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ABSTRACT

A study of the physical activity or motor responses associated with curiosity, persistence, and problem solving behaviors was undertaken to learn more about the general developmental nature of these behaviors among elementary school children. The sample consisted of 125 children from kindergarten, second, fourth and sixth grade, all of whom voluntarily went to a game room to play Piaget's billiard game. Each was unexpectedly confronted with a scheduled delay during which time he was invited to wait in a waiting room where his behaviors were observed and analyzed. Multivariate and subsequent univariate analyses of variance indicated that: (1) curiosity increased with age, black children were more curious than non-black, no sex differences existed; (2) problem solving ability increased with age, with boys being more successful ultimately than girls; and (3) persistence appeared to be related to age but not to sex or race. The investigation has established a data bank containing baseline information pertaining to the examined behaviors, which can and should play an increasingly important role in educational research. (Author/CJ)

CURIOSITY, PERSISTENCE AND PROBLEM SOLVING BEHAVIORS AMONG ELEMENTARY SCHOOL CHILDREN

FINAL Report

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Title of Report

CURIOSITY, PERSISTENCE, AND PROBLEM SOLVING BEHAVIORS OF ELEMENTARY SCHOOL CHILDREN

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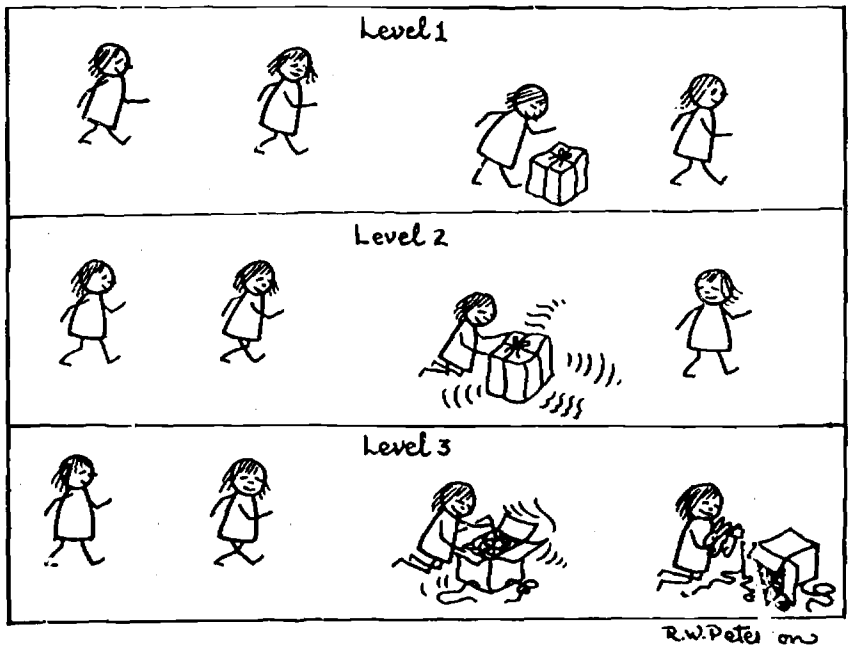

THREE INCREASINGLY COMPLETE VERSIONS
OF CURIOSITY IN YOUNG CHILDREN:
LEVEL 1 - APPROACHES, LEVEL 2 - MANIPULATES,
LEVEL 3 - REORGANIZES

FOREWORD

A proposal to study exploratory behavior in elementary school children was submitted to the Department of Health, Education and Welfare in July of 1968. The objectives focused upon a comparison of curiosity behavior with certain variables, namely age, sex, race and school achievement. In addition, a comparison was planned of an ethological approach to assessing curiosity (i.e., an analysis of motor responses) with two other curiosity assessment techniques: Individual Interviews and Teacher Ratings.

In March of 1969, the study proceeded essentially as proposed without H.E.W. support and without videotape as a form of documentation. From the results of that study (published as a dissertation), the author reported that the amount of exploratory motor activity toward a particular set of stimuli was influenced by the race of the child, partially by his age depending upon the number of unsolicited questions he asked, and not at all by his sex or I.Q. A lack of correlation between amounts of exploratory motor activity and amounts of curiosity as determined by Individual Interviews or by Teacher Ratings was also reported. It was concluded that there is likely to be an observable difference between the amount of curiosity an individual actually exhibits through motor responses, and the individual's perception of how curious he is as indicated by interviews or how curious his teacher perceives him to be in the classroom.

By June of 1969 the initial proposal was funded by H.E.W. A decision was made by the author to expand the work to include a study of the relationship between curiosity, persistence, problem solving and intellectual development. The study described on the following pages is the outcome of that expanded investigation.

Rita W. Peterson

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We would like to express our appreciation to those who gave their time and assistance throughout the duration of this investigation: to Audrey Wallace who ably conducted the Piagetian interviews, and Carolyn Dobson who acted as a consultant for administering Piagetian tasks; to Tracy Sokol and Mary Ann Wilson who served as special teachers for the children during their visit to the Lawrence Hall of Science; to Sandy Abrams for his careful work in video and audio recording; to John Quick and Carlton Lyon who served as consultants for camera operations; to David Ridgeway for his advice and guidance in all aspects of video recording; to Larry Malone who designed special materials for disguising the hidden camera in the waiting room; to Alan Portis, Bob Rice and other members of the Lawrence Hall of Science staff for making arrangements, space, facilities and the use of the video camera and recording equipment available throughout the investigation; to Darshan Sachdeva for the design and implementation of the statistical program; to Robert Karplus, Herbert Thier and Carl Berger for their critical reading of portions of the final draft of this report; and finally to the teachers and children of Whittier, Le Conte, Franklin, and Lincoln schools for their participation in this investigation.

R.W.P.

L.F.L.

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ABSTRACT

Introduction

Curiosity, persistence, and problem solving behaviors of young children often involve a large measure of physical activity. A study of the physical activity or motor responses associated with these behaviors was undertaken in order to learn more about the general developmental nature of intellectual curiosity, persistence and problem solving among elementary school children.

An environment was created within the laboratory which fostered the expression of these behaviors in a somewhat natural way. The resultant behaviors were recorded on video tape to provide documentation which would permit delayed analysis and multiple analyses among investigators. Four primary questions were investigated:

1) How are curiosity, persistence and problem solving behaviors related to such variables as age, sex and race among elementary school children?
2) How are curiosity, persistence and problem solving behaviors related to each other?
3) How is intellectual development, described by Piaget, related to curiosity, persistence and problem solving behaviors?
4) Can different measures of curiosity, such as teacher ratings and the analysis of motor responses, be equated?

Method

The sample consisted of 125 children. Approximately equal numbers of a)kindergarteners, second, fourth and sixth graders, b) boys and girls, and c)Black and non-Black children were represented. All children voluntarily went to a game room to play Piaget's billiard game. Upon arriving, each child was unexpectedly confronted with a scheduled delay. He was invited to wait in a waiting room, partially partitioned within the game room. Behaviors exhibited during the waiting period and during the game playing period were analyzed in the following manner.

Curiosity - The first five minutes spent in the waiting room was designated as a measure of curiosity. The waiting room was filled with objects chosen to stimulate curiosity. Each child was told he might sit or do as he wished with any of the objects in the room while waiting. Curiosity or exploratory behavior was identified as information-gathering responses such as looking, touching, listening, smelling and tasting. These responses were assigned to one of three categories

x

or levels of sensory input: Level 1 - approaching the object(s), Level 2 - manipulating the object(s) without causing parts or objects to interact, and Level 3 - reorganizing the object(s) by causing parts or objects to interact with each other or the environment.

