Beaver, Wanda Joy

THE DEVELOPMENT OF THE MENTAL ABILITIES OF YOUNG CHILDREN TO SEPARATE AND CONTROL VARIABLES

The University of Oklahoma Ed.D. 1984

THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

THE DEVELOPMENT OF THE MENTAL ABILITIES OF YOUNG CHILDREN TO SEPARATE AND CONTROL VARIABLES

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the degree of

DOCTOR OF EDUCATION

By

WANDA JOY BEAVER

Norman, Oklahoma

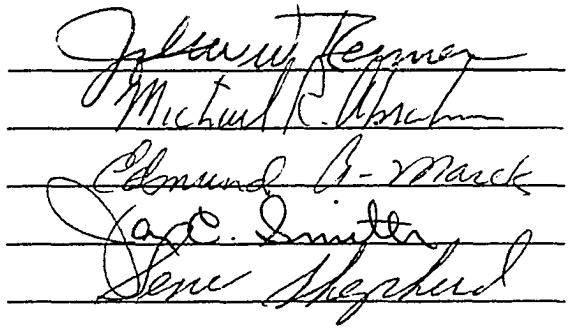
1984

THE DEVELOPMENT OF THE MENTAL ABILITIES OF

YOUNG CHILDREN TO SEPARATE AND

CONTROL VARIABLES

APPROVED BY



DISSERTATION COMMITTEE

ACKNOWLEDGEMENTS

It is with great humility that I express my sincere thanks and deep appreciation to those who have so generously contributed their time and expertise toward this dissertation.

First, I want to thank my major advisor, Dr. John Renner, for introducing me to Piaget and the Inquiry Method of Teaching, and for his continual help and encouragement throughout the research and the writing of this dissertation. Dr. Renner has truly been an inspirational teacher, a mentor, and a friend.

I am also deeply indebted to Dr. Michael Abraham for serving as co-advisor for the research and dissertation and for his time, patience, kindness and assistance in the interpretation of the data.

To Dr. Gene Shepherd, I owe a debt of gratitude for the teaching, support, encouragement, and for the constructive writing suggestions. Thanks also for introducing me to a more scientific way of supervising instruction.

To Dr. Jay Smith, I sincerely appreciate the interest, the continual support, the kindness and the friendship. Thanks also for the teaching and introducing me to instructional

technology and "COIK".

To Dr. Ed Marek, I want to express my appreciation for the kindness, time, encouragement, and timely suggestions.

A very special thanks to Dr. Larry Toothacre and Martha Banz, for so ably assisting in the design of the study, the computerization and interpretation of the research results.

To Dr. Tom Gallaher, many thanks for serving on the prospectus committee for this research.

To Mr. Olen McClain, principal of Rollingwood Elementary School, and the kindergarten and primary teachers, I want to thank you for your courtesty, cooperation, and assistance during the research with the children.

Finally, I must express my everlasting gratitute to my family for all of their help and for "hanging in there" with me. I appreciate their encouragement and their understanding, especially when I could not give them needed time and attention. So a GREAT BIG THANKS to my husband Don, my children Jill, Gina, and Mike, and my Mom and Dad!

[X] ALL OF THE ABOVE. IT WOULD NOT HAVE BEEN POSSIBLE WITHOUT EACH AND EVERYONE OF YOU!

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

THE DEVELOPMENT OF THE MENTAL ABILITIES OF YOUNG CHILDREN TO SEPARATE AND CONTROL VARIABLES

CHAPTER I

INTRODUCTION AND STATEMENT OF THE PROBLEM

This study investigated the mental abilities of young children to separate and control variables. From their research, Inhelder and Piaget (1955), concluded that the separation and control of variables belonged exclusively to the formal operational stage of development. The present research however, involved subjects from five to nine years of age who were in or somewhere between the preoperational and concrete operational stages of development.

Studies by Cowan (1978), and Case (1974), indicated that perhaps the model, regarding when individuals in their thinking began to separate and control variables, needed alteration. In reference to a series of sixteen experiments with subjects from four to eighteen years of age, conducted by Inhelder and Piaget in 1955, Cowan said, "I can find five interrelated achievements which mark the emergence of formal operations"

(Cowan, 1978, p. 249). Linn reported that a relationship was found between the ability to name variables and the ability to control them, and a relationship between field dependency and the ability to name variables (Linn, 1979). Case concluded that seven and eight year old children should be able to achieve the control of variables scheme if they were field independent (Case, 1974). Similar studies were made by Flavell (1971), Grippin, et al., (1973), Case (1975), Levine and Linn (1977), Wollman (1977), Danner and Day (1977), Howe and Mierzwa (1977), Lawson and Wollman (1977), Linn (1978), Stone and Day (1978), Lawson (1979), Linn and Rice (1979), and Tobin and Capie (1980, 1980).

According to the research by Inhelder and Piaget (1955), referred to earlier, the ability to separate and control variables belongs exclusively to the formal operational thinker. Individuals may enter the formal operational stage between 12 to 15 years of age, but for many people it is somewhat later. In a study involving 1,552 students in grades four to twelve, Wollman (1977) noted that for students of above average intelligence, the formal operational stage usually developed by about age 14, and developed somewhat later for less able students. He also reported the probability that there was no single formal concept of controlling variables. Wollman further suggested that all characteristics of the formal operational stage did not develop spontaneously and that the concept of controlling variables was developed gradually during

the concrete stage, but was not fully developed until around 14 years of age (Wollman, 1977). The foregoing research was done primarily with subjects between nine and 18 years of age.

STATEMENT OF THE PROBLEM

In view of the foregoing, the present research addressed itself to the following question: Do the beginnings of the developmental scheme of the abilities to separate and control variables appear in children between the ages of five and nine? If a scheme is present that allows young children to begin to separate and control variables, what patterns of language do they use when employing that scheme?

PURPOSE OF THE STUDY

The purpose of the study, therefore, was the need to clarify if, how, and when young children develop the abilities to separate and control variables.

LIMITATIONS

The sample of students used in the research was limited to students attending one elementary school within a large suburban public school district in Oklahoma.

DEFINITION OF TERMS

The following terms will be used throughout this study

and should be interpreted as follows:

Preoperational thought: "The type of thinking in which a child seems to make judgments without the necessary data or theoretical basis; thinking is characterized by a fusing together of ideas or statements" (Gorman, 1972, p. 113).

Concrete operations: The internal manipulations of ideas from objects that are being or have been experienced; thinking that is dependent on the concrete, real world (Gorman, 1972).

Formal operations: The internal manipulation of concepts, relations, and propositions with or without the benefit of concrete experiences. Thinking that can concern itself with the possible rather than the real, the form of a statement as distinct from it's content, and the abstract rather than the concrete (Gorman, 1972).

Separation of variables: The process of grouping all factors in a set so that the unique properties of each factor are discernible and possibly manipulatable (Webster, 1968).

Control of variables: The cognitive operation which permits one to isolate one factor in order to examine it while equalizing the effect of the other factors. "All other things being equal" (Gorman, 1972).

Mental Structures: A system of transformations used to assign meaning to information received (Renner, et al., 1976).

Scheme: The basic unit of a mental structure that is repeatable and/or generalizable in similar situations (Renner, et al., 1976).

THEORETICAL FRAMEWORK

This research study was carried out largely within the framework of the developmental theory of Piaget. Of particular significance were the stages of development according to Piaget. The subjects in this study were somewhere within or between the preoperational and the concrete operational stages of development. The questions being researched however, challenged Piaget's specification that the separation and control of variables scheme was found only at the formal operational stage of development.

The studies cited earlier dealt primarily with subjects from 9 to 18 years of age. This study was made with subjects between five and nine years of age. Experiences with children and observations of children made over several years, have led to the hypothesis that perhaps the beginnings of the operations relevant to the separation and the control of variables started much earlier than previously thought. The primary reason for that hypothesis was young children's utilization of the concept of "fairness" in their language. The children who participated in the present research study, were within the accepted age definition of early childhood education, that is, birth through eight or nine years of age.

CHAPTER II

GENERAL DESIGN OF THE RESEARCH

Data to answer the research question stated earlier were collected by administering tasks to children in kindergarten through grade three. The tasks were designed to enable the measurement of students' abilities to separate and control variables. A total of 108 randomly selected students in kindergarten, first, second, and third grades, participated in the research. The subjects were given a series of three tasks with three variables each. The following tasks were administered: (a) The Bouncing Balls Task, (b) The Footrace Task, and (c) The Bending Rods Task. Each of the tasks contained three levels of difficulty. The tasks were administered to subjects who were students attending classes in a middle-class, self-contained, surburban elementary school, located in Northwest Oklahoma City and one of 16 elementary schools in a large school district.

EXPERIMENTAL PROCEDURE

The student sample consisted of 27 students each from

kindergarten, first grade, second grade and third grade who were interviewed to determine if there was a pattern of cognitive development emerging in those age groups which might suggest that those children have begun to separate and control variables. The chronological ages used for this study were as follows:

Kindergarten - Five years and six months to six years and five months of age.

First Grade - Six years and six months to seven years and five months of age.

Second Grade - Seven years and six months to eight years and five months of age.

Third Grade - Eight years and six months to nine years and five months of age.

Three different tasks were administered to the subjects to determine if those young children were able to or were beginning to separate and control variables. Each student interviewed experienced only one difficulty level of one task. That procedure was followed in order to eliminate the learning effect from task to task and/or from level to level within each task. A Table of Random Numbers was used to establish an order for administering each difficulty level of each task (Minium, 1978).

The standard Piagetian Bending Rods Task (Inhelder and Piaget, 1955) was adapted for the student groups and two additional tasks were designed, content validated and tested with children. The newly designed tasks were The Bouncing Balls Task and The Footrace Task. In all three tasks the degree to which the subjects had developed the separation and control of variables scheme, was determined by their recognition of the "fairness" or "unfairness" of a test and their abilities to explain why the test was "fair" or "unfair". The "fairness" criterion is discussed later. A general description of each task follows:

The Bouncing Balls Task -

Variables: Height, surface, and force of a throw.

(1) Two tennis balls are dropped from different heights.
(2) Two tennis balls are dropped from different heights onto two different surfaces.
(3) One tennis ball is dropped and one tennis ball is thrown from different heights onto two surfaces.

For each level of the Bouncing Balls Task, the subject was asked if the test was a "fair" test to see which ball had more bounce. If the child responded that the test was "unfair", he/she was asked why the

test was "unfair" and what changes were necessary in order to make the test a "fair" test. When the child indicated no additional changes were necessary or if he/she said that the test was a "fair" test, the interview was terminated.

The Footrace Task -

Variables: Footwear, cluttered path, and books.

(1) Two boys in a footrace with one wearing tennis shoes and one wearing boots.
(2) Two boys in a footrace with one wearing tennis shoes and one wearing boots. The boy in boots has a cluttered path in front of him.
(3) Two boys in a footrace with one wearing tennis shoes and one wearing boots. The boy in boots has a cluttered path in front of him and he is carrying his school books.

