PROBLEM-SOLVING ABILITIES OF YOUNG CHILDREN AS A FUNCTION OF THREE SENSORY CONDITIONS

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PREFACE

This study analyzes the performances of 330 children representing kindergarten, first grade, second grade, third grade, and fourth grade on two class-inclusion problem-solving tasks each presented in one of three randomly assigned sensory conditions as follows: auditory, auditory-visual, or auditory-visual-kinesthetic. The purpose of this investigation is to observe the effects of increasing amounts of sensory stimuli on the problem-solving abilities of young children.

The author wishes to express appreciation for the guidance and assistance provided throughout the study by the committee chairman, Dr. Paul Warden, and members, Dr. Joseph Pearl and Dr. Michael Warner.

For his support, encouragement, and many sacrifices, I dedicate this study to my husband, Don.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

THE RESEARCH QUESTION

Introduction

As early as 68 A.D. a reference to multisensory instructional techniques was made by the Roman orator, Quintilian, who advocated, "learning the sound and the form of the letter simultaneously" (Fernald, 1943). Numerous studies dating from 1894 indicated that when information is transmitted simultaneously through two sensory modalities, more information is retained than when only one modality is involved (Day and Beach, 1950). Additional research has agreed with this conclusion (Massad and Etzel, 1972: Thorpe, Lampe, Nash, and Chiang, 1981). Numerous approaches to teaching have been based on the assumption that the utilization of two or more sensory modalities most effectively maximizes perception, learning, and retention (Fernald, 1943; Lehtinen, 1955; Strauss and Kephart, 1955; Kephart, 1968).

In contrast, Grossman (1981) reported that multisensory procedures have been employed by educators for years with little evidence supporting their applications. An analysis of multisensory instructional methods by Thorpe and Borden (1985) stated that few studies have been conducted and the results of these studies are inconclusive. Furthermore, Johnson and Myklebust (1967) warn of the effects of sensory overloading which create a breakdown in neurological processes leading to a reduction of one's ability to learn. Tulloch (1984), in a discussion

of sensory overloading, stated that many learning problems may not lie in the child, but in an environment that is inappropriate and nonconducive to learning.

Statement of the Problem

More research is needed to determine what effects multisensory stimuli have on the thinking and the learning processes of an individual. Multisensory experiences are those in which a variety of sensory channels are utilized simultaneously. Of the various sensory channels, seeing, hearing, touching, smelling, and tasting, those of greatest importance to educators are the visual (seeing), auditory (hearing), and kinesthetic (touching) modalities (Bissel, White, and Zivin, 1971). The possibility that not only the quality but also the quantity of the stimuli transmitted through these modalities may affect the problem-solving abilities of an individual has significant implications for the fields of education and assessment. Once this issue is resolved, educators may design more effective instructional strategies involving optimal conditions for learning, for example, whether the use of multisensory teaching methods is beneficial. This issue is of special importance to early childhood educators since emphasis is placed on teaching with visual and kinesthetic methods while possibly obscuring the auditory capabilities of young children (McClinton, 1981). Research has indicated that young children solve problems most efficiently when presented the tasks in a verbal-only condition without the distractions of visual and kinesthetic cues (McClinton, 1981; Wohlwill, 1968). Furthermore, the assessment procedures of children's problem-solving abilities could be improved with increased knowledge concerning with what type of presentation, for example, auditory or auditory plus visual cues, a child

performs best. In addition, the most effective presentation may be different for different age levels.

This investigation examines the effects of three sensory conditions, auditory, auditory plus visual, and auditory plus visual plus kinesthetic, on the problem-solving abilities of young children. It is designed to answer the following question: Is there a significant difference in the number of correct responses to problem-solving tasks when comparing the performance of the subjects within each grade level by conditions?

Purpose of the Study

The purposes of this study are to examine relevant research and to investigate young children's problem-solving abilities as these abilities are affected by the presentation of tasks in three sensory input conditions as follows: auditory, auditory-visual, and auditory-visual-kinesthetic. A total of 330 subjects representing kindergarten, first grade, second grade, third grade, and fourth grade compose the sample. Each subject was presented two class-inclusion tasks in one of three randomly assigned sensory conditions. The class-inclusion problem involved the presentation of a set of objects to a subject whereby the main task was to compare the majority subset to the superordinate set. For example, when viewing a set of six dogs and three cats, a child was asked, "Do I have more dogs or more animals?" The successful completion of the task required the subject to compare the majority subset (dogs) with the superordinate set (animals). In the auditory condition, a child was presented the two class-inclusion tasks without visual or visual-kinesthetic cues. The auditory-visual condition consisted of the presentation of the same two tasks verbally with the addition of visual cues.

The third condition, auditory-visual-kinesthetic, presented the same tasks with the combination of verbal, visual, and kinesthetic cues. An analysis of variance was conducted for each grade level in order to determine if any significant differences exist between the mean number of correct responses for each of the three conditions thereby observing the effects of multisensory stimuli on the problem-solving abilities of young children.