For an analysis of the video tape, 20 observations were made at 15-second intervals during each 5 minutes of curiosity behavior for each child. Within each 15-second interval, only the highest level of response was scored. For example, within 15 seconds a child might approach an equal arm balance (Level 1), pick up some weights (Level 2) and place them on the balance pan (Level 3); he would receive a score of 3 for that interval. Tabulations of all numerical scores derived from the response level of each interval resulted in a composite score for each child. Composite scores were interpreted as the amount of curiosity expressed, and were used in quantitative comparisons between children.

Problem Solving - During the second five minutes of his wait, each child was presented with a problem to solve, a "puzzle box". The box was made of wood, with a lid that hinged on one side and was secured on the remaining sides by 3 padlocks differing in color and shape. With the puzzle box, the child was also given an assortment of keys and told, "The puzzle is to open the box using these keys. If you get the box open, you may choose one of what is inside."

Problem solving behavior was analyzed according to 1) the strategies used to solve the problem, and 2) ultimate success in opening the box, regardless of the strategy used. Strategy levels were based on the degree to which the child controlled one set of variables (either the locks or the keys) while changing members of the other set of variables: Level 1 - trial and error, (e.g., key #1 in red lock, key #2 in blue lock, etc.); Level 2 - fragmented patterns, (e.g., key #1 in red and blue locks, keys #2,3,4 in yellow lock, etc.); Level 3 - more or less complete patterns, (e.g., all keys in red lock, or key #1 in all locks, etc.). Strategy levels assigned to children were treated as scores for comparisons between children. 2) Ultimate success in solving the problem was represented by the number of locks opened; this number was also treated as a score in a second set of problem solving scores.

Persistence - The amount of time each child spent trying to solve the problem constituted his measure of persistence. Time was measured in minutes and seconds, and converted into a score based on the percent of time he persisted during the 5-minute interval in which he had access to the problem.

Piagetian Level - The verbal responses of each child playing the billiard game were analyzed according to criteria developed by Piaget for the billiard game, to distinguish between developmental levels of intelligence.

Results

Multivariate and subsequent univariate analyses of variance indicated that 1a) curiosity increased with age when children were left alone in the waiting room ($p = .05$); Black children were found more curious than non-Black children ($p = .05$); and no significant differences were found in curiosity between sexes. 1b) In solving problems, the use of strategies based on logic increased with age ($p = .05$), but did not vary between sexes or racial groups. 1c) Ultimate success in solving the problem, regardless of the strategy used, increased with age ($p = .05$); boys were found more successful than girls ($p = .05$), and no significant differences were found between racial groups. 1d) The analysis of persistence in relation to age, sex and race was limited due to unexpected "ceiling effects" (88% of the children were 100% persistent); but within these parameters, persistence appeared to be related to age and not to sexes or racial groups. 2) Scores of curiosity, persistence and problem solving were not found significantly correlated to each other over all groups; but this outcome may be due to the effect of limited measurement intervals used and/or the constricted range in persistence scores, as much as to any inherent relationship between these behaviors. 3) Piagetian stages were found to have a strong positive association with successful solution of the problem ($F_{2,122}(.95) = 3.07$, $p = .001$); weak but positive association with curiosity ($p = .09$) and persistence ($p = .13$), and no association with strategies used in solving the problem. 4) No significant correlation was found between the amount of curiosity expressed through motor responses to concrete objects in a waiting room and the amount of curiosity assessed by the Teacher Rating method when applied by the participating classroom teachers. Finally, the findings of this study confirm earlier findings (1-a, above), reported by the senior author in a previous study of the curiosity behavior of elementary school children (Peterson, 1969).

Conclusions

This investigation has established a data bank containing baseline information pertaining to curiosity, persistence and problem solving behaviors of elementary school children. The data are stored on approximately 20 hours of 1-inch video tape. Such information, stored in data banks, can and should play an increasingly important role in educational research. Audio and video recorded experiments will permit investigators to "rerun" their experiments in the sense needed to make finer discriminations, to establish agreement among investigators, and to avoid costly duplication when multiple baselines or frames of reference are used.

The results from the analysis of the data recorded during this

investigation differ in a number of ways from results reported by other investigators in this field of study. When curiosity, persistence, and problem solving behaviors were studied from the standpoint of physical activity (motor responses) toward concrete objects, these behaviors varied between age, sex, racial, and Piagetian groups in many ways not predicted by paper-and-pencil tests. Clearly, research is now needed which will clarify the nature of these differences resulting from the use of various measurement techniques. Such research should lead to an understanding of the difference, if one exists, between the exploration of concrete objects in the environment and exploration of conceptual ideas, between solving concrete problems and the solution of abstract problems.

From both theoretical and practical viewpoints, the present results have implications for the assessment of curiosity, and perhaps for some other learning behaviors as well. The wide use of written or picture tests for measuring human curiosity has been based on assumptions about how individuals, if curious, would respond to certain questions, symbols, or pictures. The present findings suggest that these assumptions should now be re-examined in terms of responses to actual as well as simulated situations. The dictum, "do as I say, not as I do," provides an interesting paradox to be probed in behavioral assessment when it is rephrased "watch what he does, not what he says."

INTRODUCTION

Man is a curious animal. Given a new object or frontier, he explores. Given a problem which he or nature has created, and speaking generally, he persists until he finds some solution.

Those of us who are concerned with socializing the young, whether we are parents or teachers, people watchers or scientists, have witnessed the fervor with which a determined young child explores and the persistence with which he works on problems of his own choice. Yet we have also experienced the disappointment when frontiers we have offered are not explored and problems we have presented are not persistently probed for solutions. The effort we expend in an attempt to capture this natural motivation of young children and harness it to what must be learned, resembles chasing the "elusive butterfly". The study presented in the following pages is a description of our attempt to learn more about the nature of curiosity, persistence and problem solving as they occur in somewhat natural situations for young children. It is hoped that our observations may help bring about a better fit between the learner and what must be learned.

The major focus of this behavioral study is the assessment of motor responses. One might ask why effort should be spent surveying motor responses when the essence of curiosity and problem solving is going on "upstairs".

A great deal of the concern for what is happening "upstairs" in learning is being explored through research dealing with responses to written, pictoral or symbolic materials. However, because so much of the curiosity and problem solving behavior of young children is expressed through motor responses (e.g., approaching, manipulating and reorganizing parts of their environment), some effort needs to be made to clarify the relationship of motor responses to the total behavioral picture.

Motor responses do not just happen, but are directed by a cognitive nervous system. When a child moves toward some aspect of his environment and reaches out to explore or solve a problem, his motor responses provide us with clues about his thought processes. Such information suggests something about the differences between individuals and groups, and changes over time. Ultimately, these findings may lead to a better understanding of the nature of the differences between exploring concrete objects in the environment and exploring conceptual ideas, and of solving concrete problems and the solution of abstract problems.

THE PROBLEM

The problem undertaken is to create an environment within the laboratory which will foster the expression of curiosity, persistence and problem solving in a somewhat natural way. These behaviors will be recorded on video tape by means of a hidden camera to the end that such documentation will permit close and multiple analyses over time. From such an experiment, answers will be sought to the following broad questions:

1. In what ways are curiosity, persistence, and problem solving related to such variables as age, sex, and race among elementary school children?
2. How are curiosity, persistence, and problem solving behaviors related to each other?
3. How is intellectual development, as described by Piaget, related to curiosity, persistence, and problem solving among elementary school children?
4. Can different measures of curiosity, such as Teacher Ratings and Exploratory Motor Responses, be equated?

