children. Eighty-five percent of the learning disabled children are non-conservers, while only 46% of the

non-learning disabled children are non-conservers. The difference in the two groups is nearly as large in the transitional stage, with eight percent of the learning disabled children classified as transitional, as compared to 38% of the non-learning disabled children who are transitional. On the conservation classification, the percentages are closer with eight percent of the learning disabled children conserving, while fifteen percent of the non-learning disabled children conserved. This data is summarized in Table IV.

TABLE IV

NUMBER AND PERCENTAGE OF CHILDREN IN EACH CONSERVATION CLASSIFICATION

	Learning Disabled (Avg. Age 7.9)	Non-Learning Disabled (Avg. Age 7.10)
Non-Conservers	11	6
Percentage	85%	46%
Transitional	1	5
Percentage	8%	38%
Conservers	1	2
Percentage	8%	15%

The fact that the learning disabled and non-learning

disabled children are classified differently with regard to conservation ability suggests that despite the non-significant statistical findings of Hypothesis I, differences in the learning disabled and non-learning disabled might exist within their individual responses. These response differences will be emphasized in Research Question II.

Research Question II. Do learning disabled children attend to similar stimulus dimensions as do children without learning disabilities on tasks of conservation of continuous quantity?

Using the procedures described in Chapter III, it is found that in conservation of continuous quantity, there are seven different dimensions attended to by the learning disabled and non-learning disabled children. These are height; height and width together; quantity; quantity and width together; height and quantity together; and height, width, and quantity together; and no response. In addition, it is found that for each of the learning disabled and non-learning disabled children, only one of these seven dimensions characterizes his answers; that is, one dimension is salient throughout all three required explanations during the quantity task. This would mean, for example, if height is salient for a child, then his three responses would all deal with height. To compare the learning disabled and non-learning disabled children, it is necessary to find the total number of responses possible for each dimension. This is done by multiplying the number of each

group of children, which is thirteen, by three to get a total number of responses, which is 39; thus, there are 39 possible responses for each of the seven stimulus dimensions. The comparison is then made on the basis of total number of responses in each dimension and the percentage of the 39 possible responses for the dimension. When the results as to salience of stimulus dimensions in the continuous quantity task for the learning disabled and non-learning disabled children are ranked from most salient to least salient, the response differences are easily seen. The learning disabled children most often prefer the dimension of height and width together (46%); while the non-learning disabled prefer height, width, and quantity together (31%). None of the learning disabled children attend to the dimension of height, width, and quantity together. The next dimension in terms of salience for the learning disabled children concerns the single dimension of height (31%), while for the non-learning disabled children, the single dimension of height, and the dimension of height and quantity together are attended to equally (23%). The last group of salient dimensions for the learning disabled children involves the dimensions of width and quantity together, the single dimension of quantity, and no response, each being attended to eight percent of the time. For the non-learning disabled child, height and width is the next most salient dimension (15%). The least salient dimension attended to by the non-learning disabled child is quantity (8%). Table V summarizes this information.

TABLE V

STIMULUS DIMENSIONS IN CONTINUOUS QUANTITY

Learning Disabled			Non-Learning Disabled		
Stimulus Dimension	Total No. Responses	%	Stimulus Dimension	Total No. Responses	%
Height & Width	18	46	Height, Width & Quantity	2	31
Height	12	31	Height	9	23
Width & Quantity	3	8	Height & Quantity	9	23
Quantity	3	8	Height & Width	6	15
No Response	3	8	Quantity	3	8
Height & Quantity	0	0	Width & Quantity	0	0
Height, Width & Quantity	0	0	No Response	0	0

The data gathered to answer Research Question II indicates that the learning disabled and non-learning disabled children find different dimensions more salient in the quantity task. The most salient dimension for the learning disabled is height and width together. For the non-learning disabled children the dimension of height, width, and quantity together is most salient. In addition, two other differences in the dimensional responses of the learning disabled children may be seen. In terms of the salience hierarchy from most to least, there is an increased facility of the non-learning disabled children to utilize more dimensions than the learning disabled children. The

extra dimension used by the non-learning disabled children is quantity in relation to height and width. The other difference is in the utilization of the dimension of width and quantity together by the learning disabled children. In contrast, width and quantity is not used at all by the non-learning disabled children. Rather, the non-learning disabled children use height and quantity together, whereas the learning disabled do not use the dimension of height and quantity.

As mentioned in Chapter III, the quantity dimension has been found to be more related to conservation than the other dimensions. Whether or not the dimensions of height, width, and quantity together; height and quantity together; and width and quantity together are also more related to conservation ability will be emphasized in the process of answering Research Question III.