For each level of the Footrace Task, the subject was asked if the test was a "fair" test, to see which boy could win the race from the street curb to the ice cream store. If the child responded that the test was not "fair", he/she was asked why the test was "unfair" and what changes were necessary in order to make the test a "fair" test.

When the child indicated no additional changes were necessary or if he/she said the test was a "fair" test, the interview was terminated.

The Bending Rods Task -

Variables: Length, diameter, and weight.

(1) Two identical rods positioned in a support stand with one rod extending further than the other. Two identical weights which could be hung on the hooks on the ends of the rods.
(2) Two rods of identical length but of different diameters, positioned in a support stand with one rod extending further than the other. Two identical weights which could be hung on the hooks on the ends of the rods.
(3) Two rods of identical length but of different diameters, positioned in a support stand with one rod extending further than the other. Two weights of different values which could be hung on the hooks on the ends of the rods.

For each level of the Bending Rods Task, the subject was asked if the test was a "fair" test to determine which rod was the more bendable. If the child responded that the test was not a "fair" test, he/she was

asked why the test was "unfair" and what changes were necessary in order to make the test a "fair" test. When the child indicated no additional changes were necessary or if he/she said the test was a "fair" test, the interview was terminated.

Each of the three tasks were administered at three levels with each level introducing an additional variable as shown below:

Task I - The Bouncing Balls

Level 1: Uncontrolled variable - height.

Level 2: Uncontrolled variables - height, surface.

Level 3: Uncontrolled variables - height, surface, force.

Task II - The Footrace

Level 1: Uncontrolled variable - footwear.

Level 2: Uncontrolled variables - footwear, cluttered path.

Level 3: Uncontrolled variables - footwear, cluttered path, carrying books.

Task III - The Bending Rods

Level 1: Uncontrolled variable - length.

Level 2: Uncontrolled variables - length, diameter.

Level 3: Uncontrolled variables - length, diameter, weight.

The protocols which were designed to be used for the interviews in administering the tasks described above, are described in detail and are included in Appendix A, pages 64 to 86.

VALIDITY OF THE TASKS

In collecting data for any investigation, the instruments for collecting data are of prime importance. Measuring instruments are considered to be valid if the instruments measure what they purport to measure. There are two important factors in establishing validity in any measuring device: (a) The kind(s) of validity a particular instrument should have and (b) the extent to which the instrument must show the particular type(s) of validity (Turney and Robb, 1971).

There are "two major standards for ensuring content validity: (a) a representative collection of items and (b) 'sensible' methods of test construction" (Nunnally, 1978, p. 81). Content validity was ensured by the plan of content and the plan for constructing items. "Face validity concerns the extent to which an instrument 'looks like' it measures what it is intended to measure" (Nunnally, 1978, p.99). While content validity is incorporated into a measuring

procedure as it is being constructed,

> "face validity concerns judgments about an instrument after it is constructed. . . .Thus face validity can be considered one aspect of content validity, which concerns an inspection of the final product to make sure that nothing went wrong in transforming plans into a completed instrument" (Nunnally, 1978, p. 99).

In order to provide a "sensible" way of constructing the interviews, the items in the protocols were carefully constructed, evaluated and revised by the investigator and the two research advisors. The protocols were used in trials with kindergarten and primary children to determine the suitability of the language and the time required for the interviews. Positive judgments were made by the investigator and the two research advisors relative to the content and face validity of the completed protocols.

In establishing construct validity, Nunnally (1978) further suggested three points to consider:

> (a) "specifying the domain of observables, (b) determining to what extent all, or some, of those observables correlate with each other or are affected alike by the experimental treatments, and (c) determining whether or not one, some, or all measures of such variables act as though they measure the

construct" (p. 87).

The separation and control of variables is an abstract construct which is mentally constructed by each individual.

> "A construct is something that does not exist as an isolated, observable dimension of behavior," . . . rather "it represents an hypothesis with which a variety of factors correlate. Constructs concern domains of observables," which can be scored. "The combined scores from a number of measures of observables in the domain can be thought of as having a degree of construct validity for the domain as a whole" (Nunnally, 1978, p. 86).

In this study, the observables were clearly specified, and were given the same treatment with the same examiner using the same set of protocols. To further establish construct validity, college seniors were interviewed in addition to the kindergarten and primary children. Data collected by Renner, et al. (1976), and Wollman (1977), led to the conclusion that college seniors should have attained the operational concept of separating and controlling variables. Using college seniors, therefore, helped to determine if the protocols would in fact measure what they were designed to measure.

Using the task protocols, the tasks were administered to 27 college seniors with three students responding to each level of each of the three tasks. The results were as follows:

I. The Bouncing Balls Task	Controlled Variables	
Variables	Yes	No
1. Height	3	0
2. Height/surface	2	1
3. Height/surface/force	3	0

II. The Footrace Task	Controlled Variables	
Variables	Yes	No
1. Footwear	3	0
2. Footwear/cluttered path	3	0
3. Footwear/cluttered path/ carrying books	3	0

III. The Bending Rods Task	Controlled Variables	
Variables	Yes	No
1. Length	3	0
2. Length/diameter	2	1
3. Length/diameter/weight	3	0

The foregoing led to the conclusion that the protocol for each level of each task did measure what it was designed to measure. The tasks were judged to have construct validity.

SCORING THE TASKS

As was stated earlier, the decision was made to use the "fairness" of a task as the principal criterion to judge whether or not a child could separate and control variables.

The decision to use the "fairness" criterion has precedent. In a series of tasks involving 12 and 13 year old students, Steller (1977), used "I think it is fair/unfair because. . ." (p. 142), as the criterion to judge the quickness of the emptying of bottles. The bottles were of different sizes and shapes, had different sized necks, and contained different liquids, such as coffee and molasses. Also, Linn and Rice (1978), used the "fair test" criterion for the evaluation of subjects responding to their Springs Task, in a study concerning formal thought and naming variables. Stone and Day (1978), in the report of their study involving third, fifth and seventh grade students used a "good" or "bad" test as the criterion to determine spontaneous, latent, or nonusers of formal strategy. Selnes (1983), had his students use "fair" as the criterion for judging controlled experiments in junior high school science.

In designing a rating scale and a response sheet for this particular study, the scale was designed so that if the child identified the task as being "unfair" he/she was assigned a score of one point. If the child correctly indicated what needed to be changed to make the test a "fair" test, by separating and controlling the variable(s), he/she was assigned two additional points. Success on the entire task, therefore, resulted in the subject earning a total of three points. If the child did not separate and/or control the variable(s),

that is, thought the test as presented was a "fair" test, he/she was assigned a score of zero. Using this method of scoring, the subjects made a total score of zero, one, or a three, with three being the highest possible score (Figure 2.1).

SELECTING THE SUBJECTS

The classroom teachers for each of the age/grade groups, assigned numbers from 1 to 27 to their students as they were listed in alphabetical order in their class record book, and as the students fell within the aforementioned age groups.

In using the Table of Random Numbers (Minium, 1978), to determine the order of the children to be tested, a separate order was established and used for each of the four age/grade level groups. The first three numbers from each list of numbers derived from the Table of Random Numbers, determined which three children from each of the age/grade groups were tested for Task I, Level One, and the next three numbers from each list determined which children were tested for Task I, Level Two, and so on. This procedure accomplished complete randomization of subjects to each task and level.

The subjects interviewed with the validated protocols were randomly selected as described, from an elementary school within a large surburban public school system located in Oklahoma City, Oklahoma. For each task, the sample of children

was distributed among the age/grade level groups as depicted in Table 2.1.

Figure 2.1. A Sample of the Individual Subject Task Response and Evaluation Sheet

SEPARATION AND CONTROL OF VARIABLES STUDY

Subject_____

Grade____Age____Date of Birth_____ M F Date of Interview_____

Task_____Level____ 1 2 3

I. BOUNCING BALLS	Height		Height, Surface		Height, Surface, Force		Score
Fair Test:	Yes	No	Yes	No	Yes	No	_____
Changes suggested:_____							_____
_____							_____
II. THE RACE	Boots		Boots, Cluttered Path		Boots, Cluttered Path, Carrying Books		Score
Fair Test:	Yes	No	Yes	No	Yes	No	_____
Changes suggested:_____							_____
_____							_____
III. BENDING RODS	Length		Length, Diameter		Length, Diameter, Weight		Score
Fair Test:	Yes	No	Yes	No	Yes	No	_____
Changes suggested:_____							_____
_____							_____

COMMENTS:

_____

Table 2.1

Task and Level Distribution

of Subjects per Grade Level

GRADE LEVEL	TASK I			TASK II			TASK III			TOTALS
	L_1	L_2	L_3	L_1	L_2	L_3	L_1	L_2	L_3	
K	3	3	3	3	3	3	3	3	3	= 27
1	3	3	3	3	3	3	3	3	3	= 27
2	3	3	3	3	3	3	3	3	3	= 27
3	3	3	3	3	3	3	3	3	3	= 27
TOTALS:	12	12	12	12	12	12	12	12	12	=108

Table 3.2

Random Order Depicting the Order of Administering the Levels of Tasks Within Each Main Set of Tasks for Each Age/Grade Level

	TASK I BOUNCING BALLS	Task II FOOTRACE	TASK III BENDING RODS
Level One one variable	K- 11, 07, 14	K- 15, 25, 16	K- 02, 21, 12
	1- 13, 15, 22	1- 17, 21, 04	1- 23, 12, 27
	2- 23, 07, 15	2- 11, 03, 27	2- 01, 26, 24
	3- 04, 05, 10	3- 12, 13, 02	3- 03, 11, 15
Level Two two variables	K- 13, 19, 09	K- 22, 05, 23	K- 24, 08, 10
	1- 24, 08, 10	1- 01, 14, 09	1- 07, 05, 19
	2- 12, 18, 19	2- 17, 09, 13	2- 16, 10, 06
	3- 09, 18, 22	3- 01, 08, 14	3- 07, 16, 06
Level Three three variables	K- 26, 01, 06	K- 03, 27, 17	K- 04, 18, 20
	1- 26, 18, 25	1- 15, 20, 11	1- 03, 06, 02
	2- 25, 04, 20	2- 14, 05, 22	2- 21, 02, 08
	3- 19, 23, 25	3- 20, 17- 27	3- 24, 26, 21

Table 2.2

Random Assignment of Subjects per Grade Level

Kindergarten	First Grade	Second Grade	Third Grade
11	13	23	04
07	16	07	05
14	22	15	10
15	17	11	12
25	21	03	13
16	04	27	02
02	23	01	03
21	12	26	11
12	27	24	15
13	24	12	09
19	08	18	18
09	10	19	22
22	01	17	01
05	14	09	08
23	09	13	14
24	07	16	07
08	05	10	16
10	19	06	06
26	26	25	19
01	18	04	23
06	25	10	25
03	15	14	20
27	20	05	17
17	11	22	27
04	03	21	24
18	06	02	26
20	02	08	21

Note: From the Table of Random Numbers, (Minium, 1978), digits one and two were used for kindergarten, digits two and three for first grade, digits three and four for second grade, and digits four and five were used for third grade.