In order to answer these general questions, six hypotheses have been generated and are presented in the null form on page 20.

SEARCH OF LITERATURE

Curiosity

Studies of curiosity or exploratory behavior have proceeded in two major directions which differ markedly on the basis of the individuals being studied. That body of research with its focus on human curiosity draws mainly from the fields of education and psychology where curiosity has been measured primarily on the basis of responses to written or picture tests. Berlyne, Maw and Maw, Penny, Day, Rubenstein, and Fantz are a few leaders who have established continued interest in this field. In contrast, studies concerned with the exploratory behavior of animals have been pursued primarily by psychologists and by increasing numbers of ethologists (i.e., animal behaviorists), who measure behavior in terms

of the frequency, duration, or intensity of motor responses. Such leaders as Welker, Montgomery, Butler, Darchen, Fowler, Loizos, Harlow, and again Berlyne have made continued contributions in this area.

Very recently, a new trend in research has begun to emerge which attempts to look at the behavior of human subjects in ethological terms. Such studies use no "test" but empirically observe, describe, and analyze motor responses of curiosity among children in much the same way as Piaget has described and analyzed the intellectual development of children. Far from thinking of their subjects in animal-like terms, these investigators are committed to analyzing only what they observe rather than testing what they believe about behavior. Hutt, Blurton-Jones, and Peterson-Lowery have all independently developed research procedures using this approach.

The research pursuits of these major sources differ in philosophy as well as method; but because these scientists have addressed themselves to mutually relevant aspects of curiosity, the diverse sources will be brought together here and examined simultaneously under the headings listed below.

A. Curiosity and the Nature of the Stimulus.

B. Curiosity and Role of Experience.

C. Curiosity and the Age Variable.

D. Curiosity and the Sex Variable.

E. Curiosity and the Race Variable.

F. Curiosity and Intelligence.

G. Curiosity and Personality Traits.

H. Curiosity and Teacher-Ratings.

I. Persistence and Problem Solving

J. Summary.

A. Curiosity and the Nature of the Stimulus

By far the most popular area of research to date in the field of exploratory behavior has been that which considers the relationship of curiosity to the nature of the stimulus. This is certainly understandable: historically, man has looked first to the most obvious for clues to cause-and-effect relationships. This is not to imply that investigators cited here have assumed casual relationships; on the contrary, they have used the nature of the stimulus as a source of information for learning more about reactions of curiosity behavior in general.

Berlyne (1957, 1960, 1966) and Fowler (1950, 1964) were among the first to investigate the nature of curiosity-arousing stimuli, for both animals and humans. These two men worked independently at describing the nature of curiosity or exploratory behavior. They found that certain kinds of external stimuli induced more curiosity than others. For example, events, situations, or objects which were novel, complex, irregular, or incongruous elicited more exploration on the parts of subjects than events, situations, or objects which were familiar, lacking in complexity, or symmetrical in form (Berlyne, 1966 [a]; Fowler, 1964). These findings have been substantiated often in the work of other investigators, as reflected below.

Studies involving human subjects in this area of research suggest that a preference for surprise, change, and novelty is distinguishable at a very early age. Infants will play peek-a-boo longer when they are surprised by the changing location of the next peek-a-boo than when the peek-a-boo comes from a constant source.(Charlesworth, 1966). Likewise, infants prefer to watch changing patterns in contrast to repeated patterns when they are presented with pairs of patterns for ten one-minute exposures (Fantz, 1964). Nursery school children aged 3-5 years were presented with a strange red metal box that made noises and had a gear shift which could produce changing visual effects. As the number of times increased that the children were exposed to the red box the duration of their explorations decreased (Hutt, 1966).

First grade children in a waiting room full of familiar and unfamiliar objects lifted a partition to watch an unfamiliar kangaroo rat four times more often than they picked up and looked at familiar first grade books (Peterson, 1967). Additional studies by Cantor and Cantor (1964, Maw and Maw (1965), Peters and Penney (1966), Berlyne and Frommer (1966) and Rubenstein (1967) all support the finding that surprise, novelty, complexity, and incongruity stimulate greater exploration or are characteristic of the preference of highly curious children.

Animals like children, appear to prefer novelty, complexity, and change. Rhesus monkeys, after being deprived of visual stimulation, seek greater amounts of visual stimulation (i.e., peeking through a window at other monkeys) than normal control monkeys (Butler, 1957). Chimpanzees will increase exploration of a cube in proportion to the number of ways in which the cube is altered: experimental cubes which differ in size, shape, and color arouse proportionally greater amounts of exploration than a standard white cube (Loizos, 1967--after Menzel, 1961). Infant chimpanzees, like human infants, prefer to watch changing patterns over constant patterns when such patterns are presented in pairs (Berkson and Fitz-Gerald, 1963).

When hamsters are allowed to run down alleys with end boxes containing (a) nothing, (b) a constant set of objects, and (c) a changing set of objects, they appear to prefer a changing set of objects as measured by running time for repeated alley runs (Schneider and Gross, 1965). Rats also prefer novelty as demonstrated when they are offered a choice of two or more equally long pathways to food. On any given trial after the first trial, they tend to avoid the path most recently travelled (Dennis, 1939). Even cockroaches explore a colored cube more promptly after 30 minutes exposure to an empty box than after 15 minutes exposure to the same box (Darchen, 1957).

One of the few generalizations that has been demonstrated experimentally with regard to curiosity is that objects, events and situations which are complex, novel, irregular, or incongrous usually stimulate more exploration than those which are simple, familiar, symmetrical, or in general what the subject expects. But even this generalization must be qualified. Surprise, novelty, complexity--these are all relative terms when used to describe the nature of a stimulus, for they must be compared with the experience of the subject.

B. Curiosity and the Role of Experience

Previous experience is likely to affect the amount of curiosity a subject expresses, according to several investigators. Babies, for example, which have highly attentive mothers (i.e., mothers who look at, hold, or talk to their babies more than mothers who do not) tend to watch, manipulate, and vocalize to novel objects more than do babies whose mothers are less attentive. Rubenstein suggests that maternal attentiveness may facilitate exploratory behavior in infants (Rubenstein, 1967).

Likewise, experimental laboratory rats which have been handled in infancy explore more in a test apparatus (i.e., cages with light and colored panels) than control laboratory rats which have not been handled (De Nelsky, 1966).

One might conclude from these studies that, in general, the greater the variety of experience encountered by subjects, the more they tend to explore novel stimuli (De Nelsky, 1966; Rubenstein, 1967). However, some investigators have found evidence contradictory to this conclusion. McCall has shown that a rearing experience with movable objects in a cage causes rats to explore less in an open field than rats reared in cages with immovable objects (McCall, 1967). McCall suggests this difference may be a function of more rapid habituation to the strange environment by more experienced rats (i.e., those reared with moveable objects); McCall mentions that others (Thompson and Melzack, 1956) have obtained similar results with dogs. Loizos, in further analyzing the factors which affect responses to novel stimuli in the chimpanzee, states:

> "What is affected by the manner in which the animal was raised is the difference in the level of arousal created by similar situations. Thus, the more experience a chimpanzee has had with a particular class of object, the less easily aroused he will be by the introduction of a further object of the same or a related class"(Loizos, 1967).