Hypotheses

The .05 level of significance was specified as necessary in rejecting the following hypotheses:

1. There is no significant difference between the mean number of correct responses to the problem-solving tasks when comparing the auditory, auditory-visual, and auditory-visual-kinesthetic presentations for kindergarten subjects.
2. There is no significant difference between the mean number of correct responses to the problem-solving tasks when comparing the auditory, auditory-visual, and auditory-visual-kinesthetic presentations for first grade subjects.
3. There is no significant difference between the mean number of correct responses to the problem-solving tasks when comparing the auditory, auditory-visual, and auditory-visual-kinesthetic presentations for second grade subjects.
4. There is no significant difference between the mean number of correct responses to the problem-solving tasks when comparing the auditory, auditory-visual, and auditory-visual-kinesthetic presentations for third grade subjects.

5. There is no significant difference between the mean number of correct responses to the problem-solving tasks when comparing the auditory, auditory-visual, and auditory-visual-kinesthetic presentations for fourth grade subjects.

Limitations

All students in the sample attended the same public school located in a rural southwestern Oklahoma community of approximately five thousand residents. For this reason, caution should be used when generalizing the results to other populations.

Summary

By analyzing the performances of young children on two class-inclusion problem-solving tasks, each presented in three sensory conditions, the most successful condition in the completion of each task was identified for each grade level. 330 children representing kindergarten, first grade, second grade, third grade, and fourth grade were tested. Each child was administered two class-inclusion tasks in one of three randomly assigned conditions as follows: auditory, auditory-visual, or auditory-visual-kinesthetic. The purpose of the study was to observe the effects of multisensory stimuli on the problem-solving abilities of young children.

CHAPTER II

REVIEW OF LITERATURE

Multisensory Research

The suggestion that not only the quality, but also the quantity of sensory stimuli may affect the processing of information is of utmost concern to education in view of the widely accepted assumption that those conditions containing more stimuli increase learning. Day and Beach (1950) asserted that when redundant information is simultaneously transmitted through two sensory modalities, for example, vision and hearing, retention is increased when compared to the condition whereby only one modality is involved. These researchers cited seven studies dating from 1894 to 1936 supporting this position. Grossman (1981) reported that multisensory techniques for teaching spelling and reading have been used since the 1920's. Thorpe and Borden (1985) outlined the following rationalizations supporting the use of multisensory techniques: 1) Multisensory methods provide maximum sensory input to the brain (Haring and Bateman, 1977). 2) Kinesthetic input compensates for visual and auditory weaknesses (Hallahan and Kauffamn, 1976). 3) Auditory and kinesthetic modes support the visual channel (Gearheart, 1981). 4) The recognition of the specific characteristics of the learning tasks may be enhanced by the active involvement of all of the senses (Smith, 1983). 5) A child's visual attention is drawn to a manual task since, over the years, a bond is formed and strengthened as a child is continually reinforced

by visual sensory input as he performs a manual task (Thorpe and Borden, 1985).

Thorpe and Borden (1985) examined the effects of multisensory instruction upon the word reading accuracy and the on-task behaviors with seven, eight, and nine-year-olds identified as learning disabled. One conclusion of this study was that the visual-auditory-kinesthetic-tactile techniques produced superior results when compared to visual-auditory techniques on on-task behaviors and short term learning. A second conclusion was that multisensory procedures are successful because the student displays increased attention to the task. A third conclusion was that multisensory instruction is an efficient way to increase learning.

Key, Bell, and Davis (1981) reported in a review of research concerning paired associative learning, the combination of a verbal plus a pictorial presentation proved superior relative to a verbal only presentation. This superiority remained invariant across grade levels. Jones (1973) achieved similar results with his finding that a combination of pictures and words was the best overall condition to produce greater learning in preschoolers. Furthermore, Levin, Bender, and Lesgold (1976) reported that the verbal recall of information about stories is increased for those subjects seeing pictures while listening to words.

In contrast to the previously cited literature and of particular importance to this study is a theoretical framework for the processing of information as a single channel system provided by Broadbent (1958). This theory contends: 1) A nervous system acts to some extent as a single channel and should be regarded as having limited capacity. 2) A selective operation is performed upon the input to the communication system taking the form of selecting information from all sensory events. 3) The selection of input is not completely random and the

properties of the stimulus and various states of the organism increase the probability of a particular class of events to be selected.
4) Physical intensity, amount of passed time since the information from the last input entered the limited capacity channel, and the type of stimuli, for example, sound as opposed to touch, are properties of the stimulus which increase the likelihood of selection by the organism.
5) The selective process of shifting from one stimulus to another requires a certain amount of time which is significant compared to the time required to perceive an event.