TREATMENT OF THE DATA

The data were collected and analyzed using a randomized block factorial design (Winer, 1971). The randomized block factorial design was used because it:

(1) provided for the complete analysis of all the possible interactions of all the main effects.

(2) assured equality of all of the treatments.

(3) provided a sound way to use a design for the control of extraneous variability.

(4) controlled the within groups biasing effect due to the random assignment of subjects to treatments.

(5) assured that initial differences between groups would be attributable only to chance.

(6) provided a clean, clear, neat, and well organized design for treatment of the data.

In using the randomized block factorial design, this study resulted in a three by three by four design consisting of 36 cells. Each of the 36 cells represented a specific task level and a specific age/grade level consisting of three scores each. A three-way analysis of variance was used to analyze the three main effects and all of the interactions

as shown. The following analyses were made:

The main effects -

1. Tasks
2. Levels
3. Age/grade level groups

The interaction of -

1. Tasks and levels
2. Tasks and age/grade level groups
3. Levels and age/grade level groups
4. Tasks, levels, and age/grade level groups

All analyses were made with the computer using the Statistical Analysis System. (Statistical Analysis System [SAS], 1982).

CHAPTER III

RESULTS AND INTERPRETATION OF THE STUDY

Chapter III is divided into five sections. The first section contains a brief overview of the general procedure. of the study, including the method, subjects, scoring and evaluation. The second section summarizes the overall analysis as depicted in the ANOVA (analysis of variance) source table. (Table 3.1) Section three concentrates on the interaction of Tasks and Levels and section four the main effect of Age. The fifth and last section of this chapter contains additional information and findings which were not a part of the original design of the study, but which were available.

GENERAL PROCEDURE

Groups of 27 students from each of the age/grade levels kindergarten, first grade, second grade, and third grade, responded to three tasks. Those tasks were The Bouncing Balls Task (Task I), The Footrace Task (Task II), and the modified Piagetian Bending Rods Task (Task III). The three tasks were

administered to a total of 108 randomly selected subjects. The subjects were also grouped by months of age as follows: Group One, included subjects from 66 months through 78 months of age; Group Two, from 79 through 90 months of age; Group Three, from 91 through 102 months of age; and Group Four, consisted of subjects from 103 through 114 months of age. Each subject responded to only one level of one task. Level One of each task consisted of one variable; Level Two, two variables; and Level Three consisted of three variables.

Using the "fair test" criterion, if the subject was able to separate the variable(s) by identifying the test as being "unfair", he/she was assigned a score of one point. If the subject could then go on to control the variable(s), by determining what changes needed to be made in order for the test to become a "fair test", he/she was assigned two additional points, making a total score of three points. Each subject had a score of zero, one or three points, with three being the highest possible score. The protocols for all levels of each task, are included in Appendix A, pages 65 to 86.

GENERAL ANALYSIS

Eleven percent of the subjects scored zero, 33% earned a score of one, and 56% achieved the score of three. A complete profile for each of the 108 subjects by grade level,

containing the individual scores for each subject, is found in Appendix B, Tables A, B, C, and D.

The three tasks, each with three levels of difficulty, and the four age/grade groups, permitted the use of a 3 X 3 X 4 design. Each of the 36 cells represented by the design contained the scores for three subjects. An a priori decision was made to use the 0.05 level to determine the significance of each of the three main effects: (1) tasks, (2) levels, (3) age/grade groups; and the four interactions: (1) tasks by levels, (2) tasks by age/grade groups, (3) levels by age/grade groups, and (4) tasks by levels by age/grade groups. The analysis was computed using the Statistical Analysis System (SAS, 1981), with the Tukey HSD (Honestly Significant Difference), also commonly referred to as the Tukey Studentized Range Statistic (HSD) (Hays, 1981), and with $\alpha = 0.05$. A randomized block factorial design with a three-way analysis of variance, was used to assess the main effects with all of the possible interactions.

A complete model of the study for the overall analysis, is exhibited in the ANOVA source table. (Table 3.1) The statistical significance levels are included for the three significant main effects, and the one significant interaction, as well as the three non-significant interactions in order to present a complete profile of all of the results as proposed in the original design of the study. The design of this study

was described in detail in Chapter II.

Table 3.1

ANOVA Source Table for the Overall Analysis

Source	DF	SS	F Value	P>F	
Tasks	2	18.2198	7.95	0.0008	*
Levels	2	7.1967	3.14	0.0491	*
Age Groups	3	14.4535	4.21	0.0085	*
Tasks X Levels	4	12.0643	2.63	0.0409	*
Tasks X Age Groups	6	0.7746	0.11	0.9947	
Levels X Age Groups	6	2.3112	0.34	0.9154	
Tasks X Levels X Groups	12	6.0031	0.50	0.9110	
Error	72	82.4166			
Total	107	143.9629			

* = P<0.05

An inspection of the ANOVA source table revealed that the following interactions were non-significant: (a) Tasks and Age Groups; (b) Levels and Age Groups; and (c) Tasks, Levels, and Age Groups. The interaction of Tasks and Levels however, was statistically significant at the 0.05 probability level. A further inspection of the ANOVA source table (Table 3.1) revealed that the three main effects, Tasks, Levels, and the Age Groups, were statistically significant. An interpretation of the main effects for Tasks and Levels, however, was mediated

by the significant interaction for the tasks and levels. Results of the main effect of tasks and levels were integrated into the task-by-level interaction results, while the results for the main effect of the age/grade level groups are reported separately.

THE INTERACTION OF TASKS AND LEVELS

Since a significant task-by-level interaction was found, mean score comparisons were made using the Tukey (HSD) Test (Hays, 1981), in order to determine exactly where the significant differences were between the tasks and/or levels. To further assess the interaction of tasks-by-levels, cell mean comparisons were calculated from the columns and rows as shown in Table 3.2, which resulted in eighteen pairs of scores from the nine possible pairs in the rows and the nine possible pairs in the columns. The critical value used was based on the Cicchetti approximation, K(K-1)/2 (Cicchetti, 1972, p. 406), to the Tukey values, when performing less than all possible pairwise comparisons. Since "K" is equal to the number of treatments (the three tasks X the three levels), the Cicchetti approximation applied to this study was: 9(9-1)/2 = 36 possible pairs. The 36 pairs included all of the possible pairs within the rows and columns as well as all possible diagonal pairs. Only the 18 possible row and column comparisons were needed for this study. Comparisons of the diagonal

mean scores, such as comparing Level Two of Task I with Level Three of Task II, would be difficult to interpret; those cell mean comparisons would be confounded and/or would be essentially uninterpretable (Winer, 1971).

The Cicchetti approximation was specifically designed as a modification for the Tukey (HSD) Test (Hays, 1981), to help in the control of alpha while maintaining maximum power of the results. This was accomplished by modifying the critical value when performing less than all possible pairwise comparisons. The Cicchetti approximation provides a more powerful test (Cicchetti, 1972), than if all 36 pairwise comparisons had been performed. The Tukey equation used for the cell mean comparisons was as follows:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{2 \; MSw_{/I}}}$$ (Cicchetti, 1972).

The comparisons indicated that there were significant differences between Levels One and Three of Task III and between Tasks I and II of Level One. No other statistically significant differences were found. The mean scores for the task-by-level interaction are shown in Table 3.2 and Figures 3.1 and 3.2. For the cell mean comparisons from the mean scores of the task-by-level interaction, derived from the Cicchetti approximation, see Table 3.3.

Table 3.2

Mean Scores for the Interaction of Tasks and Levels

Task	Level 1	Level 2	Level 3	Combined $\bar{X}$s
I(balls)	3.00	2.42	2.25	(2.56)
II(race)	1.67	2.17	2.00	(1.94)
III(rods)	2.42	1.25	1.00	(1.56)
Combined $\bar{X}$s	(2.36)	(1.94)	(1.75)	

N = 12 Ss per task-level combination

DF = 4 SS = 12,0643 F Value = 2.63 PR.<0.0409

Table 3.3

Pairwise Comparisons by Columns and Rows (as Shown in Table 3.6), for all Tasks and Levels.

Tasks	Levels	t
I	1	
		1.34
I	2	
I	1	
		1.72
I	3	
I	2	
		0.38
I	3	
II	1	
		1.14
II	2	
II	1	
		0.76
II	3	
II	2	
		0.38
II	3	
III	1	
		2.67
III	2	
III	1	
		3.24 *
III	3	
III	2	
		0.57
III	3	

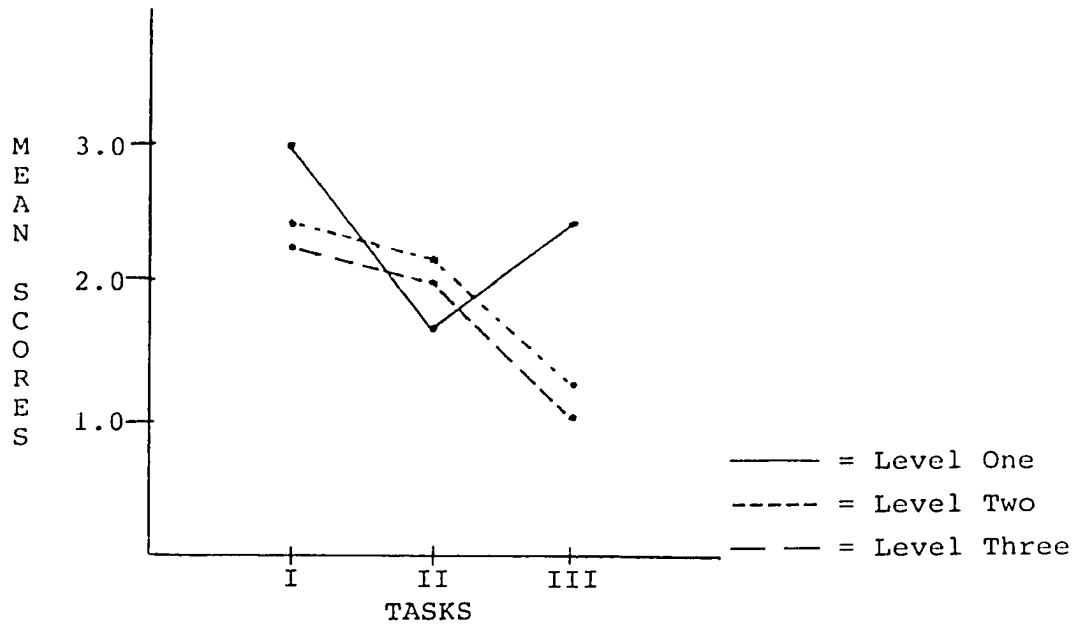
* $p < 0.05$

Table 3.3——Continued

Tasks	Levels	t
I	1	
II	1	3.05 *
I	1	
III	1	1.34
II	1	
III	1	1.72
I	2	
II	2	0.57
I	2	
III	2	2.67
II	2	
III	2	2.10
I	3	
II	3	0.57
I	3	
III	3	2.86
II	3	
III	3	2.29