Piaget also has concluded that curiosity is a function of the individual's experience. "It is determined not by the nature of the stimulus but by the degree to which the object is discrepant from what the individual has experienced previously" (Ginsburg and Opper, 1969).

One might guess, based on the studies cited here, that early rearing experiences such as fondling or handling appear to have beneficial effects on encouraging the young to explore, and that because of such precocious explorations these individuals may become satiated with certain classes of stimuli earlier than nonprecocial explorers. In this respect, one might ask what effect differences in socio-economic experience might have upon exploratory behavior.

C. Curiosity and Age

One of the most common beliefs about curiosity is that it is a characteristic of the young, and that it diminishes with age. As Welker concluded after years of experimentation with animals, "There is an age of maximum exploration for each animal type" (Welker, 1961). Many who have worked with children would extend Welker's generalization to include the human species.

Yet in spite of the popularity of this notion, comparable studies are relatively few. One study involving children is an investigation by Pielstick and Woodruff (1964). They have compared the exploratory behavior of average and gifted second grade children with that of matched sixth grade children under two different conditions. First, the subjects were observed in a semi-structured situation in which they were permitted to interact with six selected objects. Following the observation, the subjects were allowed to expose as frequently as they wished, each of a series of slides varying in complexity. An analysis of variance applied to the exploration time (i.e., task 1: interacting with the objects) yeilded no significant differences for age or ability variables, but did show a significant result across objects. However, tachistoscopic exposure frequencies of the slides (task 2), were influenced by age and ability variables as well as by stimulus complexity Pielstick and Woodruff, 1964).

In a study comparing the amounts of exploratory behavior of four different age groups of elementary school children (5-6, 7-8, 9-10, 11-12 years), slight but statistically nonsignificant differences were found between age groups in the amounts of exploratory motor responses (i.e., approaching, manipulating, and reorganizing stimulus objects (Peterson, 1969).

In contrast to patterns in motor activity, however, Peterson found that 5-6 year olds asked approximately four times as many unsolicited questions as 11-12 year olds with an adult present in the waiting room. This difference was significant at the $p < .01$ level. Likewise, question-asking behavior was found to be inversely related to exploratory motor activity: the more questions a child asked, the less he explored through motor activity. One might infer then that younger subjects were more curious, since they exhibited amounts of exploratory motor activity nearly equal to 11-12 year olds and in addition asked more than four times as many questions.

The content of unsolicited questions asked by children in the study suggests that some but not all verbal responses of curiosity may be substitutes for exploratory motor activity. The example below, which is typical of most "bouts" of question-asking behavior by single individuals shows all of the questions except the first to be just as easily answered by motor responses as by verbal responses:

> "Subject 2-25 (in response to first seeing caged kangaroo rat): 'What's that? A flying squirrel? A wood rat? Will he bite? ——— Will you take him out? ——— How do you open it [the cage]?' " (Peterson, 1969).

Because question-asking behavior was found to correlate with age in Peterson's previous study, an attempt will be made in the current investigation to exclude verbal responses from the behaviors permitted by removing the adult from the waiting room. If question-asking behavior is a substitute for exploratory motor responses, and therefore has masked differences in curiosity between age groups, then by removing the opportunity to ask questions, one should find a corresponding effect upon the amounts of exploratory motor activity exhibited.

Isolating the effect of age alone upon curiosity is difficult. Loizos, and others have suggested that age and experience are inseparable variables:

> "Thus an infant chimpanzee (one year old) will remain interested in a simple block of wood for longer than a three-year old, who in turn will manipulate it for longer than an adult. Welker, like Menzel, et. al., found that age, and hence experience of the animal, is a major factor in determining the response to novelty" (Loizos, 1967).

An examination of two additional studies will provide further evidence to suggest the complexity of the age variable. Williams, Carr, and Peterson selected as subjects young rats of four ages: 27 days, 51 days, 78 days, and 116 days old. The amount of locomotor exploration in a maze by young rats increased with age to a maximum at 78 days and then decreased (Williams, et. al., 1966). In contrast to these findings, Goodrick found no marked difference in exploratory activity for albino rats ranging in age from 30 and 45 days to 660 days (Goodrick, 1966). Contradictory results such as these invite further investigation. If there is an age of maximum exploration for each animal type, as Welker has suggested, identifying that peak or optimum may not be too difficult if experience is controlled in the laboratory. Finding such an age of maximum exploration in children may be infinitely more difficult in view of the wide variability of experiences found among school children, and the improbability of controlling these experiences.

A final aspect of interest in the curiosity-age relationship has to do with the hesitance of very young subjects to respond to novelty. In a study by Hutt, nursery school children showed marked differences in approaching strange or novel objects, depending upon the presence or absence of an adult.

> "The presence of an adult in the room appeared to make the nursery school children more adventurous and less apprehensive of novelty... The children who were by themselves [in the room with novel objects] showed more neophobia and even when they did approach the object, their early responses were tentative. All of them, also first approached the object with a familiar toy [in hand]" (Hutt, 1966).

A timid reaction or "latency of response" described by Hutt in nursery school children was similarly found to be a pattern among young chimpanzees. Welker noted that young chimpanzees of ages one and two years were initially more timid when presented with novel objects than were chimpanzees three and four years of age (Welker, 1961).

These findings by Hutt and Welker suggest that latency in expressing exploratory behavior may be distinguishable characteristic between age groups, when the presence of an adult is experimentally manipulated. This current study may shed some light on the question, if the outcome of the current experiment can be compared with the results of the previous study (Peterson, 1969). In that study, the investigator remained in the room with the children, while in the current study the children will remain alone in the waiting room.

D. Curiosity and Sex

A number of studies have found differences in curiosity between boys and girls. The findings, however, are somewhat complex and suggest that curiosity differences between boys and girls vary depending upon the nature of the test situation or instrument.

A study by Lucco describes sex differences in curiosity which vary with the "security" of the test situation as well as with the "independence" of the child (Lucco, 1967). In an "insecure situation", (i.e., a situation in which the child is asked to wait in a room with toys on a table), nursery school boys and girls who were rated by their teachers as "independent" were found to explore more than their peers who were rated "dependent" by the teachers. However, in a "secure situation", (i.e., one in which the child is asked to view visual stimuli through a box), dependent girls explored complex stimuli for longer periods of time than dependent boys and longer than independent boys or girls. From these findings, one might conclude that boys and girls display equal amounts of curiosity in insecure situations, but unequal amounts of curiosity in secure situations. Lucco's findings were supported by Peterson (1969), in the case of insecure situations. As described previously (forward), no differences were found between boys and girls in the amounts of exploratory behavior they exhibited while in a waiting room furnished somewhat similarly to that described by Lucco.

In studies making use of interviews and pictures investigators have found conflicting differences in curiosity as related to sex. Penney and McCann devised a ninety-item Reactive Curiosity Scale, a test to discriminate between children who would or would not "react to their curiosity," as determined by their answers to True or False statements Penney and McCann, 1964). Girls were found to have higher mean reactive curiosity scores than boys, significant at beyond the .001 level of confidence ($F = 29.71$, $df = 2/427$). A contrast to these findings is reported by Day (Day, 1968). In a series of three experiments to determine the importance of specific curiosity in school achievement, junior high school students were asked to evaluate their degree of interest (on a 7-point scale) in each of a series of figures which varied in complexity. Subjects' responses constituted a test of specific curiosity (TSC). Day found that there was no significant difference between sexes, as determined by TSC scores.