Research Question III. Is there a relationship between the stimulus dimension that is most salient for the learning disabled child and the stimulus dimension that is most salient for the non-learning disabled child and the children's level of conservation on tasks of continuous quantity?

To examine this question, it is necessary to present the data derived from the classification procedure described in Chapter III and to relate this to the findings of the previous research question, which concerns stimulus dimensions attended to by the learning disabled and non-learning disabled children.

The procedure involved is pairing the previously-made classification of the child's level of conservation with the stimulus dimension found to be most salient for him. After this pairing, the learning disabled children and the non-learning disabled children are grouped according to stimulus dimensions, and a percentage is computed for the number of children in each group who are in each of the conservation classifications. This was done in the same way for both groups on the continuous quantity task. The purpose of this procedure was to see what relationship, if any, there is between what the child attends to and his conservation ability.

For the learning disabled children on the task of conservation of continuous quantity, it was found that all (100%) of those who found height the most salient dimension had been previously classified as non-conservers. Of those that attended to height and width together, 83% had been previously classified as non-conservers, while the remaining 17% were previously labelled conservers. For the learning disabled children who attended to the dimension of width and quantity, 100% had been previously labelled as non-conservers. Of those who attended to the dimension of quantity, 100% were previously labelled as transitional. This data is summarized in Table VI.

TABLE VI

PERCENT IN STIMULUS DIMENSION CORRESPONDING WITH PREVIOUS CONSERVATION CLASSIFICATION (LEARNING DISABLED ON QUANTITY TASK)

Stimulus Dimensions	Non-Conserver	Transitional	Conserver
Height	100%	0	0
Height & Width	83%	0	17%
Quantity	0	100%	0
Width & Quantity	100%	0	0

For the non-learning disabled children on the quantity task, 100% of the children attending to height alone were previously classified as non-conservers; those attending to height and width together were also previously classified as 100% non-conservers. Of those attending to quantity only, 100% were conservers. Of the children who were attending to height, width, and quantity, 75% were previously classified as transitional, and 25%, as conservers; and of those oriented to the dimension of height and quantity together, 67% were transitional, and 33% were non-conservers. This information is summarized in Table VII.

TABLE VII

PERCENT IN STIMULUS DIMENSION CORRESPONDING WITH PREVIOUS CONSERVATION CLASSIFICATION (NON-LEARNING DISABLED ON QUANTITY TASK)

Stimulus Dimensions	Non-Conserver	Transitional	Conserver
Height	100%	0	0
Height & Width	100%	0	0
Quantity	0	0	100%
Height, Width & Quantity	0	75%	25%
Height & Quantity	33%	67%	0

An inspection of the data on Research Question III reveals that there is a relationship between what the learning disabled and non-learning disabled children attend to and their conservation abilities. Furthermore, this relationship is different for the learning disabled children than for the non-learning disabled children. The relationship of stimulus dimension to conservation ability for the non-learning disabled children agrees with the study by Gelman (1969a) which indicates that non-conservers attend to irrelevant but salient dimensions, such as height, while conservers attend to the relevant dimension of quantity in the continuous quantity task. In the present study, the dimension most associated with ability to conserve is that of quantity, while single dimensions, such as height alone or