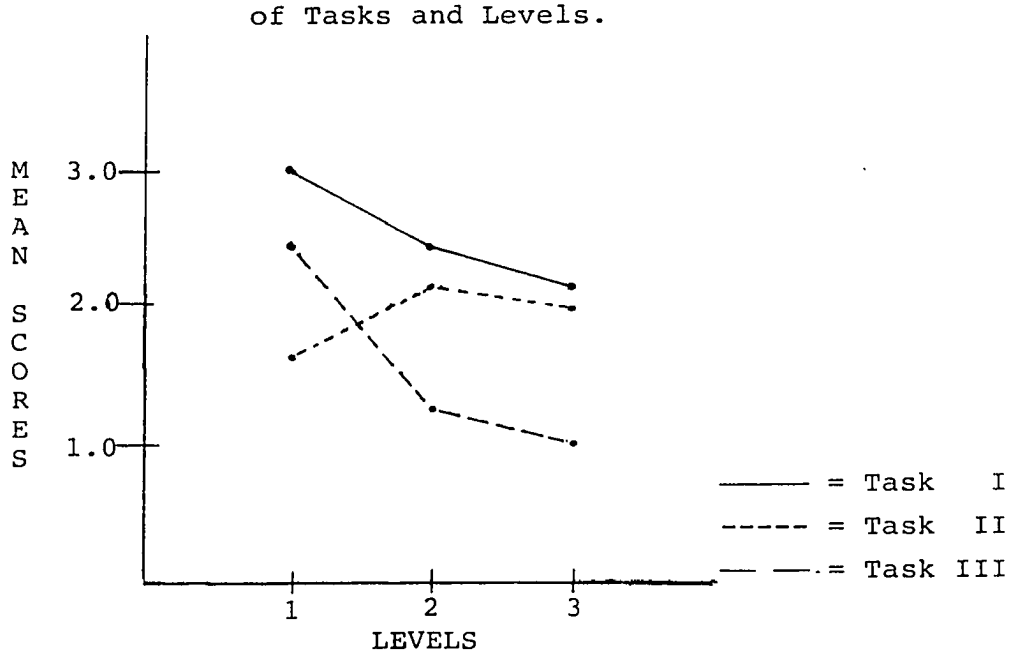
* = $p < 0.05$

Figure 3.1. Mean Scores of the Interaction of Tasks and Levels.



N = 12 Ss per Task-Level Combination

Figure 3.2. Mean Scores of the Interaction of Tasks and Levels.



N = 12 Ss per Task-Level Combination

An examination of the mean scores for the task-by-level interaction (Table 3.2), indicated that the 108 subjects participating in the research had the greatest success for performance on Task I, Level One. That particular task-level combination was the only one where all twelve children achieved the perfect score of three, thereby demonstrating their ability to both separate and control the variable of "height".

In responding to Level Two of Task I, nine of the twelve children were able to separate and control the variables of "height and surface", and made a score of three. Two of the subjects separated the variables, (thought the test was "unfair"), but could not go ahead and control the variables, (they could not explain what changes were needed in order to make the test "fair"), and made a score of one. One subject could neither separate nor control the variables and made a score of zero.

Seven of the twelve children who responded to Level Three of Task I, were able to separate and control the variables of "height, surface, and force", and made a score of three; four children could separate the variables and made a score of one; one child could neither separate nor control the variables and made a score of zero. Although non-significant, an inspection of the mean scores for all three levels across Task I, indicates that as the number of variables increased, the scores decreased. In other words as the task became more difficult

success decreased.

Based on the regular results from Task I, an inspection of the results of Task II, Level One, revealed a rather surprising factor. The lowest mean score for all levels of Task II was achieved on Level One. Level One of Task II also had a lower mean score than either Task I or Task III for the same level, indicating Level One of Task II was the most difficult for all children responding to Level One of their respective tasks. Although the children were randomly selected and there was random assignment for the order in which they were tested, it was surprising to note that only one-half of the children (six of the twelve), were able to both separate and control the variable of "footwear", for Level One of Task II. Also, at Level One, only two of the children were able to separate the variable (thought the test was "unfair"), and made a score of one point. There were four children, however; who could not identify the variable, and made a score of zero. The scores for Levels Two and Three of Task II, followed the pattern for Levels Two and Three of Task I; the scores decreased as the number of variables increased.

For Level Two of Task II, seven of the subjects were able to both separate and control the two variables of "footwear" and the "cluttered path", and made a score of three. Five of the children were able to separate the variables, making a score of one, and there were no children who scored zero at

Level Two of Task II.

Six of the 12 children who participated in the study for Level Three of Task II, achieved the score of three points as they were able to both separate and control the three variables of "footwear", the "cluttered path" and "carrying books", and the remaining six children who participated at that level, scored one point for separating the variables. None of the subjects at that level scored zero.

The Tukey comparisons (Hays, 1981), indicated a significant difference between Level One of Task I (3.00), and Level One of Task II (1.67), (Table 3.3). This was a surprising result, since both Task I and Task II dealt with more familar content than the content represented in Task III. Because Task III dealt with the more unfamilar content, it was equally surprising that the mean score for Level One of Task III (2.42) was higher than the mean score for Level One of Task II. Another unexpected factor was that more children controlled the variable of "footwear" when in combination with one or two other variables than when alone. There really is no valid explanation for the low mean score for Level One of Task II, but a speculation is that the particular children randomly assigned to that task and level, were not necessarily concerned about the "footwear" the two boys in the task were wearing. It is probable that those children were more concerned with the race and getting to the "ice cream store".

In all probability, it did not occur to some of those children that shoes or "footwear" should be changed when racing to the "ice cream store". The children probably focused on the "ice cream" and getting there quickly. Perhaps the results would have been completely different for the children respond- to Level One of Task II, if the "boys" had been engaged in a footrace in a gymnasium or on a track.

A look at the mean scores for Task III (The Bending Rods), revealed that Level One was the least difficult of the three levels, for all of the 36 children that responded to Task III. It was also easier than Level One of Task II which was discussed more fully in the foregoing section. In responding to Task III, Level One, nine of the 12 children were able to separate and control the variable of "length", and achieved the score of three. Two of the subjects separated the variable and scored one point, while one child could neither separate nor control the variable and made the score of zero.

For Level Two of Task III, six children were able to separate and control the variables of "length and diameter", and six were able to separate the variables, and made scores of three and one respectively. None of the children performing Level Two of Task III, made a score of zero.

In responding to Level Three of Task III, only one child was able to both separate and control the variables of "length, diameter, and weight", and achieve the score of three. Nine

of the children could separate the variables (thought the test was "unfair"), and made a score of one, but could not go ahead and control the variables and suggest the changes that needed to be made in order for the test to become a "fair" test. Two of the children did not recognize the test as being "unfair", and made the score of zero. Task III followed the pattern of Task I and Task II (except for Level One of Task II)--the scores decreased as the number of variables increased.

The Tukey comparisons (Hays, 1981), of the mean scores indicated that there was a significant difference between Levels One and Three of Task III. Level One had a combined mean score of 2.42, while Level Three had a combined mean score of 1.00. Only one child of the twelve subjects (a third grade child, eight years and nine months), from kindergarten through third grade, was able to both separate and control the three variables, "length, diameter, and weight". Nine of the twelve were able to both separate and control the one variable of "length". Perhaps the higher score for Level One of Task III, can in part be attributed to the fact that children have had many experiences involving length. From a very early age, most children have been involved in dividing such things as sticks of gum, candy bars, and pieces of string, in both in their play and everyday life experiences. Similarly, children who attended nursery school and/or kindergarten have had many experiences with building block construction which involved a

variety of experiences with length. Children tend to have had more concrete, everyday experiences with "length" than they have had with the other two variables of task III, "diameter" and "weight". This does point out another factor however, and that is that the subjects achieved the separation and control of one variable more easily than they achieved the separation and control of two variables, and the subjects achieved the separation and control of two variables more easily than they achieved the separation and control of three variables.

Across all three levels of all three tasks, the scores gradually and consistently decreased as the number of variables increased, except for Level One of Task II. The combined mean scores for all tasks and levels, as shown in Table 3.2, in parenthesis, revealed a gradual and continuous decrease in total scores from task to task and level to level within the tasks. This was a clear indication that as the number of variables increased, the tasks became more difficult.

An overview of the interaction of tasks and levels, suggested the following trends and/or patterns:

1. As the number of variables increased from level to level within each task, the scores tended to decrease, indicating that the tasks became more difficult when progressing from one variable to

three.

2. Task I (mean score 2.56), had the highest success rate of all the tasks (Table 3.2).

3. Task II (mean score 1.94), was more difficult than Task I and less difficult than Task III except for Level One (Table 3.2).

4. Task III (mean score 1.56), was the most difficult of all the tasks except for Task II, Level One (Table 3.2).

Possible explanations for the suggested trends is the fact, that as a rule, it was more difficult for the children to separate and control two variables than it was to control one variable, and it was more difficult for those young children to control three variables than it was to separate and control one or two variables. The data indicated that Task I was easier than Task II or III and that Task II was easier than Task III. Tasks I and II involved more familar content, and Task III dealt with the most unfamilar content. Level Three of Task III had the lowest score (1.00) of all tasks and levels, and was the most difficult for all of the subjects. Level I of Task I, had the highest score (3.00), of all of the tasks and levels and was the easiest for all of the subjects. In fact, that particular task and level (Task I, Level One) was the only one where all subjects achieved the perfect score of three.

The present study confirmed that when the separation and control of variables tasks were presented concretely and consisted of familar content and materials, the young children who participated in this study, did in fact, demonstrate the beginnings[1] of the ability to separate and control variables. An important factor was that the "fair test" criterion--the "fairness" or "unfairness" of a particular test--used a language with which the children were comfortable and familar. Children have had many experiences with "fair", "unfair", "not fair", or "fair play", in both their play and learning experiences. Most of the children had no difficulty in relating to the language during task performance. They did, in fact utilize the language with relative ease.

THE MAIN EFFECT OF AGE

The data in Table 3.1, indicate the main effect of age was statistically significant. An analysis was made with the subjects grouped two different ways with respect to age: (a) the subjects were grouped in clusters by months of age, and (b) the subjects were grouped by grade level (Tables 3.4, 3.5). Comparisons indicated there was no significant difference when measuring all of the results with the ages grouped

---

1 "The point at which something begins to exist. . . .the basic element. . . .the introductory period or the early period" (Webster, 1968).

in clusters of months, or when measuring all of the results with the grade level groups. Results of the analysis, showing the mean scores of the subjects as they were grouped by months of age, can be seen in Table 3.4 and Figure 3.3. Results of the analysis showing the mean scores of the subjects as grouped by grade level can be seen in Table 3.5 and Figure 3.4.

Table 3.4

Mean Scores for Age Groups, Grouped by Months of Age

Age Groups by Months of Age	*	$\bar{X}$	N
1. 66- 78 mos. of age	A	1.52	27
2. 79- 90 mos. of age	A B	1.83	29
3. 91-102 mos. of age	A B	2.24	25
4. 103-114 mos. of age	B	2.52	27

* Means with the same letters are not significantly different.