In following Broadbent's model, one would expect that the presentation of information as simultaneous multiple sensory inputs would not facilitate the processing of the information. According to this model, the inputs entering one sensory mode would have access to the higher levels of operations of the brain while other information through other sensory modes would be briefly stored until the channel is cleared thus allowing passage to higher centers of the brain. The inputs which do not gain access soon diminish. It follows that a slower rate of presentation would allow for a person to better switch from one mode to another and that at high rates of transmission one may only actively process one stimulus at a time. The interference of one input with another may result in a perceptual blocking as a result of one's inability to use or store the information. Broadbent's theory may provide an explanation concerning the results of several studies whereby the sensory stimuli are manipulated. These studies revealed a decrement in performance when added sensory cues are simultaneously presented.

One such study was conducted by Van Mondfrans and Travers (1964). This study using adult subjects indicated that:

> ...simultaneous presentation of redundant stimuli at high rates of presentation could result in a decrement in learning as compared to the presentation of the same material using only one sense modality (p. 751).

Baker and Raskin (1973) when studying the performance on letter learning and recognition by kindergarten, first grade, and second grade students, utilizing visual, tactual, and visual plus tactual training, found that the additional tactual input did not increase performance. Vision alone was just as efficient. Ringler and Smith (1973) also reported that the addition of a kinesthetic element was not beneficial in a study focusing on learning modality and word recognition of first grade children.

Interference of one sensory mode with another may also be a factor in the verbal facilitation effect identified by Wohlwill (1968) and McClinton (1981). Wohlwill examined the responses of young children to visually presented items and verbal-only presented items on class-inclusion tasks. It was found that the children's performance in the verbal condition was significantly superior to the visual condition. The effect was termed by Wohlwill as the "verbal facilitation" effect since the verbally presented items did not evoke a distracting "perceptual set" as did the items presented visually. Removing the visual stimuli facilitated the task for the young children. McClinton (1981) added a third presentation which was a kinesthetic presentation to the class-inclusion tasks. The results revealed that a substantial number of four-year-old children responded correctly to the problem solving tasks in the verbal presentation but not when given visual or kinesthetic cues. Although the intent of McClinton's study was to examine the problem-solving abilities of children with tasks presented in separate modalities, this was not possible due to the visual presentation's

inclusion of verbal input. For example, the experimenter said, "Here's a picture of shapes. These are circles and these are squares (pointing). In the picture, are there more squares or shapes? Why (p. 439)?" The same was true of the kinesthetic presentation whereby the experimenter once again added verbal input after the child sorted the objects by stating, "These are circles; these are squares. Are there more circles or more shapes? Why (p. 439)?" These presentations deal more with multiple sensory input techniques rather than studying problem-solving in the separate modalities. It is the purpose of this study to further clarify the effects of the presentation of multisensory input and its relationship to the problem solving abilities of children.

Class-Inclusion Research

A brief review of literature involving class-inclusion problem-solving is germane to this study. The ability to successfully formulate the subclass to superordinate comparisons and to perform the reversible operations on quantified classes is considered to be an indication of the transition from preoperational to concrete operational thought (Trabasso, Isen, Dolecki, McLanahan, Riley, and Tucker, 1978). According to Piaget (1967), the preoperational child's thinking is described as "intuitive" without rational coordination but rather the "simple internalization of percepts and movements in the form of representational images and 'mental experiences' (p. 30)." In comparison, the concrete operational child has the capability to use logic. Piaget (1967) states, "Intuitions become transformed into operations as soon as they constitute groupings which are both composable and reversible (p. 49)." In the Piagetian framework, the failure on class-inclusion tasks by preoperational children

is due to the lack of three abilities: 1) reversibility of transformations, 2) awareness of the inclusion relation, and 3) conservation of the whole (Trabasso, Isen, Dolecki, McLanahan, Riley, and Tucker, 1978).

Winer (1980), in an examination of class-inclusion research, including studies involving the manipulation of the context of the questions, the use of additional perceptual components, the training of subjects, and the determination of the age of skill attainment reported that the results of these studies are inconclusive and more research is needed.

One area of class-inclusion research of particular importance to this study is the determination of the age of development of this skill. The age range suggested by Piaget is from seven to eight years of age and is concurrent to the attainment of concrete operational skills. In a review of thirty-six studies, Winer (1980) revealed that studies indicating later development of the class-inclusion skill, that is past eight years of age, outnumbered studies indicating early development by the ratio of 3:1. In relation to this study, it remains important to examine the performance of young children, for example, kindergarteners, since problem solving performance has been shown to be enhanced by the manipulation of perceptual variables as illustrated by Wohlwill (1968) whereby children between the ages of five and seven had significantly more correct responses to class-inclusion tasks in a verbal-only presentation. In addition, McClinton (1981) produced similar results with four-year-olds.