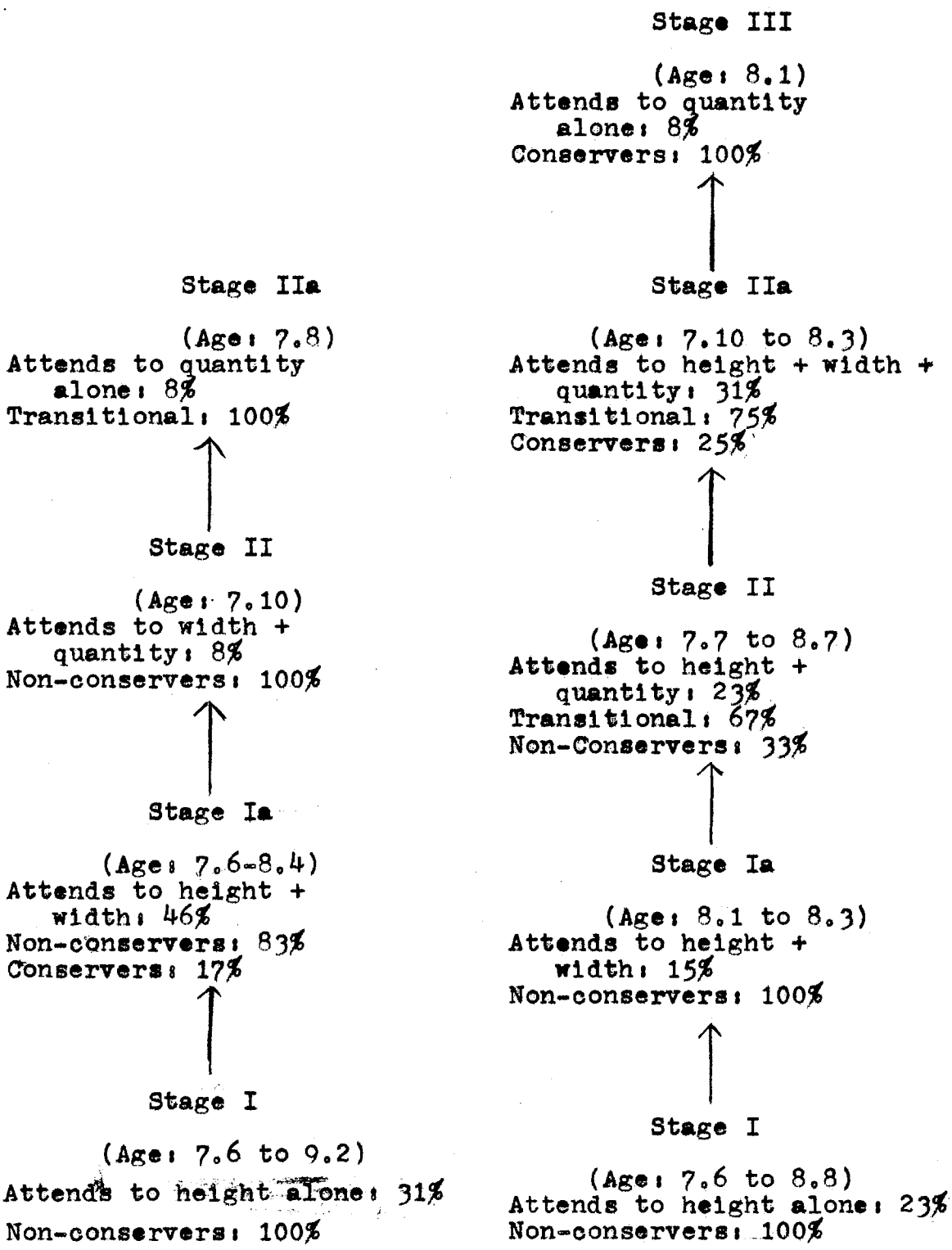
width alone, or the dimension of height and width together, are least associated with conservation ability.

In contrast, the findings with regard to stimulus dimensions and conservation ability for the learning disabled children do not agree with Gelman's study. The learning disabled children who attend to the dimension of quantity do not conserve, but are in the transitional stage, and all other dimensions are irrelevant to conservation. Another finding is that those non-learning disabled children who integrate height and quantity together, or height, width, and quantity together, are classified as transitional. For the non-learning disabled children, the only dimension integrated with quantity is width, and all the children who made such an integration are non-conservers.

Research Question IV. Is there an observable developmental trend for the learning disabled children which is similar to the observable developmental trend for the non-learning disabled children, involving the ability to use different stimulus dimensions in a conservation of quantity task?

As mentioned in Chapter III, this question was designed to bring all of the information gathered in this paper on the quantity task together to see if there are any observable developmental trends. The data on stimulus dimensions reveals a difference between the learning disabled children and the non-learning disabled children concerning salient dimensions. This difference is in the form of a trend for

the non-learning disabled children to prefer other stimulus dimensions together with the quantity dimension. These dimensions are height, or height plus width in relation to quantity. In contrast, the learning disabled attend only to the dimension of width in relation to quantity. A further analysis with regard to stimulus dimension and conservation ability reveals an association between what the child attends to and his conservation ability. This is easily seen if all the findings are put in a conservation hierarchy as described in Chapter III. (See Figure I.)



Learning Disabled Children Non-Learning Disabled Children

Figure 1. Developmental Trend of Two Groups on the Quantity Task

This hierarchy reveals a different approach to the acquisition of conservation between the learning disabled and non-learning disabled children. For example, for the non-learning disabled children, there is an approach to utilizing stimulus dimensions which progresses from one dimension, height, to height plus width, to height plus quantity, to height plus width plus quantity, and then to quantity alone. These dimensions build upon the other in a steady progression upward to conservation. In contrast, the learning disabled children utilize a different progression marked by the use of height alone, width alone, height plus width, width plus quantity and then quantity alone. The difference here between the learning disabled and non-learning disabled children is in the use of width and quantity by the learning disabled as opposed to height and quantity, and height, width, and quantity by the non-learning disabled children. The different progression followed by the learning disabled children also leads to different results. The learning disabled children never reach the conservation level, but attend to quantity and are still classified as transitional. They are fluctuating between the use of single dimensions and two dimensions together, and they have failed to take into account the dimension of quantity in relation to height alone or height plus width.