In two other studies using written and picture tests, qualitative differences in curiosity were found between sexes among fifth grade children (Maw and Maw, 1964, 1965). From the use of such tests, the authors identified high- and low-curiosity groups within normal school populations. As expected, a number of ways were found in which high-curiosity children differ from low-curiosity children, but of greater interest here are the differences they observed between sexes. Boys appeared to (a) excel in tests of general information, (b) show greater

persistence in hidden-picture tests, and (c) select more outgoing activities; while girls seemed to (a) ask more and better questions when presented with stories or pictures, (b) show greater persistence in code tests, and (c) prefer (at times) more unbalanced or unfamiliar geometric figures (Maw and Maw, 1964).

E. Curiosity and Race

There has been little or no research pertaining to the relationship between exploratory behavior and race. Among animal behaviorists "race" is recognized as a denotation of subspecies or variety and is often the subject of genetic experimentation; however, race is not used as a population variable in studies of the exploratory behavior among animal groups. In the area of human curiosity, no reference other than work by the author could be found to document either racially-determined similarities or differences in exploratory behavior of elementary school children. When equal numbers of Black and non-Black students (N=120) were asked to wait for ten minutes in a waiting room filled with objects for exploration, Black students at all age levels (kindergarten, second, fourth and sixth grades) explored more by approaching, manipulating and reorganizing parts of the waiting room environment than non-Black students explored (Peterson, 1969).

F. Curiosity and Intelligence

Although curiosity may be considered a correlate of intelligence among human beings (Maw and Maw, 1964), there is less effort to associate curiosity with intellectual activity on behalf of animal subjects. Rather, exploratory or investigatory behavior among animals is looked at in terms of its probably survival value (Lorenz, 1956; Loizos, 1967).

A number of studies have examined the relationship between measures of curiosity in children and measures of intelligence (I.Q.) or school achievement. Penney and McCann have defined reactive curiosity as a child's willingness to respond affirmatively on paper to situations portrayed to stimulate exploration. By such a Reactive Curiosity Scale (RCS), 433 children from grades 4, 5, and 6 were tested. When scores from the RCS were compared with I.Q. scores as determined by the California Test of Mental Maturity, no significant correlation was found (Penney and McCann, 1964).

Following the work of Penney and McCann, Day has developed a Test of Specific Curiosity (TSC) which evaluates student responses of interest in the visual complexity of a series of figures projected on a screen (Day, 1968). When the TSC scores of Canadian junior high school students were compared with their respective I.Q. scores (as measured by the

Dominion Group Test of Learning Capacity--Intermediate), Day found no significant correlations. Likewise, by comparing TSC scores with school grades (as determined by "end-of-term marks in all subjects"), Day again found no significant correlation did exist between I.Q. scores and school marks.

In contrast to the findings of Penney, McCann and Day, Jenkins found curiosity and intelligence related in a complex measure. The curiosity of children with high intelligence (as determined by Primary Mental Abilities Test, S.R.A.) tended to decrease as the familiarity of the stimulus (the number of science experiences) increased while the curiosity of children with average and below average intelligence did not vary with the familiarity of the situation (Jenkins, 1969).

In each of the studies cited above, curiosity was measured through the use of verbal or picture tests. When curiosity, as measured through motor activity, was compared with mental ability, as reflected through standardized tests, significant correlations of any kind were still lacking (Peterson, 1969). Pielstick and Woodruff (1964) likewise found no differences in the amount of time spent examining objects among children of different ability groups.

In an effort to compare children of high and low levels of curiosity, Maw and Maw first selected subjects of comparable mean intelligence scores; yet they found that high-curiosity children shared certain intellectual characteristics. These children,

1. asked more and better questions,
2. had more general information about the world in which they lived,
3. could recall more specific facts,
4. persisted longer at problem solving, and
5. were more alert to verbal absurdities.

The authors concluded that these characteristics which differentiated high-curiosity groups (of equal I.Q.'s) were perhaps aspects of intelligence not revealed on the intelligence tests used; and further that "what has been called curiosity may itself be a part of intelligence" (Maw and Maw, 1964).

A comparison of the curiosity behavior of normal and mentally retarded children was made by Hoats, Miller, and Spitz (1963). Three groups of children were used in a test which determined "perceptual curiosity" by measuring preference for complexity, asymmetry, and incongruity in pairs of figures: 30 mental retardates were compared with 30 normals of equal chronological age and 30 normals of equal mental age. Hoats, et. al., found that retarded males showed less curiosity than their age-equals or mental-equals. In addition, retarded males and females tended to avoid complexity when compared with normal age-

equals but not when compared with normal mental-equals (Hoats, et.al., 1963). This unusual study seems to suggest that while complexity tends to arouse similar responses in mental retardates and normals of equal mental age, asymmetry and incongruity appear to differentiate between these two groups, especially in the case of males. The implications of this study for making statements regarding normal intelligence and curiosity are not clear at this moment; but a similar study to the one carried out by Hoats, et. al., that measures locomotor responses to novel, concrete stimuli instead of verbal responses to visual stimuli, should shed valuable light on this particular aspect (i.e., intellectual) of curiosity.

The predominant trend in the literature cited indicates a lack of correlation between curiosity and intelligence in children. This is not surprising when one considers the basic mechanisms being compared. Tests of curiosity, as cited here, measure the subject's tendency to seek novelty, change, and complexity. Tests of intelligence, again as cited here, measure the subject's ability to transform information into meaning (i.e., to relate new information to existing cognitive structures). Current tests of curiosity measure something corresponding more closely to short-term memory and are more indicative of the child's or organism's tendency to respond to or monitor changes in his environment. This primitive capacity may have little relevance to higher order kinds of thinking as described by Gagne (1965).

This criticism is not intended to suggest that curiosity is actually limited to simple stimulus-response types of learning, but rather that few of us as investigators have gone beyond that level of testing in studies of curiosity. In the current investigation Piagetian levels have been derived for children, and used in place of scores from I.Q. or achievement tests.

G. Curiosity and Personality Traits

Maw and Maw (1965) have attempted a comprehensive study of the relationship of curiosity to personal and social variables in elementary school children. The sample, 217 girls and 224 boys from predominantly middle-class suburban families, was given a series of 16 standardized tests to assess the various characteristic differences between high- and low-curiosity groups of children. Among the results were the following: High-curiosity children were found to be:

a. more self-accepting;

b. more self-sufficient;

c. more secure;

d. more creative, flexible, and consistent in thought processes;

e. more dependable;

f. more loyal to the group;

g. more willing to participate in group activity;

h. more responsible for group welfare; and,

i. overall, better socially adjusted. (Maw and Maw, 1965)

Such a comprehensive study of personal and social factors related to curiosity has not been attempted since the work done by Maw and Maw. However, a study by Penney (1965) has investigated the anxiety variable in this context. Using the Manifest Anxiety Scale, Penney found that school children who were high in reactive curiosity were less anxious than children who scored low, as measured by the Reactive Curiosity Scale described earlier (Penney and McCann, 1964).

Because personality traits, like many other aspects of our behavior, are influenced by early experience, it seems reasonable to assume that curiosity behavior, at least that portion which is observed, is linked to some extent with personality. A recent finding reported by Thomas, et. al., (1970) suggests curiosity and other personality factors remain relatively stable over a ten year period beginning with birth.