Summary

The existing literature concerning the effects of simultaneous multisensory input on children's thinking and learning processes is inconclusive. The traditional view that the use of multisensory techniques leads to

increased learning is supported by studies dating from 1894. Several commonly used teaching programs are based on this assumption. In contrast, other research indicates that perceptual blocking occurs as more stimuli are added leading to a decrement in performance. No research was found specifically examining the effects of varying degrees of sensory input on the problem-solving skills of young children.

In addition, a review of literature concerning class-inclusion problem-solving revealed that more research is needed to determine what effect the use of additional perceptual components has on problem solving abilities (Winer, 1980). Some evidence suggests that children between the ages of four and seven may perform significantly better in a verbal-only condition (Wohlwill, 1968; McClinton, 1981).

CHAPTER III

METHODS AND PROCEDURES

Subjects

A total of 330 students representing kindergarten, first grade, second grade, third grade, and fourth grade was tested. A description of the subjects including number, sex, and age is shown in Table I. All students attended regular classes in a public elementary school located in a rural southwestern Oklahoma community of approximately five thousand residents. Each child was checked for adequate visual and auditory acuity based on school records and teacher reports.

TABLE I

DESCRIPTION OF SUBJECTS

Grade	N	Sex Ratio		Mean Age/Median Age	
		M	F		
K	72	34	38	5-10	5-11
1	72	32	40	6-11	6-11
2	60	33	27	8-1	8-1
3	66	32	34	9-0	9-1
4	60	26	34	10-0	10-0

Tasks and Materials

Tasks involving class-inclusion-solving were utilized in this study for several reasons. One reason was that the completion of such tasks necessitates the use of logical operations (Wadsworth, 1979). According to Wadsworth, a logical operation is considered to be the most important developmental cognitive act during the concrete operational period. He further states:

> Logical operations are internalized cognitive actions that permit the child to arrive at conclusions that are 'logical.' These actions are directed by cognitive activity rather than being dominated by perceptions (p. 101-102).

Piaget describes the following as four characteristics of an operation: 1) It is an action that can be internalized. 2) It is reversible. 3) It involves conservation and invariance. 4) It never exists singularly but works in relation to other operations (Wadsworth, 1979). In addition, Klahr and Wallace (1972) reported that class-inclusion reasoning is considered to be the standard measure of concrete operational development by some investigators.

A second reason that class-inclusion tasks were selected to illustrate problem-solving abilities is that it is one of the logical operations that can be readily translated into a verbal form as well as a verbal-visual form and a verbal-visual-kinesthetic form.

Appendix A and Appendix B contain a detailed description of the tasks to be utilized in this study.

Procedures

Within each grade level, subjects were randomly assigned to a condition, auditory, auditory-visual, or auditory-visual-kinesthetic.

Within each condition, problem one and then problem two were administered. Half of the subjects within each condition received the first problem with the superordinate class title heard last and the second problem with the superordinate class title heard first as follows: Problem I-Do I have more dogs or more animals? Problem II-Do I have more flowers or more roses? Half of the subjects within each condition were presented the tasks with the order of the superordinate class title and the majority subclass title reversed as follows: Problem I-Do I have more animals or more dogs? Problem II-Do I have more roses or more flowers? This procedure was followed in order to control for a "recency effect" (Siegel and Goldstein, 1968) whereby when given two choices, a child who does not know the correct response will be more likely to give the last heard alternative as the answer.

Each task was presented in a steady, straightforward manner with no special emphasis on any particular words or phrases. The examiner sat opposite each subject separated by a desk. All materials were kept out of view until the appropriate time. On the record form, Appendix C, all correct responses were coded one and incorrect responses as zero creating the highest possible score of two and the lowest score as zero. In addition, the reason for each response as stated by the subject was recorded below the score on the record sheet.

Statistical Analysis

Separate analyses of variance were computed for each grade level to examine the mean number of correct responses and what effects were significant. The Newman-Keuls multiple comparison procedure was used to identify the source of significant differences among the three condition means. For example, did the subjects in the auditory condition

give more correct responses than those in the auditory-visual or auditory-visual-kinesthetic conditions? The level of significance was set at .05.

Pilot Study

In order to evaluate the proposed record form, the assessment instruments, and the testing procedures, a pilot study was conducted using forty-eight students from kindergarten, second grade, third grade, and fourth grade with twelve subjects from each grade level. All students attended a private elementary school in Tulsa, Oklahoma.

The tasks were altered for the pilot study in that all three conditions including both problems one and two were administered to the same child in one sitting. The formal study presented only one condition to each subject. The three relevant orders of conditions, auditory, auditory-visual, auditory-visual-kinesthetic; auditory-visual, auditory-visual-kinesthetic, auditory; auditory-visual-kinesthetic, auditory, auditory-visual, were counterbalanced resulting in four subjects within each grade level receiving each order. Half of the subjects received the first problem with the superordinate class title heard last and the second problem with the superordinate class title heard first. Half of the subjects were presented the tasks with the order of the superordinate class title and the majority subclass title reversed. In addition, the objects utilized in the class-inclusion tasks were changed for each problem and for each condition. A pilot study task description is located in Appendix D.