Other trends are evident in Figure 1, with regard to the stages of conservation acquisition. The stages in Figure 1 reveal that, rather than only three stages in the

development of conservation, characterized by attention to single dimensions, to several dimensions at different times, and then to several dimensions together, there are more; and as shown by the age ranges associated with these dimensions, they all are interrelated and overlap.

Summary

The hypotheses and research questions relating to the ability of the learning disabled children and non-learning disabled children to conserve on a continuous quantity task have been presented, analyzed, and discussed. The findings in this section reveal that although a non-significant statistical difference between the learning disabled children and non-learning disabled children was found, there are observable differences between the learning disabled children and non-learning disabled children as far as their responses in the quantity task. The response differences between the learning disabled children and non-learning disabled children are summarized in Chapter V, and implications from the data for further research are discussed.

Conservation of Substance

Hypothesis II. There is no significant difference in performance between the learning disabled children and the non-learning disabled children on tasks of conservation of substance.

The procedures for analyzing the data are exactly the

same as for the hypothesis and research questions concerning continuous quantity. The t-test for the substance task is significant at the .05 level, with a t more than 1.708. This information is summarized in Table VIII.

TABLE VIII

STATISTICAL DATA

Variable	df	t-score	significance level
Substance	25	2.013	> .05

This finding means that there is a significant statistical difference in performance on the substance task between learning disabled children and non-learning disabled children. The direction of this difference will be emphasized when discussing Research Question V.

Research Question V. Do learning disabled children display abilities to conserve which are similar to those displayed by children without learning disabilities on tasks of conservation of substance?

For the learning disabled group, eleven subjects were classified as non-conservers, while two were transitional, and none conserved. In the non-learning disabled group, six were classified as non-conservers, four as transitional,

and three subjects conserved. This in itself answers Research Question I and reveals that the direction of the statistical difference is that of a better performance by the non-learning disabled children on the substance task than the learning disabled children. This direction is more easily seen by looking at the percentages of children in the total group in each conservation classification. For the learning disabled children, 86% are labelled as non-conservers; while only 46% of the non-learning disabled children are non-conservers. Fifteen percent of the learning disabled children are transitional as compared to a higher 31% of the non-learning disabled children who are transitional. On the conservation classification, none of the learning disabled children conserved, while 23% of the non-learning disabled children conserved. This data is summarized in Table IX.

TABLE IX

NUMBER AND PERCENTAGES OF CHILDREN IN EACH CONSERVATION CLASSIFICATION

	Learning Disabled (Avg. Age 7.9)	Non-Learning Disabled (Avg. Age 7.10)
Non-conservers	11	6
Percentage	85%	46%
Transitional	2	4
Percentage	15%	31%
Conservers	0	3
Percentage	0%	23%

The data from Research Question V has revealed that the direction of statistical difference found in Hypothesis II is toward an increased ability of the non-learning disabled children to conserve. Research Questions VI, VII, and VIII will attempt to clarify this difference by pointing out the qualitative differences in the two groups' responses.

Research Question VI. Do learning disabled children attend to similar stimulus dimensions as do children without learning disabilities on tasks of conservation of substance?

Using the procedures described in Chapter III, it is found that there are five different dimensions attended to by the learning disabled children; these are shape, size, size and shape together, substance and shape together, and substance. As in the continuous quantity task, it is found that one of these dimensions is salient for each child throughout all three required explanations. The procedure for getting the total number of responses possible in each dimension is the same. The next step in analyzing this data is through the use of a comparison, as described in Research Question II for the quantity task. When the results of this comparison for the learning disabled and non-learning disabled children are ranked from most salient to least salient, the qualitative response differences are easily seen.

For the learning disabled children on the substance task, the most salient dimension is size and shape together, with 21 responses, or 59% of the total possible responses.