H. Curiosity and Teacher Ratings

One measure of the validity of curiosity tests is reflected by the degree of correlation found between scores on curiosity tests and estimations of curiosity levels by students' teachers. The Teacher Rating technique was developed by Maw and Maw primarily for the prupose of establishing criterion groups of high and low curiosity, but has been adopted by other investigators because the technique as presented by Maw and Maw provides minimal standards for gathering information. Basically, the instrument provides the teacher with a definition of curiosity along with several illustrations of curiosity behavior; it warns against expecting all such behaviors from any one child or necessarily from only the best students. Each teacher is then asked to rank all of the students in her class, first listing the most curious, and so forth (Maw and Maw, 1965). The authors established average reliability estimates of .77 over an 8-week separation period.

A study by Day (1968) compared curiosity scores on a picture test with teacher evaluations of curiosity, using a technique patterned after the work of Maw and Maw in 1965. In comparing the top quarter of the class (8 subjects) with the bottom quarter, a t-test of differences was significant at the .001 level of probability, indicating a substantial agreement between curiosity test scores and teacher evaluations, according to Day.

In previous work (Peterson, 1969), teachers of the four age groups of children participating in the study were asked to rank the children of their respective classes according to the Teacher Rating scale developed by Maw and Maw (1965). Using Spearman's Rank Correlation Coefficient, no significant correlation was found between the actual amount of exploratory motor activity children exhibited and the amount of their curiosity as determined by Teacher Ratings.

The Teacher-Rating scale developed by Maw and Maw was used again in this study in the hope that video tape analysis would provide a better comparison of the results. A copy of the instrument appears in Appendix D.

I. Persistence and Problem Solving

The decision to include persistence and problem solving as co-variables in a study of curiosity may help to clarify the nature of curiosity, hopefully, but at the same time may frustrate the reader who expects an in-depth treatment of the literature dealing with persistence and problem solving. The extensive research dealing with these latter behaviors exceeds the time and monies allotted this research grant. However, within the limitations of the grant, perhaps the contribution to be made by the addition of these co-variables will outweigh the disadvantage imposed on the reader by the limited literature cited here.

Persistence

Persistence among elementary school children appears to be influenced by a number of factors. The nature and magnitude of the reward, the age and possibly the sex of the child, and the child's logical or chance approach to solving the problem all appear to affect how persistent he is. Likewise, the child's previous history of persistence as well as the ease or difficulty of the problem appear to affect the amount of persistence he exhibits. A brief consideration of these factors is presented below.

One might expect persistence to increase as the magnitude of the reward increases. However, for children rated highly persistent by their parents and teachers, conditions of high reward did not increase the persistence as much as conditions of low reward (Nakamura and Ellis, 1964). The reverse was true, however for children rated low in persistence: low rewards decreased persistence while high rewards increased persistence. Other studies that have found the nature and magnitude of reward to have differential effects on different children have been reported by Brackbill and Jack (1958), Gewirtz (1959), and Amsel and Ward (1965).

Persistence and other temperamental behaviors appear to remain relatively constant in quality as children mature. This finding was reported by Thomas, Chess and Birch (1970) following a ten year longitudinal study of the origins of personality. As professors of psychiatry and pediatrics, the authors have identified nine temperamental behaviors which they observed regularly from the time 141 infants were two months of age until they reached the age of ten years. Thomas, et. al., concluded that "a given environment does not have the identical functional meaning for all children," including children of the same family, and that further "much depends upon the temperamental makeup of the child." This study is primarily descriptive. It is hoped that the authors will present quantitative data in subsequent publications of their important work.

In view of the findings of Thomas et. al., one might not expect to find great differences in persistence among children of different age groups. However, when Nakamura and Ellis compared the persistence of kindergartners with third graders they found older children significantly more persistent, as determined by activity in a lever pulling task. The overall activity level was interpreted to be an index of effort, and slower responses reflected attitudinal changes (Nakamura and Ellis, 1964).

The difference in persistence between age groups reported by Nakamura and Ellis may be due to the strangness of the problem solving situation for kindergarteners. Hutt found the curiosity of nursery school children affected by the degree of strangness of the situation (Hutt, 1967). In the current investigation, no differences are expected in persistence between age groups, provided that the waiting room environment (i.e., being left along in a waiting room) does not interfere with normal behavior of kindergarteners.

There is some evidence that suggests girls are judged more persistent in general than boys by their parents and teachers. Nakamura and Ellis asked the parents and teachers of equal numbers of boys and girls (N=56) to rate the children according to a persistence rating scale. Among children rated highest in persistence, girls predominated while boys were predominant among children rated low in persistence (Nakamura and Ellis, 1964).

The work by Nakamura and Ellis,(1964),and Nakamura and Lowenkron (1964) involves white upper middle class children or children from private schools. Likewise, the longitudinal study reported by Thomas, et. al., studied children of highly educated professional adults. A question of particular relevance relates to the applicability of these findings to minorities such as Black and non-Black low income populations. If one were to assume that children from economically deprived backgrounds experience conditions of general low reward, then according to the literature cited above, one would expect to find these children less persistent on tasks with low rewards. By presenting a manipulative problem with multiple levels of reward to children of various racial and socio-economic backgrounds, no differences are expected in

persistence on the basis of race or socio-economic conditions. In this investigation race but not socio-economic status (SES) is considered as a demographic variable; however, SES may be inferred from the extent to which race and SES overlap in this particular population.

Children who use a logical orientation in problem solving appear to be more persistent than children depending upon chance for solving problems. This finding reported by Nakamura and Lowenkron (1964) measured persistence in terms of the number of trials to extinction following the termination of reward. Logical orientation was determined by the amount of knob turning, where knob turning constituted an attempt to discover the pay-off pattern in a lever pulling task. Evidence of the use of some logical orientation for solving problems suggests that the subject persists until he has tried one or more hypotheses relevant to solving the problem. According to Piagetian theory such a logical approach would begin to appear in fragmented form at State II, Concrete Operations, and would be found in more or less complete form at Stage III, Formal Operations (Inhelder and Piaget, 1958). The problem designed for the current study will examine the relationship between persistence and logical vs. chance approaches, as well as Piagetian stages of intellectual development.

Problem-Solving

Problem solving abilities of elementary school children vary greatly due to a number of factors. Age, sex, and socio-economic status are sometimes related to success in solving problems depending upon the nature of the problems.

Piaget has described specific thought processes identified with general intellectual development which help to account for a child's ability to deal with particular problems or physical phenomena. In general, these processes deal with the child's ability to focus on one, several, and finally all relevant elements of problem solving or events in a way which permits him to see the relationship of the parts to each other, and finally to the whole, and to anticipate strategies needed for solving problems or understanding events (Inhelder and Piaget,1958). Such intellectual development, according to Piaget, is determined by maturation as well as experience.

Bourne has found that younger children solve rule learning problems in a rote fashion while older children are capable of learning strategies from indirect experience. Younger children appear to require direct training in component skills if they are to achieve the same strategies (Bourne, 1969). Odum also reports that age plays a significant role in determining the kind of strategy employed by elementary school children (Odum, 1967). In the current investigation, age differences are expected to account for a major source of difference in problem solving abilities.

Previous experience undeniably affects performance in solving problems, but the degree to which one's ability is dictated by his social-ethnic-economic experience is poorly understood. Jensen has suggested that differences in problem solving ability, as manifested by I.Q. and achievement tests, may be partially accounted for by heritability or genetic components (Jensen, 1969-a, 1969-b). Understandably, there is little support for Jensen's position (Kagen, 1969; Mc V. Hunt, 1969; Bereiter, 1969; Elkind, 1969; Cronbach, 1969) since such genetic differences imply a condition over which educators would have little control. However, the evidence of gross differences in problems solving abilities with which Jensen and his critics are concerned is the subject of intensive investigation (Greenberger, et. al., 1970; Gruen, et. al., 1969, 1970; Dreistadt, 1969; Sieber, 1969; Murray and Dennis, 1969; Bourne, 1969; Vogler and Ault, 1969; Whimbey, 1968; Odum, 1967).