The results of the pilot study revealed that the total percentages of correct responses in the auditory condition were equal to or greater than the total for the auditory-visual condition or the total for the

auditory-visual-kinesthetic condition. These results are summarized in Table II.

TABLE II

PERCENTAGE OF CORRECT RESPONSES
BY GRADE LEVEL- PILOT STUDY

Grade	Condition		
	A	A-V	A-V-K
Kindergarten	38	0	0
Second Grade	21	21	17
Third Grade	75	67	67
Fourth Grade	75	54	71

The results of the pilot study indicated a similar pattern of responses to those found by Wohlwill (1968) and McClinton (1981) whereby young children gave more correct responses to class-inclusion tasks in a verbal-only condition. These findings suggested that a replication of the study utilizing a larger number of subjects was in order.

In addition, based on the information gained from the pilot study, minor changes were made in the format of the record sheet as well as the decision to administer only one condition to each subject rather than all three conditions to each subject. This procedure was followed in order to eliminate any familiarity with

the class-inclusion task that a subject might gain from a previous condition. This alteration further allowed the utilization of the same two subclass titles for each problem in each of the three conditions as follows: Problem one, in the formal study, used dogs and cats to represent animals in all conditions. Problem two used daisies and roses to represent flowers in all conditions.

CHAPTER IV

ANALYSIS OF DATA

Results

Following the collection of data, a statistical analysis as outlined in Chapter III was conducted in order to determine if any significant differences existed in the number of correct responses given when comparing the presentation of tasks in the three sensory conditions. A description of the grade x condition interaction is shown in Table III.

TABLE III

PERCENTAGE OF CORRECT RESPONSES
BY GRADE AND CONDITION

Grade	(N)	Condition		
		A	A-V	A-V-K
K	(72)	40	10	6
1	(72)	38	8	13
2	(60)	35	25	15
3	(66)	61	41	36
4	(60)	63	33	38

The percentages of correct responses in the auditory condition were greater than those for the auditory-visual or the auditory-visual-kinesthetic conditions at every grade level. The percentages of correct responses for the auditory-visual condition surpassed those of the auditory-visual-kinesthetic condition in three of the five grade levels. It should be noted that all subjects stated a response. None of the subjects responded, "I don't know." In addition, Table III does not reflect a chance result since it is the compelling nature of the class-inclusion task to formulate a majority subset to a minority subset comparison rather than the correct majority subset to superordinate class comparison. Therefore, a subject who does not possess the class-inclusion problem-solving skill tends to give the incorrect response (the majority subclass title) rather than guess the correct response (the superordinate class title).

Separate analyses of variance using the Newman-Keuls multiple-comparison test were performed for each grade level to determine if the differences between each of the three conditions were significant at the .05 level of significance. The results are summarized in Table IV.

The analysis indicated that the kindergarten and first grade subjects performed significantly better in the auditory condition than in the auditory-visual or the auditory-visual-kinesthetic conditions. No significant differences existed in the performances of second grade, third grade, or fourth grade subjects in any of the three conditions. In addition, no significant differences in performance were indicated between the auditory-visual or auditory-visual-kinesthetic conditions at any grade level.

TABLE IV

ANALYSES OF VARIANCE RESULTS

Grade	DF	ANOVA SS	F Value	p F	Conclusion
K	2	6.86	10.88	.0001	Significant
1	2	4.78	6.26	.0032	Significant
2	2	1.60	1.29	.2837	Not Significant
3	2	2.03	1.27	.2870	Not Significant
4	2	4.43	2.97	.0591	Not Significant

In reference to the recency effect (Siegel and Goldstein, 1978), there was no indication that the position of the correct answer in the sentence influenced the subjects' selections of correct responses. Half of the subjects received problem one with superordinate class title heard last as follows: Are there more dogs or more animals? Problem two followed with the majority subclass title heard last as follows: Are there more flowers or more roses? Half of the subjects received problem one with the majority subclass title heard last and problem two with the superordinate class title heard last. Of the 199 correct responses given by the total number of subjects, 50.3% had the correct alternative heard first, while 49.7% had the correct alternative heard last. This data is summarized in Table V.