DF = 3 SS = 14.4535 F Value = 4.21 PR $<$ 0.0085

Figure 3.3. Mean Scores of Age Groups in Months

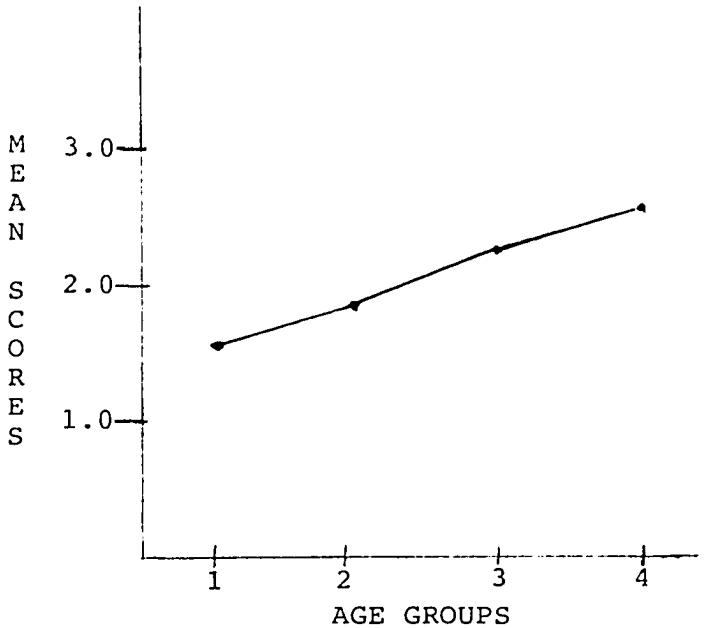


Figure 3.4. Mean Scores of Age/Grade Groups.

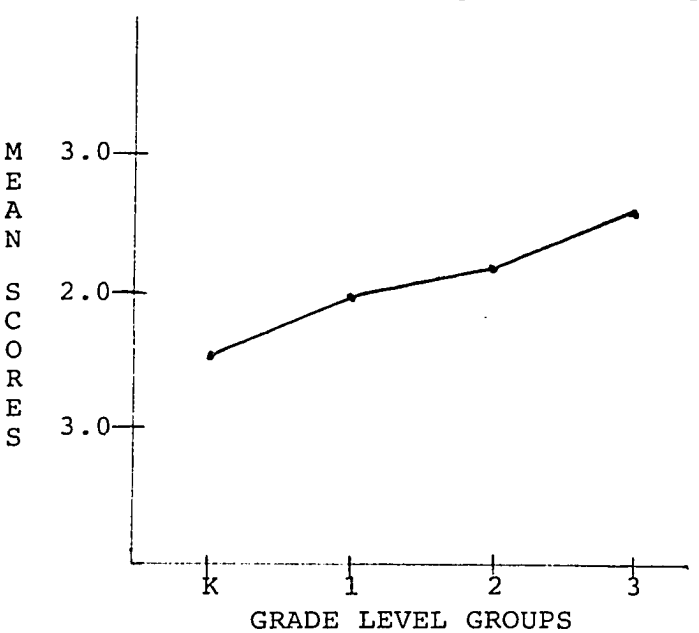


Table 3.5

Mean Scores for Groups, Grouped by Grade Level

Age Groups by Grade Level		*Tukey Comparisons	$\bar{X}$	N
(5y/6m-6y/5m)	Kind.	A	1.52	27
(6y/6m-7y/5m	1st	A B	1.89	27
(7y/6m-8y/5m	2nd	A B	2.15	27
(8y/6m-9y/5m	3rd	B	2.52	27

* Means with the same letters are not significantly different.

DF = 3 SS = 14.4074 F Value = 4.18 PR < 0.0088

Mean comparisons, using the Tukey (HSD) Test (Hays, 1981), were made to determine the significant differences for the main effect of age (Tables 3.4 and 3.5). The results indicated there were no significant differences between Age Groups One and Two, Two and Three, or One and Three; there were no significant differences for Kindergarten and First Grade, First Grade and Second Grade, or for Kindergarten and Second Grade; those comparisons are statistically the same. There was however, a significant difference in achievement between Age Groups One and Four; and there was a significant difference in achievement between Kindergarten and Third Grade as shown in Tables 3.4 and 3.5, and as shown in Figures 3.3 and 3.4. A break-down of how the children scored for each group, follows:

Age by Months/Group 1. (66- 78) N 27	10 children achieved the perfect score of three, 11 children made a score of one, and six scored zero.
Grade Level Group K. N = 27	There was no difference in the individual scores from Age Group One.
Age by Months/Group 2. (79- 90) N = 29	13 children made a score of three, 14 children scored one point, and two made zero.
Grade Level Group 1st N = 27	13 children made a score of three, 12 scored one point, and two scored zero.
Age by Months/Group 3. (91-102) N = 25	17 children made a score of three, five made a score of one, and three scored zero.
Grade Level Group 2nd N = 27	17 scored three, seven made a score of one, and three scored zero.
Age by Months/Group 4. (103-114) N = 27	20 children achieved the perfect score of three points, six made a score of one, and one child made a score of zero.

Grade Level N = 27	Group 3rd	There was no difference in the individual scores from Age Group Four, by months.

When the original design of the study was proposed, the decision was made to test 27 children from each grade level, kindergarten through grade three. Later, it was decided, for purposes of analysis, to group the children in clusters by months of age (disregarding the grade levels) so the two methods of grouping could be compared. Using the two different grouping procedures had only a slight effect on the composition of the groups. Specifically, only two children who previously were classified in grade level three, were between 79-90 months (Age Group Two), resulting in 29 children in Age Group Two and 25 children in Age Group 3. There were no other changes from the grade level groups. This slight difference (with only two of the 108 children affected) was not discovered until after the analysis was made (Tables 3.4, 3.5).

In view of the foregoing, it was not surprising that comparisons indicated that there was no significant difference when measuring all of the results by either method of grouping; there was a significant main effect of age with both methods of grouping. Perhaps this can be attributed to the fact that there is a state mandated law in Oklahoma as to when children may enter school. Before entering kindergarten or first grade, a child is required by law, to have reached his/her fifth or

sixth birthday on or before the second day of September. The children who participated in this study, entered school according to the State mandated law. Also, the State school age requirements were a factor in setting the age requirements within the grade levels. Since the children were tested during the last half of the spring semester, none of the subjects would have been younger than five years and six months in kindergarten; six years and six months in first grade, seven years and six months in second grade; and eight years and six months of age in the third grade.

When evaluating the main effect of age, there was one distinct trend that was clearly evident. It was clearly evident, that as the children participating in this study increased in age, they achieved higher on the tasks. The trend was gradual and consistent (See Tables 3.4, 3.5 and Figures 3.3 and 3.4). This study revealed that the young children who participated in this study did in fact demonstrate the <u>beginnings</u> of the ability to separate and control variables, and it became easier for them or they became more successful as they became older or were in a higher grade level. According to Piaget's stages of development, the children in this study (five years and six months of age through nine years and three months of age), were somewhere in/or between the preoperational and concrete operational stages of development, and therefore should not have acquired the mental structures necessary for

the separation and control of variables. Consequently, this study has raised questions concerning Piaget's theory for the the separation and control of variables, especially that the ability to separate and control variables more or less belongs to the formal operational stage of development. In view of the findings of this study, it is appropriate to concur with Wollman, who also does not believe that the concept of the separation and control of variables develops spontaneously or that the concept was found only at the formal stage of development (Wollman, 1977). This study clearly revealed a gradual, continuous and consistent unfolding of understandings necessary for the beginnings of the ability to separate and control variables. In view of this study and the findings, it is necessary to support the notion that development is gradual, consistent and continuous across all stages of development.

ADDITIONAL INFORMATION

Although gender was not considered as one of the main effects in the original design of the study, the gender information was available from each subject's response form. Analysis indicated there was no significant difference due to gender, as shown in the ANOVA source table (Table 3.6). The mean scores for the age groups by gender are found in Table 3.7, and the mean scores for the interaction of tasks-by-levels, are recorded in Table 3.8. Gender Group 1 was assigned to males, while Gender Group 2 was assigned to the female subjects.

Table 3.6

ANOVA Source Table of Overall Results by Gender

Source	DF	F Value	PR < F
Gender	1	1.15	0.7037
Gender X Tasks	2	0.03	0.9751
Gender X Levels	2	1.19	0.3128
Gender X Groups	3	0.86	0.4689
Gender X Tsks. X Lvls.	4	0.44	0.7792

$\alpha = 0.05$

Table 3.7

Mean Scores for Age Groups as Measured by Gender

Gender	Age Groups in Months	N	$\bar{X}$
1(M)	1 (66 - 78 mos.)	15	1.93
1(M)	2 (79 - 90 mos.)	15	1.60
1(M)	3 (91 - 102 mos.)	10	2.40
1(M)	4 (103 - 114 mos.)	13	2.46
2(F)	1 (66 - 78 mos.)	12	1.00
2(F)	2 (78 - 90 mos.)	14	2.07
2(F)	3 (91 - 102 mos.)	15	2.13
2(F)	4 (103 - 114 mos.)	14	2.57

PR > 0.47

Table 3.8

Mean Scores of Tasks and Levels When Measuring by Gender.

Gender	Tasks	Levels	N	$\overline{X}$
1 (M)	I	1	5	3.00
1 (M)	I	2	8	2.50
1 (M)	I	3	4	2.00
1 (M)	II	1	6	1.67
1 (M)	II	2	6	2.33
1 (M)	II	3	9	1.89
1 (M)	III	1	8	2.13
1 (M)	III	2	5	1.20
1 (M)	III	3	2	1.00
2 (F)	I	1	7	3.00
2 (F)	I	2	4	2.25
2 (F)	I	3	8	2.38
2 (F)	II	1	6	1.67
2 (F)	II	2	6	2.00
2 (F)	II	3	3	2.33
2 (F)	III	1	4	3.00
2 (F)	III	2	7	1.29
2 (F)	III	3	10	1.00

PR $>$ 0.78

According to the analysis, there was no significant difference when measuring all of the results by gender. Some child development specialists have promoted the idea that young boys mature more slowly than young girls during the beginning school years; however, for this study there was no significant difference in the performance of the boys and in the performance of the girls (See Tables 3.6, 3.7, and 3.6). The results for these age levels are contrary to a recent study concerning intellectual development as related to gender and age, with 140 sixteen year old students participating; Hernandez, et al. (1984), found that the boys' intellectual development was more advanced that that of the girls'.

Finally, it is of interest to note, by grade levels, the number and percentage of children who were able to both separate and control the variables of their respective tasks (Table 3.9).

Table 3.9

Number and Percentage of Subjects Able to Separate and Control the Variables by Grade Level.

Grade	N	Separate and Control	Percent
K	27	11	37%
1	27	13	48%
2	27	17	62%
3	27	20	74%

CHAPTER IV

DISCUSSION AND CONCLUSION

This chapter includes three sections: (a) A discussion of the research question, the findings and implications, (b) General conclusions of this research and the research of others which is relative to Piaget's stages of development and the theory of the separation and control of variables, and (3) Suggestions for further study.