In contrast, the dimension most salient for the non-learning disabled children is shape, with fifteen responses or 38%. The next most salient dimension for the learning disabled children is shape with nine responses and 23% of the total, while for the non-learning disabled children, the dimension of size and shape with 12 responses and 31% of the total is next. The dimension of size was the third most salient dimension for the learning disabled children, with six responses and 15% of the total. For the non-learning disabled children, substance and shape together was the third most salient dimension with six responses and 15% of the total. The least salient dimension attended to by the learning disabled children is the single dimension of substance with three responses and eight percent. The least salient dimension for the non-learning disabled children is the dimension of size and the single dimension of substance, each attended to in three responses for eight percent of the total.

An analysis of this pattern of responses reveals that the learning disabled and non-learning disabled find different dimensions more salient in the substance task. In this pattern, although the largest percentage of the learning disabled children utilized size and shape, the learning disabled children did not make reference to any other two dimension responses. In contrast, for the non-learning disabled children, a large percentage utilized size and shape and an additional two-dimensional response of substance

and shape. This suggests that the non-learning disabled attend to an extra stimulus dimension which involves substance. This data is summarized in Table X.

TABLE X

STIMULUS DIMENSIONS IN CONSERVATION OF SUBSTANCE

Learning Disabled			Non-Learning Disabled		
Stimulus Dimension	Total No. Responses	%	Stimulus Dimension	Total No. Responses	%
Size & Shape	21	59%	Shape	15	38%
Shape	9	23%	Size & Shape	12	31%
Size	6	15%	Substance & Shape	6	15%
Substance	3	8%	Size	3	8%
Substance & Shape	0	0%	Substance	3	8%

Research Question VII. Is there a relationship between the stimulus dimension that is most salient for the learning disabled child and the stimulus dimension that is most salient for the non-learning disabled child and the children's level of conservation on tasks of substance?

To examine this question, the same procedures explained in Chapter III and utilized on Research Question III of the quantity task are used. For the learning disabled children, it was found that of those attending to the dimension of

shape alone, 67% were previously classified as non-conservers, and 33% were transitional. Those learning disabled children attending to size and shape together were 100% non-conservers as were those who attended to size alone. Of the learning disabled children who were oriented to substance alone, 100% were transitional. This data is summarized in Table XI.

TABLE XI

PERCENT IN STIMULUS DIMENSION CORRESPONDING WITH PREVIOUS CONSERVATION CLASSIFICATION (LEARNING DISABLED ON SUBSTANCE TASK)

Stimulus Dimension	Non-conserver	Transitional	Conserver
Shape	67%	33%	0
Size	100%	0	0
Size & Shape	100%	0	0
Substance	0	100%	0
Substance & Shape	0	0	0

For the non-learning disabled children who attend to shape, 80% were previously classified as non-conservers, and 20% were transitional. Those oriented to size alone were previously classified 100% non-conservers, while those attending to size and shape were 75% transitional and 25%

non-conservers. Children attending to substance alone were 100% conservers, as were those paying attention to substance and shape. This information is summarized in Table XII.

TABLE XII

PERCENT IN STIMULUS DIMENSION CORRESPONDING WITH PREVIOUS CONSERVATION CLASSIFICATION (NON-LEARNING DISABLED ON SUBSTANCE TASK)

Stimulus Dimension	Non-conserver	Transitional	Conserver
Shape	80%	20%	0
Size	100%	0	0
Size & Shape	25%	75%	0
Substance	0	0	100%
Substance & Shape	0	0	100%

The information obtained in answering Research Question VII reveals that there is a relationship between what the child attends to and his conservation abilities in the substance task. This relationship for the non-learning disabled children agrees with the study by Gelman (1969a); that non-conservers attend to irrelevant but salient dimensions while conservers attend to the relevant dimensions. In the present study, the relevant dimension, that is the

one most associated with ability to conserve, is that of substance or amount of matter, while the irrelevant dimensions are the dimensions of size alone and shape alone or size and shape together. In contrast, the relationship of stimulus dimensions to conservation ability in the learning disabled children does not agree with Gelman's study. The learning disabled children attend to the same irrelevant dimensions as the non-learning disabled children. However, when the learning disabled children attend to the dimension of substance, which is relevant to conservation for the non-learning disabled child, the learning disabled child still does not conserve, but is transitional. It should also be noted that although shape, for the most part, was irrelevant to conservation, it appeared to be more relevant than size. When shape is utilized by the non-learning disabled children with substance, the result is conservation. In addition, a few learning disabled and non-learning disabled children who utilized shape alone revealed some ability to conserve.

Research Question VIII. Is there an observable developmental trend for the learning disabled children which is similar to the observable developmental trend for the non-learning disabled children involving the ability to utilize different stimulus dimensions in conservation of substance?