In studying the effects of social-ethnic-economic background on school performance, Cohen reports evidence that performance in problem solving abilities of children are strongly influenced by rule sets which originate from early experiences in primary group living styles (Cohen, 1969-a, 1969-b). "Analytic thinkers", which includes students who are most successful in school oriented tasks, tend to be the product of families with formal structure in role assignments. "Relational" or nonanalytic thinkers compete less successfully or fail to compete at all on similar school oriented tasks: flexible exchange of role assignments characterizes their primary family group living and is expressed by a student's preference for relational kinds of situations and tasks. Cohen's findings are supported in part in a study reported by Greenberger, et. al., (1970). Middle class boys who were rated high in problem solving flexibility exhibited personality correlates described as patriarchial, intrusive and assertive; this pattern was found to be more subdued for girls who rated high in problem solving flexibility.

Odum has separated the effect of SES from race by comparing the problem solving abilities of 120 Negro children from middle and lower income groups. His results show significant differences in problem solving ($p=.01$) between middle and low income groups (Odum, 1967). Likewise, Gruen and Zigler (in press) report SES to be signifcantly correlated to problem solving while Gruen and Ottinger (1969) found SES contributed no main effect to differences in problem solving which was based on skill- or chance-derived solutions.

Additional factors which appear to correlate with problem solving abilities include other behavioral characteristics as well as conditions which surround problem administration. Greenberger, et. al., (1970) found good problem solvers were generally more interested in and alert to their environment, rated higher in curiosity by their teachers, and able to recall more novel information. Murray and Denny (1969) have shown that subjects of high and low problem solving abilities perform differently when under conditions which (a) demand continued

persistence on a problem or (b) provide for incubation time. Continuous work improved the performance of high ability problem solvers but not their low ability peers, while incubation time appeared to benefit low ability problem solvers but contribute nothing to their high ability peers. The authors suggest that different types of problem solving processes may occur in high and low ability problem solvers so that interpolated activity influences these processes in opposite ways. The results of Murray and Denny do not support the general claim often made by eminent scientists that incubation time facilitates problem solving. This discrepancy may be due to the dissimilarity between the problem the authors posed for their subjects and the particular nature of the problems with which scientists work.

Logic or chance as a basis for solving problems has been shown to correlate with persistence (Nakamura and Lowenkron, 1964). However, in a study by Gruen and Ottinger (1969), skill-oriented students, that is students attempting a logical solution, showed fewer correct responses than did chance-oriented students. Such results are not surprising when one takes into account the philosophy behind a logical approach to problem solving: the individual willingly sacrifices early chance successes for later predictable successes. In problem solving tasks which observe a limited number of responses, the performance of the individual attempting to solve the problem through logical strategies would be at its lowest level in the initial trials observed.

The problem selected in the current study lends itself to a classification of responses according to logical or chance oriented solutions. If the strategies used by the children to solve a problem correspond to their Piagetian levels or stages of intellectual development, then the appearance of logic as a means of solving the problem should be associated more or less with older children (sixth graders) more of whom tend to perform at State III, Formal Operations, on the Piagetian Task administered later the same day.

J. Summary

Investigations into the nature of curiosity have tended to follow two courses: those studying the verbal-oriented responses of humans to written or picture tests; and those examining the motor responses of animals to object or spacial stimulation. Such investigations have proceeded vigorously since the early 1950's. Recently (1966) a few investigators have attempted to bridge the gap between these two approaches, and have begun to investigate human curiosity in ethological terms (i.e., using methods developed by animal behaviorists), studying motor behaviors of young children.

Few generalizations can be made yet regarding curiosity, but a brief survey leads to several tentative conclusions.

Objects, events, and situations which are novel, complex, irregular, or incongruous stimulate greater curiosity than those which are familiar, symmetrical or predictable. However, when novelty or incongruity are too extreme for the individual, withdrawal or even flight may result. The degree of stimulation a particular stimulus offers is dependent in part upon the previous experience of the individual.

Early rearing experiences such as fondling or handling appear to have beneficial effects on encouraging the young to explore. Because of such precocious exploration these individuals may become satiated with certain classes of stimuli earlier than non-precocial explorers. However, overall, the continuation of curiosity appears to be a function of the availability of unfamiliar aspects of the environment to explore.

Many observers have noted that curiosity is strongest in children and young animals, and that it appears to diminish as the young approach maturity. Yet a number of studies report little or no difference between age groups as they respond to concrete novel situations. By asking children to wait alone in a room filled with familiar and novel objects we expect to find younger children less curious.

Conflicting results give no clear-cut evidence of differences in exploratory behavior among children of different sexes. However, there is some evidence of differences in amounts of exploratory behavior between racial groups. As such behavior is recorded on video tape, the influence of age, sex and race can be considered.

Although curiosity has been considered a correlate of intelligence, investigations have shown few significant correlations between present written or picture tests of curiosity and standardized intelligence tests or school grades. The present study will investigate the relationship between motor responses associated with curiosity and intellectual development as described by Piaget.

Because there is a lack of correlation between Teacher Ratings which assess classroom curiosity behavior, Individual Interviews designed to assess children's perceptions of how curious they are, and quantitative studies of exploratory motor activity, additional research is needed to clarify the differences underlying these outcomes.

Investigations into the nature of persistence and problem solving have been less vigorously pursued here, but several aspects of these behaviors are tentatively summarized as follows:

a. The magnitude of the reward has differential effects on persistence and problem solving;

b. Age, sex, and previous experience appear to be related to persistence as well as to problem solving; and

c. The use of chance or logical strategies appears to affect persistence and problem solving in similar ways.

HYPOTHESES

The hypotheses listed below describe the overall focus of this investigation.

Hypothesis 1. There is no significant difference in the amount of curiosity exhibited by children of different (a) age, (b) sex, or (c) racial groups.

Hypothesis 2. There is no significant difference in the amount of persistence exhibited by children of different (a) age, (b) sex, or (c) racial groups.

Hypothesis 3. There is no significant difference in measures of problem solving abilities among children of different (a) age, (b) sex, or (c) racial groups.

Hypothesis 4. There is no significant correlation between measures of curiosity, persistence, and problem solving behavior.

Hypothesis 5. Intellectual development determined by Piagetian tasks is not significantly related to curiosity, persistence, or problem solving.

Hypothesis 6. There is no significant correlation between assigned ranks from Teacher Ratings of curiosity and other measures of (a) curiostiy (motor responses), (b) persistence, or (c) problem solving.

DEFINITIONS

Curiosity is a human concept, and as such might be viewed simply as a tendency to seek "surplus" information. More specifically, the term is used to describe information-gathering kinds of activity which occur when there appears to be no immediate need for such information or activity. The noticeable characteristics of this behavior include motor responses such as approaching, looking, touching, smelling, listening, tasting, manipulating, and rearranging and reorganizing parts or entire stimulus objects. Such motor responses are typical of curiosity when the sense organs being used are integrated in information-gathering activity. For example, eyes and hand movements are coordinated rather than being engaged in separate kinds of activity.