DISCUSSION

The present research was conducted to find an answer to the following question as stated in Chapter I: Do the <u>beginnings</u> of the developmental scheme of the abilities to separate and control variables appear in children between the ages of five and nine? If a scheme is present that allows young children to begin to separate and control variables, what patterns of language do they use when employing that scheme?

An interpretation of the research and analysis for the entire group of 108 subjects, revealed some rather prominent trends and patterns. The trends were not always linear or

regular, nor did they always follow a set pattern but the trends were present. (Tables 3.1 and 3.)

The following conclusions seem justified from the data provided by the 108 subjects:

1. The ability of young children to separate and control variables decreased as the task became more complex and when the content and materials were less familar.

2. The subjects scored lower as the number of variables increased. The ability of young children to separate and control variables decreased as the number of variables increased.

3. In the sample, the older children scored higher than the younger children. In general, the ability of young children to separate and control variables increased with age and grade level. There was a substantial difference in the performance between the kindergarten and the third grade children, but only a slight difference between the kindergarten and first grade children, the first grade and second grade children, and the second grade and third grade children (Tables 3.4,

3.5, 3.9; Figures 3.3, and 3.4)

4. For eight of the nine samples of the population used for this research, the increases and/or decreases in scores for task performance across all tasks and levels was gradual, consistent, and continuous. As the number of variables increased and as the tasks increased in difficulty, the overall scores gradually, consistently and continuously decreased. As the children in the sample became older and/or as they reached a higher grade level, the overall scores gradually, consistently, and continuously increased; the subjects gradually, consistently, and continuously became more successful in task performance (Tables 3.4, 3.5, 3.9; Figures 3.3, and 3.4).

The data confirm that young children do in fact, have the beginnings of the ability to separate and control variables provided the tasks are presented concretely, the content and materials are familar, and the language of "fairness" is used in the assessment of task performance. This study has confirmed that young children possess the mental structures necessary for the beginnings of the ability to separate and control variables and demonstrate that ability through task performance.

The more important implications of this research for teachers of young children and/or child development specialists are in the areas of planning curriculum and instruction. When guiding young children in the process of learning, the learning and/or assessment tasks should: (a) Be presented concretely; (b) Consist of familar content and materials; (c) Use a language that is simple, direct and easily understood. It should also be expected that as children become older and/or more mature in their cognitive development, they will become more successful with task performance.

GENERAL CONCLUSIONS

This study supports the theory that intellectual development is gradual, rather consistent, and is continuous (Tables 3.2, 3.4, 3.5, and 3.9). The present study cannot support the idea that the specific intellectual characteristics leading to the development of the scheme of the separation and control of variables, are only found in the formal operational stage of development. Nor does this research support the position that the stages are abrupt and/or spontaneous. According to the Piagetian model of intellectual development (Piaget, (1972), the children in this study were in or somewhere between the preoperational stage, two through seven or eight years, or concrete operational stage of development which children enter after seven or eight years of

age. Those children therefore, should not have been able to employ the scheme of the separation and control of variables (Piaget, 1955). The children in this study did demonstrate the beginnings of the separation and control of variables scheme as described in Chapter II and as described earlier in this chapter, as long as the criterion for judgement was "fairness" (Tables 3.2, 3.4, 3.5, and 3.9).

In view of this study and the findings, it is necessary to support the theory that for some children, the beginnings of the separation and the control of variables scheme, occurs as early as the preoperational stage with further development occurring during the concrete operational stage (Tables 3.4, 3.5, and 3.9). It is expected that as development continues, that the separation and control of variables scheme would also continue to develop.

In addition to the findings of this study, Wollman's research (1977), led him to postulate that the concept of the separation and control of variables does not develop spontaneously nor does it belong exclusively to the formal stage of development. Wollman also believed that the concept of controlled experiments using the "fair" comparison, begins to develop as early as the beginning of the concrete stage. Data presented here supports Wollman and suggests that the "fairness" concept can begin earlier. Wollman further theorized that "fairness" and "evenness" are at the "root" of the

concept of the separation and control of variables scheme. Therefore, he advised that the separation and control of variables should not be neglected at the concrete stage of development, nor should it be taken for granted at the formal stage of development (Wollman, 1977).

In addition to the findings of this research, Flavell (1971), has supported the postulate that Piaget's stages do not begin nor do they end abruptly. Flavell also perceived that if the stages emerged abruptly rather than gradually, children would spend all of their childhood years "being" rather than "becoming". It was also Flavell's belief that the Piagetian Stages may evolve more slowly and gradually toward their full functional maturity, achieving it well after the upper age boundary of a particular stage. The data presented here suggest that the characteristics of a given stage <u>can begin</u> to emerge at an earlier stage than the stage designated by Piaget. This study has confirmed that it is possible for the <u>beginnings</u> of the separation and control of variables characteristic to emerge before the formal operational stage; the separation and control of variables characteristic may begin to emerge in the preoperational and concrete operational stages. (Tables 3.1, 3.2, 3.4, 3.5, and 3.9)

Wadsworth (1984) also has raised questions concerning the Piagetian concepts and characteristics in relation to stages of development.

"There is little doubt that Piaget's theory of cognitive development will continue to change and will become more refined, as it has over the years. Some Piagetian concepts may not stand up in the face of future research. Others certainly will. . . .Needless to say, the implications of Piaget's concepts for education have not been exhausted. . . .Piaget's work has generated a degree of interest and inquiry that is unprecedented, and it shall continue to do so for many years" (Wadsworth, 1984, pp. 198-199).

SUGGESTIONS FOR FURTHER STUDY

In conclusion, there is one segment of the present research that suggests the need for further study. Specifically, more research is needed involving Level One of Task II. A close examination of the combined mean scores for all of the task-level combinations (Table 3.2), clearly indicates a distinct consistency and continuity in eight of the nine situations. There is however, a distinct discrepancy for Level One of Task II. Additional research with that particular task-level combination could help to resolve the question of the one inconsistent outcome of this research.

Although the present research does not indicate a need for the study to be repeated, perhaps replicating the research

in a similar school situation would enhance this investigation. In addition to expanding this research, repeating it could help to substantiate or refute the present research findings.

Finally, it would be interesting as well as appropriate to conduct this research study in two contrasting schools such as: (a) a textbook oriented, self-contained, traditional type of school; and (b) in an inquiry, child-centered, task oriented, open type of school. Comparisons could be made to see if instructional methodology might be a factor in the ability of young children to develop the ability to separate and control variables. Although instructional procedures were not considered as a part of this study, the influence of instruction would add a useful dimension to the present research. It would be helpful to teachers of young children and/or child development specialists in planning curriculum for children to determine if certain instructional procedures could help to facilitate cognitive development. In addition, a study such as the one suggested, would broaden the base of understanding as to <u>how</u> and <u>when</u> young children <u>begin</u> to acquire the scheme of the separation and control of variables.

REFERENCES

Case, R. (1974, Summer). Structures and strictures: Some functional limitations on the course of cognitive growth. Cognitive Psychology, 6, 4, 544-73.

Case, R. (1978). A developmentally based theory and technology of instruction, Review of Educational Research, 48, 3, 439-63.

Cicchetti, D. V. (1972). Extension of multiple-range tests to interaction tables in the analysis of variance. A rapid approximate solution. Psychological Bulletin, 77, 405-08.

Cowan, P. A. (1978). Piaget with feeling, cognitive, social, and emotional dimensions. Chapter 10: Early and late formal operations - cognitive aspects. (pp. 248-79). New York: Holt, Rinehart, and Winston.

Danner, F. W. & Day, M. C. (1977). Eliciting formal operations. Child Development, 48, 1600-06.

Flavell, J. H. (1971). Stage-related properties of cognitive development, Cognitive Psychology, 2, 4, 422-53.

Gorman, R. M. (1972). Discovering Piaget, a guide for teachers. (pp. 111-15). Columbus, Ohio: Charles E. Merrill.

Grippin, P. & et al. (1973, November). A cross-sectional study of cognitive variables. Paper presented at the Annual Meeting of the Northeastern Educational Research Association. (10 pages). Ellenville, New York.

Hays, W. L. (1981). Statistics. (pp. 401-11). New York: Holt, Rinehart, and Winston.

Hernandez, L. D., Marek, E. A., & Renner, J. W. (1984). Relationships among gender, age, and intellectual development. Journal of Research in Science Teaching, 1, 4, 365-75.

Howe, A. C. & Mierzwa, J. (1977). Promoting the development of logical thinking in the classroom. Journal of Research in Science Teaching, 14, 5, 467-71.

Inhelder, B. & Piaget, J. (1958 [originally published in 1955]). The growth of logical thinking from childhood to adolescence. (pp. 46-67). New York: Basic Books.

Lawson, A. E. (1979). Combining variables, controlling variables, and proportions: Is there a psychological link? Science Education, 63, 1, 67-72.

Levine, D. I. & Linn, M. C. (1976). Scientific reasoning

ability in adolescence: Theoretical viewpoints and educational implications, advancing education through science oriented programs. Journal of Research in Science Teaching, 14, 4, 371-84.

Linn, M. C. (1978). Influence of cognitive style and training on tasks requiring the separation of variables scheme. Child Development, 49, 3, 874-77.

Linn, M. C. & Rice, M. P. (1979, Spring). A measure of scientific reasoning: The springs Task. The Journal of Educational Measurement, 16, 1, 55-61.

Minium, E. W. (1978). Statistical reasoning in psychology and education (2nd ed.). (pp. 547-49). New York: John Wiley and Sons.

Nunnally, J. C. (1978). Psychometric Theory (2nd ed.). (pp. 75-100). New York: McGraw Hill.

Piaget, J. (1974 [originally published in 1972, Paris]). The child and reality: Problems of genetic psychology. (pp. 49-70). New York: Viking Press.

Renner, J. W., Stafford, D. G., Lawson, A. E., McKinnon, J. W., Friot, F. E., & Kellog, D. H. (1976). Research, teaching, and learning with the Piaget model. (pp. 66-139). Norman, Oklahoma: University of Oklahoma Press.

Renner, J. W. & Stafford, D. G. (1979). Teaching science in the elementary school. (pp. 3-90). New York: Harper and Row.

Selnes, M. (1983, March). Is it fair? Science Scope, National Science Teachers Association Bulletin for Middle/Junior High Science Teachers, 6, 4, 3.

Statistical Analysis System Institute. (1982). Statistical Analysis System, Inc., (82.3). Cary, N. C.: Author.

Steller, J. Ph. (1977). What is the difference? School Science Review, 59, 206, 142-45.

Stone, C. A. & Day, M. C. (1978). Levels of availability of a formal operational strategy. Child Development. 49, 4, 1054-65.

Tobin K. G. & Capie, W. (1980, April). The test of logical thinking development and applications. Paper presented at the Annual Meeting of the Association for Research in Science Teaching (53rd). (19 pages). Boston.