This question is designed to bring all of the information gathered in the previous research questions on conservation of substance together in a conservation hierarchy

based on Piaget's developmental sequence and Gelman's (1969a) and Miller's (1973) studies on stimulus dimension relevance. The purpose is to see if there are any developmental trends associated with this data and to clarify these trends through the use of ages or age ranges.

The data on stimulus dimension salience reveals that learning disabled children and the non-learning disabled children attend to different stimulus dimensions. The most salient dimension for the non-learning disabled children is shape, while for the learning disabled children it is size and shape together. However, size and shape together is the only two-dimensional response attended to by the learning disabled children; whereas, the non-learning disabled children also attend to substance and shape. The information pertaining to dimensional relevance reveals an increased facility of the non-learning disabled children to attend to the relevant dimension of substance and conserve. For the learning disabled children, attention to substance results in transitional performance.

The lack of conservation by the learning disabled children when attending to substance suggests that they are progressing in a different way toward acquisition of conservation than the non-learning disabled children. This trend is easily seen in Figure 2.

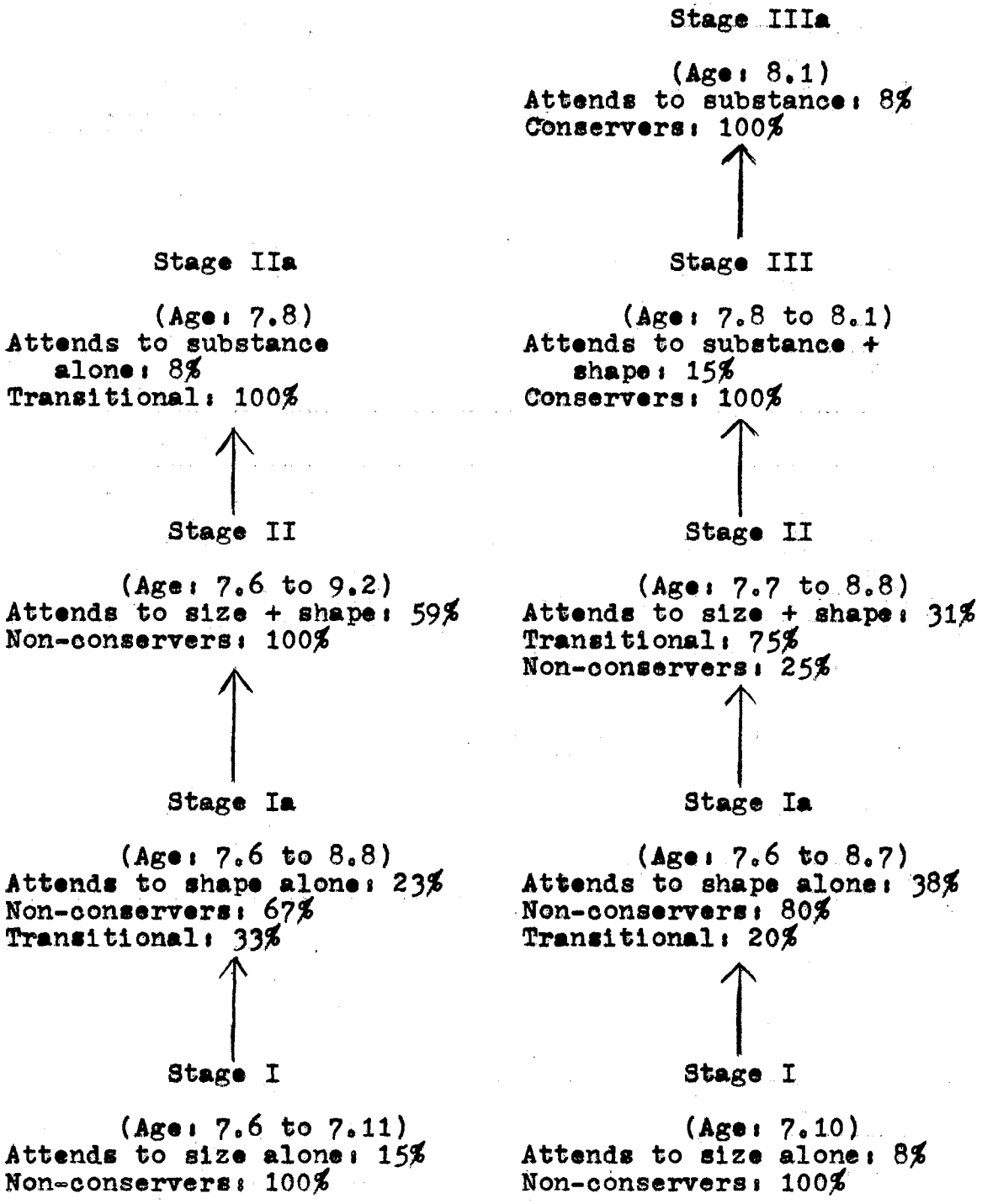


Figure 2. Developmental Trend of Two Groups on the Substance Task

The trend evident in Figure 2 reveals that for the non-learning disabled children, the stimulus dimensions build one upon the other in a steady progression to conservation. The progression begins with the single dimension of size and progresses to shape alone, to size and shape together, and then to substance and shape together and substance alone. The last two dimensions which contain substance are associated with conservation for the non-learning disabled. The learning disabled follow the same progression as far as the dimension of size and shape together. From here, the learning disabled children use substance alone and their performance is transitional. The learning disabled at this point have failed to integrate the dimension of substance with the other stimulus dimensions.

Other developmental trends are evident with regard to the stages of conservation acquisition in Figure 2. This data suggests that rather than the three stages to conservation attainment proposed by Piaget which are characterized by attention to single dimensions, several dimensions at different times, and finally several dimensions together, there are more; and as shown by the age ranges associated with these dimensions, they all are interrelated and overlap.

Summary

Hypotheses and research questions relating to the ability of the learning disabled and non-learning disabled children to conserve on a substance task have been presented,

analyzed, and discussed.

The findings in this data reveal that there is a significant statistical difference in the learning disabled and non-learning disabled children with respect to conservation ability on a conservation of substance task. The direction of this difference is found in an increased ability of the non-learning disabled children to conserve. This is easily seen, as the non-learning disabled children had a higher percentage of conservers and transitional level responses and a lower percentage of non-conservers than did the learning disabled children. The differences in the responses of the learning disabled and non-learning disabled children will be summarized in Chapter V, and implications of the data for further research are discussed.

CHAPTER V

SUMMARY AND IMPLICATIONS

Summary