Table VI provides a summary of the percentages of correct reasons for correct responses given by the subjects at each grade level. The

TABLE V

FREQUENCY OF CORRECT RESPONSES AS A FUNCTION OF POSITION OF THE CORRECT ANSWER IN THE SENTENCE

Grade	Frequency of Correct Responses							
	Condition						Total	
	A		A-V		A-V-K			
	Correct answer given:							
	first	last	first	last	first	last	f	1
K	9	10	2	3	2	1	13	14
1	10	8	2	2	3	3	15	13
2	8	6	4	6	3	3	15	15
3	12	15	9	9	8	8	29	32
4	14	11	7	6	7	8	28	25
							100	99

TABLE VI

PERCENTAGE OF CORRECT REASONS GIVEN FOR CORRECT RESPONSES FOR EACH CONDITION BY GRADE LEVEL

Grade	(N)	Percentage and Frequency of Correct Responses					
		A	(f)	A-V	(f)	A-V-K	(f)
K	(72)	21	(19)	60	(5)	33	(3)
1	(72)	72	(18)	25	(4)	84	(6)
2	(60)	72	(14)	100	(10)	100	(6)
3	(66)	89	(27)	95	(18)	100	(16)
4	(60)	100	(25)	100	(13)	100	(15)

correct reason for each of the class-inclusion tasks is defined as stating the two subclasses are included in the superordinate class. For example, dogs and cats are both animals. The ability to provide correct reasons for correct answers is somewhat greater for the auditory-visual and the auditory-visual-kinesthetic conditions for all grade levels except fourth. This may be due to the fact that the few children who overcame the distracting visual and kinesthetic cues had surpassed the intuitive reasoning stage as described by Piaget (1967). The intuitive reasoning of the young child can best be explained by the fact that a child's verbal comprehension develops before the ability to verbally express oneself. Therefore, the lack of a correct reason for a correct response does not necessarily indicate a lack of understanding. In addition, the percentages of correct reasons for the auditory-visual and the auditory-visual-kinesthetic conditions for grades kindergarten and first grade may be misleading due to the fact that the number of correct responses in those conditions was significantly lower than the number of correct responses in the auditory condition.

Testing of Hypotheses

This experiment examined the effects of varying degrees of sensory input on the problem-solving abilities of children in grades kindergarten, first, second, third, and fourth. The hypotheses presented in Chapter I were tested using the information gained by this study. The .05 level of significance was specified as necessary in rejecting each hypothesis.

Hypothesis I stated:

There is no significant difference between the mean number of

correct responses to the problem-solving tasks then comparing the auditory, auditory-visual, and auditory-visual-kinesthetic presentations for kindergarten subjects.

The statistical analysis indicated that a significant difference existed between the number of correct responses in the three conditions. Since the performance of kindergarten subjects in the auditory condition was significantly better than their observed performance in the auditory-visual or the auditory-visual-kinesthetic conditions, Hypothesis I is rejected at the .05 level of significance by the evidence presented in this investigation.

Hypothesis II stated:

> There is no significant difference between the mean number of correct responses to the problem-solving tasks when comparing the auditory, auditory-visual, and auditory-visual-kinesthetic presentations for first grade subjects.

The statistical analysis indicated that a significant difference existed between the number of correct responses in the three conditions. Since the performance of first grade subjects in the auditory condition was significantly better than their observed performance in the auditory-visual or the auditory-visual-kinesthetic conditions, Hypothesis II is rejected at the .05 level of significance by the evidence presented in this investigation.

Hypothesis III stated:

> There is no significant difference between the mean number of correct responses to the problem-solving tasks when comparing the auditory, auditory-visual, and auditory-visual-kinesthetic presentations for second grade subjects.

The statistical analysis indicated that no significant differences existed at the .05 level of significance among the mean number of correct responses in the three conditions for second graders. Therefore, Hypothesis III is not rejected on the basis of the evidence presented in this investigation.

Hypothesis IV stated:

> There is no significant difference between the mean number of correct responses to the problem-solving tasks when comparing the auditory, auditory-visual, and auditory-visual-kinesthetic presentations for third grade subjects.

The statistical analysis indicated that no significant differences existed at the .05 level of significance among the mean number of the correct responses in the three conditions for third graders. Therefore, Hypothesis IV is not rejected on the basis of the evidence presented in this investigation.

Hypothesis V stated:

> There is no significant difference between the mean number of correct responses to the problem-solving tasks when comparing the auditory, auditory-visual, and auditory-visual-kinesthetic presentations for fourth grade students.

The statistical analysis indicated that no significant differences existed at the .05 level of significance among the mean number of the correct responses in the three conditions for fourth graders. Therefore, Hypothesis V is not rejected on the basis of the evidence presented in this investigation.

Summary

It was the intent of this study to determine if the problem-

solving abilities of young children are affected by varying degrees of sensory stimuli. These degrees of stimuli were defined as auditory, auditory-visual, and auditory-visual-kinesthetic. The .05 level of significance was specified as necessary in rejecting each hypothesis. It was found that kindergarten and first grade children performed significantly better in the auditory condition when compared to their performances in the auditory-visual or auditory-visual-kinesthetic conditions; therefore, Hypotheses I and II were rejected based on the data from this investigation. No significant differences existed among the number of correct responses in each of the three conditions for second grade, third grade, or fourth grade subjects; therefore, Hypotheses III, IV, and V were not rejected based on the data presented in this investigation.