Tobin K. G. & Capie, W. (1980, April). The development and validation of a group test of logical thinking. Paper presented at the Annual Meeting of the American Educational Research Association (64th). (31 pages). Boston.

Turney, B. & Robb G. (1971). Research in education: An

introduction. (pp. 154-61). Hinsdale, Illinois: The Dryden Press, Inc.

Wadsworth, B. J. (1984). Piaget's theory of cognitive and affective development. (pp. 172-200). New York: Longman.

Webster, (1968). Webster's third new international dictionary unabridged. Philip Babcock Gove & Merriam Webster Staff (Ed.s). pp. 198, 2,533. Springfield, Mass: C. & C. Merriam Co. (Originally published 1828, 1841)

Winer, B. J. (1971). Statistical principles in experimental design (2nd ed.). (pp. 619-25). New York: McGraw Hill.

Wollman W. (1977). Controlling variables: Assessing levels of understanding. Science Education, 61, 3, 371-83.

Wollman W. (1977). Controlling Variables: A new-Piagetian developmental sequence. Science Education, 61, 3, 385-91.

APPENDIX A

THE TASK PROTOCOLS

APPENDIX A

THE TASK PROTOCOLS

Task I - The Bouncing Balls

Level 1 (uncontrolled variable - height)

Materials: Two tennis balls

Protocol:

"I have two tennis balls."

(Show the tennis balls to the child.)

"What will happen if I drop the balls and allow them to strike the floor?"

(Child should indicate that the balls will bounce.)

"How will you know if one of these balls has more bounce or will bounce higher than the other ball?"

(The child should indicate that one ball will bounce higher than the other ball.)

"We are going to test to see which ball has more bounce or will bounce higher."

"I will now do the experiment to test which ball has more bounce or will bounce higher. I will hold this

ball here."

(Hold the first ball about 1 meter directly above the floor.)

"And I will hold the other ball here."

(Hold the second ball about 1½ meters above the floor.)

"I am going to drop the two balls at exactly the same time. Will that be a "fair" test to tell me which ball has more bounce?"

(Allow for the child's response. If the child responds with a "yes" terminate the interview. If the child responds with a "no" ask:)

"Why isn't the test fair?"

"How can I change the test to make it fair?"

(Allow the child time to show he/she understands that the uncontrolled variable was not properly controlled.)

"Are there any other changes that I should make?"

(Used only in the case the child suggests at least one change.)

(The interview will be terminated when the child says no more changes are necessary.)

Task I - The Bouncing Balls

Level 2 (uncontrolled variables - height and surface)

Materials: Two tennis balls, a square of hard surface, and a square of soft surface such as a square of carpet. (Squares should already be in place.)

Protocols:

"I have two tennis balls."

(Show the tennis balls to the child.)

"What will happen if I drop the balls and allow them to strike the floor?"

(Child should indicate that the balls will bounce.)

"How will you know if one of these balls has more bounce or will bounce higher than the other ball?"

(The child should indicate that one ball will bounce higher than the other.)

"We are going to test to see which ball has more bounce or will bounce higher."

"I will now do the experiment to test which ball has more bounce or will bounce higher. I will hold this ball here so that when I drop it, it will land here."

(Hold the first ball about 1 meter directly above the hard surface. Point at the surface.)

"And I will hold the other ball here so that when I drop it, it will land here."

(Hold the second ball about 1½ meters directly above the soft surface. Point at the surface.)

"I am going to drop the two balls at exactly the same time. Will that be a "fair" test to tell me which ball has more bounce?"

(Allow for the child's response. If the child responds with a "yes" terminate the interview. If the child responds with a "no" ask:)

"Why isn't the test fair?"

"How can I change the test to make it fair?"

(Allow the child time to show he/she understands that the uncontrolled variables were not properly controlled.)

"Are there any other changes that I should make?"

(Used only in the case the child suggests at least one change.)

(The interview will be terminated when the child says no more changes are necessary.)

Task I - The Bouncing Balls

Level 3 (uncontrolled variables - height, surface, and force)

Materials: Two tennis balls, square of hard surface, and square of soft surface such as a square of carpet. (Squares should already be in place.)

Protocol:

"I have two tennis balls."

(Show the tennis balls to the child.)

"What will happen if I drop the balls and allow them to strike the floor?"

(Child should indicate that the balls will bounce.)

"How will you know if one of these balls has more bounce or can bounce higher than the other ball?"

(The child should indicate that one ball will bounce higher than the other.)

"We are going to test to see which ball has more bounce. I will hold this ball here so that when I drop it, it will land here."

(Hold the first ball about 1 meter directly above the hard surface. Point at the surface.)

"And I will hold the other ball here so that when I throw it, it will land here."

(Hold the second ball about 1½ meters directly above the soft surface. Point at the surface.)

"If I drop this ball," (indicate the first ball), "and if I throw this ball," (said without inflection but with a wrist throwing motion demonstrated), "at the same time, will that be a "fair" test to tell me which ball has more bounce?"

(Allow for the child's response. If the child responds with a "yes" terminate the interview. If the child responds with a "no" ask:)

"Why isn't the test fair?"

"How can I change the test to make it fair?"

(Allow the child time to show he/she understands that the uncontrolled variables were not properly controlled.)

"Are there any other changes that I should make?"

(Used only in the case the child suggests at least one change.)

(The interview will be terminated when the child says no more changes are necessary.)

Task II - The Foot Race

Level 1 (uncontrolled variable - footwear)

Materials: Model - consisting of the ice cream store, sidewalk path, Jack (in boots) and Joe (in tennis shoes).

Protocols:

"This is a model of Jack and Joe who are about ready to run a race."

"As you can see, Jack is wearing gym shorts, a T-shirt, and a pair of boots."

"Joe is wearing gym shorts, a T-shirt, and a pair of tennis shoes."

"The race will be run from the street curb to the ice cream store."

(Point out the course of the race to the child.)

(When certain the child understands what the model is depicting, continue:)

"Is this a fair race to see which boy can run the faster and reach the ice cream store first?"

(Allow for the child's response. If the child responds with a "yes" terminate the interview. If the child responds with a "no" ask:)

"Why isn't the race a fair test?"

"How can I change the test to make it fair?"

(Allow the child time to show he/she understands that the uncontrolled variables were not properly controlled.)

"Are there any other changes that I should make?"

(Used only in the case the child suggests at least one change.)

(The interview will be terminated when the child says no more changes are necessary.)

Task II - The Foot Race

Level 2 (uncontrolled variables - footwear and a cluttered path)

Materials: Model - consisting of the ice cream store, cluttered sidewalk path (in front of Jack), Jack (in boots) and Joe (in tennis shoes).

Protocol:

"This is a model of Jack and Joe who are about ready to run a race."

"As you can see, Jack is wearing gym shorts, a T-shirt, and a pair of boots. The path in front of Jack has a baby stroller, a stick horse and other things on it."

"Joe is wearing gym shorts, a T-shirt, and a pair of tennis shoes."

"The race will be run from the street curb to the ice cream store."

(Point out the course of the race to the child.)

(When certain the child understands what the model is depicting, continue:)

"Is this a fair race to see which boy can run the faster and reach the ice cream store first?"

(Allow for the child's response. If the child responds with a "yes" terminate the interview.

If the child responds with a "no" ask:)

"Why isn't the race a "fair" test?"

"How can I change the test to make it fair?"

(Allow the child time to show he/she understands that the uncontrolled variables were not properly controlled.)

"Are there any other changes that I should make?"

(Used only in the case the child suggests at least one change.)

(The interview will be terminated when the child says no more changes are necessary.)

Task II - The Foot Race

Level 3 (uncontrolled variables - footwear, cluttered path and carrying books)

Materials: Model - consisting of the ice cream store, models of Jack (in boots) and Joe (in tennis shoes), cluttered sidewalk path (in front of Jack) and Jack carrying books.

Protocol:

"This is a model of Jack and Joe who are about ready to run a race."

"As you can see, Jack is wearing gym shorts, a T-shirt, and a pair of boots. The path in front of Jack has a baby stroller, a stick horse and other things on it. Jack is also carrying his school books."

"Joe is wearing gym shorts, a T-shirt and a pair of tennis shoes."

"The race will be run from the street curb to the ice cream store."

(Point out the course of the race to the child.)

(When certain the child understands what the model is depicting, continue:)

"Is this a fair race to see which boy can run the faster and reach the ice cream store first?"

(Allow for the child's response. If the child responds with a "yes" terminate the interview. If the

child responds with a "no" ask:)

"Why isn't the race a "fair" test?"

"How can I change the test to make it fair?"

(Allow the child time to show he/she understands that the uncontrolled variables were not properly controlled.)

"Are there any other changes that I should make?"

(Used only in the case the child suggests at least one change.)

(The interview will be terminated when the child says no more changes are necessary.)

Task III - The Bending Rods

Level 1 (uncontrolled variable - length)

Materials: Two identical rods, two identical weights and one support stand.

Protocol:

"I have two metal rods that are exactly alike."

"Look at the rods carefully. You will notice they are made of the same material and they are the same length."

(Flex the rods.)

"When I let go it is straight again. But if I bend it too far it will not be straight again."

"Watch while I bend this piece of wire. I bent it too far. It is not straight when I let go."

"The amount I can bend a rod and have it come back straight when I let go, tells me how bendable the rod is."

"Look at the ends of the rods. One end on each rod has a hook on it."

"Now look at the ends without hooks on them. One rod is just as thick (or fat) as the other."

(Show the child the support stand. Explain the grooves and the thumb screws.)

"I will take the rods and place them in the grooves

in the stand like this and I will screw the thumb screws down tightly."

"You will notice I can make the rods longer or shorter by the way I put the rods in the stand."

(Move the rods back and forth in the grooves on the stand.)

"Now I am going to place the rods in the grooves on the stand like this and screw the thumb screws down tightly."

(Be sure the rods extend different distances from the clamp.)

(Show the child two identical weights [100 grams] and point to the numbers on the weights.)

"These two weights, weigh exactly the same."

"I am going to hang the weights on the ends of the rods that have the hooks on them."

"What do you think will happen to the rods when we hang the weights on the rods?"

(If the child says that the rods will bend, agree with him/her by saying, "So do I.")

(If the child says he/she does not know what will happen, tell him/her that the rods will bend.)

"Now I am going to hang one of these weights on each rod to see which rod is more bendable."

"Look at the rods. Before I hang these weights on the rods, tell me if hanging these weights (point to the

weights) on these rods (point to the rods) just as they are, is a fair test to see which rod is more bendable, or will bend the most?"

(Allow for the child's response. If the child responds with a "yes" terminate the interview. If the child responds with a "no" ask:)

"How can I change the test to make it fair?"

(Allow the child time to show he/she understands that the uncontrolled variables were not properly controlled.)

"Are there any other changes that I should make?"

(Used only in the case the child suggests at least one change.)

(The interview will be terminated when the child says no more changes are necessary.)

Task III - The Bending Rods

Level 2 (uncontrolled variables - length and diameter)

Materials: Two rods of different diameters, two identical weights, and one support stand.