The purpose of this study is to compare a group of second-grade learning disabled children with a group of second-grade non-learning disabled children on conservation tasks of continuous quantity and substance. The learning disabled and non-learning disabled children are matched with respect to chronological age, sex, IQ, and age at the time the Wechsler Intelligence Scale for Children is administered. The criteria for the definition of learning disabled is a performance of 90 or above on the Wechsler Intelligence Scale for Children and achievement on the Metropolitan Achievement Test, form F, of at least minus one standard error of measurement in one of the major academic areas of reading, spelling, or arithmetic, and slightly below grade placement achievement in all other areas, measured by the Metropolitan. This achievement criteria is surpassed by the learning disabled children in the present study, as these children performed at a level lower than minus one standard error, in at least one of the above listed academic areas.

The subjects were twenty-six second-grade children (twenty-two boys and four girls) from six elementary schools

in a predominantly rural community. Because of the small number of children who met the learning disabled criteria, it was necessary to utilize all children who were available and could be matched with non-learning disabled children. There are thirteen learning disabled children and thirteen non-learning disabled children.

The procedure is to administer the two conservation tasks in a fixed order with the quantity task first, and then the substance task. Each session lasted approximately ten minutes. The conservation classifications are developed from Piaget's conservation studies and from a scoring cirteria reported by Achenbach (1969). The analysis of the data is based on a hypothesis and research questions, for both conservation tasks, which were developed from the review of literature. The procedure for analysis is to state all the hypotheses and research questions dealing with the continuous quantity task and to analyze the data through the use of a t-test and analysis by inspection. The same procedure is then utilized on the conservation of substance task.

The results of the data on the continuous quantity task, reveal that although a non-significant statistical difference between the learning disabled and non-learning disabled children is found, there are observable differences between the two groups of children as far as their responses in the quantity task. The learning disabled children have a higher percentage of non-conservers and lower percentage of transi-

tional and conserving children than do the non-learning disabled children, and each group finds a different dimension most salient. The most salient dimension for the learning disabled children is height and width together; while for the non-learning disabled children, height, width, and quantity together is most salient. There is also an indication of an increased ability of the non-learning disabled children to utilize different dimensions and integrate them with quantity. In addition, it was found that for the non-learning disabled children, the dimension of quantity is most associated with conservation ability, while height or height and width together are least relevant. In contrast, the learning disabled children who attended to quantity still do not conserve, but are transitional, and all other dimensions are associated with non-conservation.

A difference in the developmental sequence of the acquisition of conservation that the learning disabled and non-learning disabled children progress through is also noted. This difference is in the utilization by the learning disabled children of the dimension of width and quantity, as opposed to height and quantity together or height, width, and quantity. The direction of this different trend for the learning disabled children is that they have not reached the stage of conservation development where they can integrate other dimensions with quantity and logically explain the transformation they have witnessed. A further developmental trend is seen in the number of stages involved in Figure 1.