CHAPTER V

DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

Discussion

The evidence presented by this study indicates that kindergarten and first grade subjects performed significantly better when presented the tasks verbally without the addition of visual or visual-kinesthetic cues. This suggests that the auditory condition without the distraction of the additional sensory stimuli allowed the child to focus his or her attention on the task; thus, improving performance. This finding supports the conclusions of similar studies by Wohlwill (1968) and McClinton (1981) whereby children between the ages of four and seven gave significantly more correct responses to class-inclusion tasks in a verbal-only condition.

With regard to the assessment of young children, caution should be taken when administering tasks requiring the child to cope with varying amounts of simultaneous sensory stimuli. As demonstrated by the performances of kindergarten and first grade subjects, the knowledge required to solve a particular problem may be present, but the correct method, that is sensory condition, might not be used to elicit the knowledge that the child possesses. For example, the reasoning abilities to solve the class-inclusion tasks may have been present for some subjects in the auditory-visual or the auditory-visual-kinesthetic conditions but the additional visual and/or kinesthetic elements restricted the

observation of those abilities.

This study which investigates the effects of varying degrees of sensory input on problem-solving abilities indicates that no significant differences exist among the performances in the three conditions for second grade, third grade, and fourth grade subjects. This conclusion supports the contention that as one develops, he or she is better able to integrate simultaneously received information from more than one sense modality (Bissel, White, and Zivin, 1971).

Conclusions

The effects of increasing degrees of sensory input on the problem-solving abilities of children in kindergarten, first grade, second grade, third grade, and fourth grade were examined in this study. The study utilized two class-inclusion tasks presented in three different sensory conditions. The auditory condition consisted of presenting each problem verbally with no visual or kinesthetic cues. The auditory-visual condition presented each task verbally accompanied by a visual depiction of the problem. The third condition, auditory-visual-kinesthetic, involved the presentation of each problem verbally accompanied by visual and kinesthetic cues in the form of objects for the subject to manipulate. It was found that those kindergarten and first grade subjects who were presented the tasks in the auditory condition performed significantly better than those subjects who were presented the tasks in the auditory-visual or auditory-visual-kinesthetic conditions.

Although the number of correct responses was highest in the auditory condition for every grade level, the differences were not significant at the .05 level for second grade, third grade, and fourth grade students.

These findings suggest that the abilities of kindergarten and first grade children to deal with verbal input and to utilize this input to solve problems are significantly affected by the amount of simultaneous sensory stimuli presented to the child. In contrast, the effect on the performances of older students was not shown significant and may be due to the fact that as one progresses developmentally, he or whe is better able to integrate simultaneous input from more than one sense modality.

Recommendations

The evidence presented by this study indicates that kindergarten and first grade subjects performed significantly better on two class-inclusion tasks in a verbal-only condition when compared to performances in an auditory-visual condition or an auditory-visual-kinesthetic condition. No significant differences in performances were observed for second grade, third grade, or fourth grade subjects. The following recommendations for future research are made:

1. Conduct additional research using subjects from different types of school systems for the purpose of cross-validation.
2. Further analyze the effects of multisensory procedures on the learning processes of individuals and the implications for teaching.
3. Similar research in this area utilizing problem-solving tasks other than class-inclusion is recommended.
4. Evaluate problem-solving abilities and how these abilities are affected by varying degrees of sensory input for younger subjects as well as for older subjects than those used in this study.

5. Examine how different types of students such as those who score high on intelligence tests function in the three conditions.
6. Investigate the effects of varying degrees of sensory stimili on skills other than problem-solving.
7. Evaluate the effects of various sensory conditions on the performances of students in various educational environments such as in open-area classrooms in contrast to self-contained classrooms.

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APPENDIXES

APPENDIX A

DESCRIPTION OF TASK I

DESCRIPTION OF TASK I

AUDITORY PRESENTATION:

Materials:
None

EXAMINER: Listen. Let's pretend that I have some animals. I have a few cats and a lot of dogs. Do I have more dogs or more animals?
(After 15 seconds elapse with no response, record no response on the record form.)

Why did you say there are more _____?
(Record response on the record form.)

AUDITORY PLUS VISUAL PRESENTATION:

Materials:
Rectangular piece of white cardboard (11 x 14) with illustrations of three cats and six dogs mounted on it

EXAMINER: Listen. I have some animals (pointing to the illustrations while speaking). I have a few cats and a lot of dogs. Do I have more dogs or more animals?
(After 15 seconds elapse with no response, record no response on the record form.)

Why did you say there are more _____?
(Record response on the record form.)

AUDITORY PLUS VISUAL PLUS KINESTHETIC PRESENTATION:

Materials:
Three toy cats, six toy dogs

EXAMINER: Listen. Will you put the cats in a pile and the dogs in a pile? (Allow the subject to sort the animals. If the subject incorrectly sorts one of the animals, correct him be saying, "No, this animal is a _____. Put it here.") Listen. I have a few cats and a lot of dogs. Do I have more dogs or more animals?
(After 15 seconds elapse with no response, record no response on the record form.)