Protocol:

(The task for this level will be exactly the same as the Level 1 except the two rods should be of different diameter.)

"I want you to look at these two metal rods."

"Look at the rods carefully. You will notice they are made of the same material and they are the same length."

(Flex the rods.)

"When I let go it is straight again. But if I bend it too far it will not be straight again."

"Watch while I bend this piece of wire. I bent it too far. It is not straight when I let go."

"The amount I can bend a rod and have it come back straight when I let go, tells me how bendable the rod is."

"Look at the ends of the rods. One end on each rod has a hook on it."

"Now look at the ends without hooks on them. One rod is thicker (or fatter) than the other."

(Show the child the support stand. Explain the grooves and the thumb screws.)

"I will take the rods and place them in the grooves in the stand like this and I will screw the thumb screws down tightly."

"You will notice I can make the rods longer or shorter by the way I put the rods in the stand."

(Move the rods back and forth in the grooves on the stand.)

"Now I am going to place the rods in the grooves on the stand like this and screw the thumb screws down tightly."

(Be sure the rods extend different distances from the clamp.)

(Show the child two identical weights [100 grams] and point to the numbers on the weights.)

"These two weights, weigh exactly the same."

"I am going to hang the weights on the ends of the rods that have the hooks on them."

"What do you think will happen to the rods when we hang the weights on the rods?"

(If the child says that the rods will bend, agree with him/her by saying, "so do I.")

(If the child says he/she/does not know what will happen, tell him/her that the rods will bend.)

"Now I am going to hang one of these weights on

each rod to see which rod is more bendable."

"Look at the rods. Before I hang these weights on the rods, tell me if hanging these weights (point to the weights) on these rods (point to the rods) just as they are, is a fair test to see which rod is more bendable, or will bend the most?"

(Allow for the child's response. If the child responds with a "yes" terminate the interview. If the child responds with a "no" ask:)

"How can I change the test to make it fair?"

(Allow the child time to show he/she understands that the uncontrolled variables were not properly controlled.)

"Are there any other changes that I should make?"

(Used only in the case the child suggests at least one change.)

(The interview will be terminated when the child says no more changes are necessary.)

Task III - The Bending Rods

Level 3 (uncontrolled variables - length, diameter, and weight)

Materials: Two rods of different diameters, two weights of different values, and one support stand.

Protocol:

(The task for Level 3 is the same as for level 2 except weights of different values should be hung from the rods.)

"I want you to look at these two metal rods."

"Look at them carefully. You will notice they are made of the same material and they are the same length."

(Flex the rods.)

"When I let go of the rod, it is straight again. But if I bend one of the rods too far, it will not be straight again."

"Watch while I bend this piece of wire. I bent it too far. It is not straight when I let go."

"The amount I can bend a rod and have it come back straight when I let go, tells me how bendable the rod is."

"Look at the ends of the rods. One end on each rod has a hook on it."

"Now look at the ends without hooks on them. One

rod is thicker (or fatter) than the other rod."

(Show the child the support stand. Explain the grooves and the thumb screws.)

"I will take the rods and place them in the grooves in the stand like this and I will screw the thumb screws down tightly."

"You will notice I can make the rods longer or shorter by the way I put the rods in the stand."

(Move the rods back and forth in the grooves on the stand.)

"Now I am going to place the rods in the grooves on the stand like this and screw the thumb screws down tightly."

(Be sure the rods extend different distances from the clamp.)

(Show the child two weights of different values; one weight 100 grams and the other 50 grams, and point out the numbers on the weights to the child.)

"These two weights have different values which means one is heavier than the other. You will notice they have different numbers on them which helps us to know which one is the lighter and which is the heavier."

"We are going to hang the weights on the ends of the rods that have the hooks on them."

"What do you think will happen to the rods when we hang the weights on the rods?"

(If the child says that the rods will bend, agree with him/her by saying, "so do I.")

(If the child says he/she does not know what will happen, tell him/her that the rods will bend.)

"Now I am going to hang one of these weights on each rod to see which rod is the more bendable."

"Look at the rods. Before I hang these weights on the rods, tell me if hanging these weights (point to the weights) on these rods (point to the rods) just as they are, is a fair test to see which rod is the more bendable?"

(Allow for the child's response. If the child responds with a "yes" terminate the interview. If the child responds with a "no" ask:)

"How can I change the test to make it fair?"

(Allow the child time to show he/she understands that the uncontrolled variables were not properly controlled.)

"Are there any other changes that I should make?"

(Used only in the case the child suggests at least one change.)

(The interview will be terminated when the child says no more changes are necessary.)

APPENDIX B

INDIVIDUAL SUBJECT PROFILES

BY GRADE LEVEL

APPENDIX B

INDIVIDUAL SUBJECT PROFILES BY GRADE LEVEL

Table A: Kindergarten

S No.	GENDER	TASK	LEVEL	GRADE/	AGE YRS.	AGE MOS.	SEP. VAR.	CONT. VAR.	TOTAL SCORE
11	M	I	1	K	5	70	1	2	3
07	F	I	1	K	5	71	1	2	3
14	M	I	1	K	5	69	1	2	3
15	M	I	2	K	5	71	1	2	3
25	M	I	2	K	5	17	1	2	3
16	F	I	2	K	6	72	0	0	0
02	F	I	3	K	5	70	1	2	3
21	F	I	3	K	5	70	0	0	0
12	M	I	3	K	5	70	1	0	1
13	M	II	1	K	5	69	0	0	0
19	M	II	1	K	5	70	1	2	3
09	F	II	1	K	5	70	1	0	1
22	M	II	2	K	5	71	1	0	1
05	F	II	2	K	5	73	1	0	1
23	M	II	2	K	5	71	1	2	3
24	M	II	3	K	6	73	1	0	1
08	F	II	3	K	6	71	1	0	1
10	M	II	3	K	6	73	1	2	3
26	M	III	1	K	6	73	0	0	0
01	M	III	1	K	6	72	1	2	3
06	M	III	1	K	6	74	1	0	1
03	M	III	2	K	5	70	1	0	1
27	F	III	2	K	6	74	1	0	1
17	F	III	2	K	6	74	0	0	0
04	F	III	3	K	6	75	1	0	1
18	F	III	3	K	6	75	0	0	0
20	F	III	3	K	6	74	1	0	1

INDIVIDUAL SUBJECT PROFILES BY GRADE LEVEL

Table B: First Grade

S No.	GENDER	TASK	LEVEL	GRADE/	AGE YRS.	AGE MOS.	SEP. VAR.	CONT. VAR.	TOTAL SCORE
13	F	I	1	1	7	84	1	2	3
16	F	I	1	1	6	83	1	2	3
22	F	I	1	1	6	82	1	2	3
17	M	I	2	1	7	84	1	2	3
21	M	I	2	1	7	86	1	0	1
04	M	I	2	1	7	84	1	2	3
23	F	I	3	1	7	87	1	0	1
12	F	I	3	1	7	86	1	2	3
27	M	I	3	1	7	86	1	0	1
24	F	II	1	1	6	81	0	0	0
08	M	II	1	1	6	83	1	2	3
10	F	II	1	1	6	83	1	2	3
01	F	II	2	1	6	83	1	0	1
14	M	II	2	1	7	84	1	2	3
09	M	II	2	1	7	84	1	2	3
07	M	II	3	1	7	84	1	0	1
05	F	II	3	1	7	86	1	2	3
19	M	II	3	1	3	86	1	2	3
26	M	III	1	1	6	81	1	2	3
18	M	III	1	1	6	82	1	0	1
25	F	III	1	1	6	81	1	2	3
15	F	III	2	1	6	83	1	2	3
20	M	III	2	1	6	83	0	0	0
11	M	III	2	1	7	84	1	0	1
03	F	III	3	1	7	84	1	0	1
06	F	III	3	1	7	86	1	0	1
02	M	III	3	1	7	85	1	0	1

INDIVIDUAL SUBJECT PROFILES BY GRADE LEVEL

Table C: Second Grade

S No.	GENDER	TASK	LEVEL	GRADE/	AGE YRS.	AGE MOS.	SEP. VAR.	CONT. VAR.	TOTAL SCORE
23	F	I	1	2	7	93	1	2	3
07	F	I	1	2	7	95	1	2	3
15	F	I	1	2	7	94	1	2	2
11	M	I	2	2	7	95	1	0	1
03	M	I	2	2	7	95	1	2	3
27	F	I	2	2	8	98	1	2	3
01	M	I	3	2	7	95	1	2	3
16	M	I	3	2	7	95	1	2	3
24	F	I	3	2	7	94	1	2	3
12	M	II	1	2	7	92	1	2	3
18	F	II	1	2	8	96	1	2	3
19	F	II	1	2	7	95	0	0	0
17	F	II	2	2	7	94	1	2	3
09	F	II	2	2	7	93	1	0	1
13	F	II	2	2	7	92	1	2	3
16	M	II	3	2	8	96	1	0	1
10	M	II	3	2	8	97	1	0	1
06	F	II	3	2	7	94	1	2	3
25	M	III	1	2	8	97	1	2	3
04	M	III	1	2	8	97	1	2	3
20	M	III	1	2	8	96	1	2	3
14	F	III	2	2	8	98	0	0	0
05	F	III	2	2	8	98	1	2	3
22	M	III	2	2	7	90	1	0	1
21	F	III	3	2	7	90	1	0	1
02	F	III	3	2	8	96	1	0	1
08	F	III	3	2	7	94	0	0	0

INDIVIDUAL SUBJECT PROFILES BY GRADE LEVEL

Table D: Third Grade

S No.	GENDER	TASK	LEVEL	GRADE/	AGE YRS.	AGE MOS.	SEP. VAR.	CONT. VAR.	TOTAL SCORE
04	M	I	1	3	9	108	1	2	3
05	M	I	1	3	8	104	1	2	3
10	M	I	1	3	8	104	1	2	3
12	F	I	2	3	8	107	1	2	3
13	M	I	2	3	9	111	1	2	3
02	F	I	2	3	9	108	1	2	3
03	F	I	3	3	9	111	1	2	3
11	F	I	3	3	8	104	1	2	3
15	F	I	3	3	8	104	1	0	1
09	F	II	1	3	8	105	1	2	3
18	M	II	1	3	8	106	0	0	0
22	M	II	1	3	9	111	1	2	3
01	M	II	2	3	9	110	1	0	1
08	F	II	2	3	9	110	1	2	3
14	M	II	2	3	8	106	1	2	3
07	M	II	3	3	8	103	1	2	3
16	M	II	3	3	9	111	1	2	3
06	M	II	3	3	9	109	1	2	3
19	F	III	1	3	8	105	1	2	3
23	F	III	1	3	8	103	1	2	3
25	F	III	1	3	8	103	1	2	3
20	M	III	2	3	8	103	1	2	3
17	F	III	2	3	8	104	1	0	1
27	F	III	2	3	8	103	1	0	1
24	M	III	3	3	8	104	1	0	1
26	F	III	3	3	8	105	1	2	3
21	F	III	3	3	8	105	1	0	1