This reveals many more stages in conservation acquisition than the three proposed by Piaget. In addition, the age ranges matched with these stages indicate that all of the stages are interrelated and overlap.

The results of the data on the conservation of substance task reveal a statistically significant difference in the performance of learning disabled and non-learning disabled children. This difference is seen in an increased ability of the non-learning disabled to conserve. In addition, there are observable differences in the responses of the two groups. The learning disabled children attended to fewer stimulus dimensions in their explanations than did the non-learning disabled children, and each group found a different stimulus dimension most salient. The most salient dimension for the learning disabled children is size and shape together; while for the non-learning disabled children, shape is most salient, with size and shape a very close second. This salience data also reveals an increased facility of the non-learning disabled children to attend to more stimulus dimensions. This extra dimension involved substance and shape together.

Another difference is found in the relation of stimulus dimension to conservation ability. It is found that for the non-learning disabled children, substance is the most relevant to conservation, while shape together with substance is also relevant to conservation. The least relevant dimensions are size and shape together and the single dimension of size. In contrast, the learning disabled children who attended to

substance did not conserve but were transitional, and the other dimensions were also found to be irrelevant for conservation. This data suggests a different sequence in conservation development between the learning disabled and non-learning disabled children. The difference in this progression is in the use by the learning disabled children of size and shape together and the failure to integrate shape with substance. In addition, there are developmental trends evident in Figure 2 which indicate that there are more stages in the acquisition of conservation of substance than the three given by Piaget. Furthermore, the age ranges paired with these stages suggest that they are all interrelated and overlap.

Implications

The implications of the data on both conservation tasks are broad. The learning disabled children appear to be developing at a slower rate than the non-learning disabled children with regard to the development of logical thought. If this is the case, studies dealing with accelerating or improving the conservation abilities of learning disabled children may prove valuable. In this respect, a longitudinal study on learning disabled children which involves a pre-test measure of conservation, strengthening of perceptual problem areas, and then training in conservation followed by a post-test of conservation ability would be excellent. This study might include the effects of different conserva-

tion training procedures on learning disabled children and a measure of any transfer to the classroom.

The lack of randomization and the small group involved in the present study suggests the need for more carefully controlled research dealing with learning disabled children. One suggestion for a further study would be to use a learning quotient to define the learning disabled and to concentrate on specific disabilities, such as math. Another suggested study would be to correlate certain subtest scores of the Wechsler Intelligence Scale for Children with the conservation performance scores of learning disabled children.

Of course, replications of the present study are recommended and should be made, but in addition to this, there are several other implications within the research questions which suggest additional studies. On the continuous quantity task, the learning disabled children fail to integrate the dimensions of height, and height and width together, with the quantity dimension. Instead, the learning disabled children appear to attend to width and quantity and are non-conservers. The reason why the learning disabled attend to width and quantity rather than height and quantity as the non-learning disabled do may be because the learning disabled are attending to the dimension which takes up the most space in their visual field. This data suggests that stimulus preference studies dealing with horizontal spatial dimension may be valuable. This also seems to suggest that height is more relevant to conservation than width.

The developmental trend found to be involved in the quantity task, which suggests that the learning disabled and non-learning disabled children may follow a different developmental sequence with regard to conservation acquisition, may indicate that studies concerning Piaget's stages and the conservation ability of learning disabled children would be worthwhile. Another study suggested by the developmental trend data would be to examine the child's approach to problem solving and its relation to performance on conservation.

The data on the conservation of substance task suggests, just as the quantity data, that the learning disabled as compared to the non-learning disabled are not integrating different dimensions with the substance dimension. This problem with the integration of dimensions may be the result of several different but related difficulties. The child may simply have inadequate concepts of the dimensions involved, or he may have the concepts and be confusing them.

This confusion may cause a breakdown in association processes, or the child may have a perceptual problem which is causing him to incorrectly perceive the dimensions. For example, this may be a problem with form constancy. These implications suggest the possibility of several studies. One such study might involve screening the learning disabled child before the conservation tasks to assure that he has the vocabulary and concept formation necessary for the task. Another might utilize only learning disabled children with

or without perceptual constancy problems. If the child is confusing the dimension involved, it may be worthwhile to give the learning disabled child a conservation task as a pre-test, then train or provide experiences in classification and handling of different stimulus dimensions, and then give a post-test with a conservation task.

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