Why did you say there are more _____?
(Record response on the record form.)

NOTE: Refer to Procedures section for details concerning the order of the conditions, problems, and majority subclass titles.

APPENDIX B

DESCRIPTION OF TASK II

DESCRIPTION OF TASK II

AUDITORY PRESENTATION:

Materials:
None

EXAMINER: Listen. Let's pretend that I have some flowers. I have a few daisies and a lot of roses. Do I have more roses or more flowers?
(After 15 seconds elapse with no response, record no response on the record form.)

Why did you say there are more _____?
(Record response on the record form.)

AUDITORY PLUS VISUAL PRESENTATION:

Materials:
Rectangular piece of white cardboard (11 x 14) with illustrations of three white daisies and six red roses mounted on it.

EXAMINER: Listen. I have some flowers (pointing to the illustrations while speaking). I have a few daisies and a lot of roses. Do I have more roses or more flowers?
(After 15 seconds elapse with no response, record no response on the record form.)

Why did you say there are more _____?
(Record response on the record form.)

AUDITORY PLUS VISUAL PLUS KINESTHETIC PRESENTATION:

Materials:
Three white silk daisies, six red silk roses

EXAMINER: Listen. Will you put the daisies in a pile and the roses in a pile? (Allow the subject to sort the flowers. If the subject incorrectly sorts one of the flowers, correct him by saying, "No, this flower is a _____. Put it here.") Listen. I have a few daisies and a lot of roses. Do I have more roses or more flowers?
(After 15 seconds elapse with no response, record no response on the record form.)

Why did you say there are more _____?
(Record response on the record form.)

NOTE: Refer to Procedures section for details concerning the order of the conditions, problems, and majority subclass title.

APPENDIX C

SAMPLE RECORD FORM

GRADE_____
BIRTHDATE_/_/___
AGE_-___
SEX M F
RACE_____

TASK:	AUDITORY Problem I	Problem II	AUDITORY-VISUAL Problem I	Problem II	AUDITORY-VISUAL-KINES. Problem I	Problem II
correct						
incorrect						
don't know						

GRADE_____
BIRTHDATE_/_/___
AGE_-___
SEX M F
RACE_____

TASK:	AUDITORY Problem I	Problem II	AUDITORY-VISUAL Problem I	Problem II	AUDITORY-VISUAL-KINES. Problem I	Problem II
correct						
incorrect						
don't know						

GRADE_____
BIRTHDATE_/_/___
AGE_-___
SEX M F
RACE_____

TASK:	AUDITORY Problem I	Problem II	AUDITORY-VISUAL Problem I	Problem II	AUDITORY-VISUAL-KINES. Problem I	Problem II
correct						
incorrect						
don't know						

GRADE_____
BIRTHDATE_/_/___
AGE_-___
SEX M F
RACE_____

TASK:	AUDITORY Problem I	Problem II	AUDITORY-VISUAL Problem I	Problem II	AUDITORY-VISUAL-KINES Problem I	Problem II
correct						
incorrect						
don't know						

APPENDIX D

PILOT STUDY TASK DESCRIPTION

PILOT STUDY TASK DESCRIPTION

PROBLEM ONE

Auditory Condition

EXAMINER: LISTEN. LET'S PRETEND THAT I HAVE SOME ANIMALS. I HAVE A FEW COWS AND A LOT OF PIGS. DO I HAVE MORE PIGS OR MORE ANIMALS?

WHY DID YOU SAY THERE ARE MORE _____?

Auditory-Visual Condition

MATERIALS: A rectangular piece of white cardboard (11 x 14) with illustrtions of three skunks and six rabbits

EXAMINER: LISTEN. I HAVE SOME ANIMALS (pointing to the picture while speaking). I HAVE A FEW SKUNKS AND A LOT OF RABBITS. DO I HAVE MORE RABBITS OR MORE ANIMALS?

WHY DID YOU SAY THERE ARE MORE _____?

Auditory-Visual-Kinesthetic Condition

MATERIALS: Three toy cats, six toy dogs

EXAMINER: LISTEN. WILL YOU PUT THE CATS IN A PILE AND THE DOGS IN A PILE? (Allow the subject to sort the animals.) LISTEN. I HAVE SOME ANIMALS. I HAVE A FEW CATS AND A LOT OF DOGS. DO I HAVE MORE DOGS OR MORE ANIMALS?

WHY DID YOU SAY THERE ARE MORE _____?

Note: The formal study utilizes dogs and cats as subclasses for all conditions in problem one.

PROBLEM TWO:

The superordinate class title is pieces of fruit for all conditions. In the auditory condition, plums and peaches were the subclasses. The auditory-visual condition utilizes apples and oranges. Lemons and pears were used in the auditory-visual-kinesthetic condition.

Note: The formal study utilizes roses and daisies as subclasses for all conditions in problem two.

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