It is immediately apparent that motor responses described above as characteristic of curiosity also appear in other kinds of behavior with differently defined ends, such as seeking food, shelter and so forth. However, the final outcome of the behavioral sequence (i.e., what the individual does with the stimulus object) differentiates curiosity behavior from other behaviors. (Note: For a further discussion of the characteristics of exploratory behavior see Appendix A.

The definition for curiosity used in this study will be limited to a consideration of motor responses of curiosity in children, and the two terms "exploratory behavior" and "curiosity" will be used interchangeably. Latent curiosity and verbal responses of curiosity will not be evaluated although they also may constitute measures of curiosity. How motor responses of curiosity are measured is described later.

Persistence has been described as a tendency to continue working toward a goal in the face of uncertainty or indications of failure (Amsel and Ward, 1965). Like curiosity, persistence is relative; in the absence of absolutes, persistent behavior must be described in relation to some problems and points in time. These parameters will be described later.

RESEARCH DESIGN AND PROCEDURE

The Sample

In the fall of 1968, the Berkeley Unified School District of Berkeley, California, implemented a plan for racial integration in schools through bussing. Theoretically and in practice, any classroom from any school guaranteed a balanced ratio of races reflecting the racial population of the entire school district. In addition, classrooms were further balanced in terms of the range of abilities in school achievement and in numbers of boys and girls. For these reasons, the Berkeley school system was considered ideal for this experiment. (Fig. 1, Composition of Sample)

Schools within the district are designated as either lower elementary (kindergarten through third grades) or upper elementary (fourth through sixth grades). In order to compare four different age groups, the following schools and grade levels were selected for the sample of 125 children.

Whittier Elementary School -- Kindergarten -- 30 subjects

Le Conte Elementary School -- Grade 2 -- 31 subjects

Franklin Elementary School -- Grade 4 -- 31 subjects

Lincoln Elementary School -- Grade 6 -- 33 subjects

For each grade level, an entire self-contained class was chosen; however, in each case the class-size was less than 30, and the additional students needed to complete the sample were randomly selected from an alternate classroom of the same grade level and in the same school.

Matrix Showing Composition of Population Sample

(number in each cell refers to number of students)

	Male		Female		
	Black	Non-Black	Black	Non-Black	
Kdgn	8	7	6	9	30
Grade 2	9	10	7	5	31
Grade 4	10	6	7	8	31
Grade 6	7	8	7	11	33
	34	31	27	33	(125)

Fig. 1

The Environment

To obtain natural and relaxed behavior from the subjects during the observation period, the testing room was furnished as a "waiting room". A large table was placed at one side of the room and four sets of objects (described below) were casually arranged on it to stimulate exploratory behavior. Next to the large table was a chair for students who preferred to sit and wait. Shelves which lined one wall of the waiting room provided easy access to a wide assortment of colorfully-illustrated books as well as various containers of discarded and dismantled objects, referred to by the children as "junk". Concealed behind the wall of shelves in the waiting room were a video camera and microphone. The camera remained in a fixed position and focused on the area around the table and chair. Actual video and audio recordings were accomplished in an adjacent office by a technician who operated the equipment.

Upon entering the waiting room from the hall, the subjects could see an open passage which led into the"game room". The game room, which was actually a part of the waiting room that had been partitioned off by floor to ceiling book shelves, contained a low table with a game board on it and two chairs. Like the waiting room, the game room had a concealed microphone for recording sound. The game in the game room was represented to the children as the reason for their presence in the waiting room; and, in fact, the game which they played (Piaget's Billiard Game) was an essential part of the study.

Selection of the objects used to stimulate exploratory behavior was based upon two criteria: familiarity or unfamiliarity and simplicity or complexity. Two of the objects were to be generally familiar or commonplace in classrooms while the other two were to be relatively unfamiliar or perhaps novel in some way. In addition, each set of objects was to have characteristics which would permit simple as well as complex investigation. The four sets of objects are listed below with a description of each and the characteristics considered in its selection.

Stimulus 1. Rocks: A cigar box containing eight rock or mineral specimens; and a small inexpensive tripod magnifying hand lens (approximately 2" diameter).

Stimulus 2. Tadpoles: An aquarium containing many small tadpoles, sand, a plant, and water; a small inexpensive magnifying hand lens; and a small mesh dip net.

Stimulus 3. Balance: An equal-arm balance of moderate precision, with three sources of adjustment in addition to the two pans supported by the balance beam; a styrofoam cup containing an assortment of wooden and metal slabs to be used as weights.

Stimulus 4. Tortoise: A large glass terrarium (approximately 12' x 12" x 18") with an open top. To the outside of the terrarium was taped a cardboard flap (approximately 4" x 4") which read "OPEN ME". The flap concealed an underground tunnel dug in the sand by a desert tortoise. By lifting the flap or peering over the top, children could observe the tortoise. Beside the terrarium was a small dish of freshly cut green vegetables (standard food ration for desert tortoises).

The objects used in assessing persistence and problem solving are described below in the context of the procedure. The game used in the Piagetian task is described elsewhere (Inhelder and Piaget, 1958). Briefly, it consists of a flat wooden surface, approximately 15" x 24", having a 1" curb on four sides except for a small opening at one end. From the opening, the child is able to shoot marbles onto the playing field, from a small plunger mounted on the game board in a way which permits the "shooter" to swivel approximately 90° within the opening left in the curbing. As the child shoots marbles, he tries to hit colored wooden discs placed at various locations on the field, through a series of "bank" or rebound shots.

The Procedure

The study proceeded in three successive stages corresponding to the three major sources of data to be compared. Stage I was designated as an assessment of curiosity; Stage II, a measure of persistence and problem solving; and Stage III, an assessment of intellectual development in terms of Piagetian levels.

Stage I: Curiosity

Behaviors during the first five minutes spent in the waiting room were recorded on one inch video tape in order to facilitate learning precisely how children of different ages, sexes, and races behave when unexpectedly confronted with a situation structured to arouse curiosity, and when given an opportunity to do as they wished in a waiting room.

The children in each class were told in advance that they could come to the game room, if they chose, to play a new game. As each child's turn arrived for playing the game he was introduced to the investigator, greeted in a friendly manner, and taken from the classroom through the waiting room and into the game room where a game was in progress. Stepping back into the waiting room each child was told the following:

> "(Name), I guess they are still playing the game. Would you mind waiting here for a few minutes? (Pause.) There are some things over there (pointing to the large table) for you, and here (pointing to the shelves), or a chair here

(pointing to the chair) to sit on. You may do whatever you wish with anything here. As soon as they have finished the game, Mrs. Wallace will play the game with you. All right? (Pause.) If you have any questions I will be just outside the door".

The investigator then left the waiting room and remained within calling distance in the hall.

Stage II: Persistence and Problem Solving

After five minutes of waiting in an unstructured situation, the children were confronted with a new alternative. The investigator brought in a wooden box (approximately 10" x 12" x 5") with a lid which hinged on one side and was secured on the remaining three sides by three brightly painted padlocks, and a smaller plactic box containing an assortment of keys. The larger box was filled with 1¢ candies. As the investigator entered with the wooden box, each child was told:

"Here is a puzzle box you might like to play with while you're waiting, (Name). You see the box has a red, yellow and blue padlock on it (pointing to three sides). The puzzle is to open the box, using any of these keys (handing the keys to the child). If you can get the box open, you may choose one of what is inside. (Pause.) You know how keys fit into locks, don't you? (Pause.) I will still be outside if you need me".

During the subsequent five minutes, children were left with the alternative of working with the puzzle box or returning to their previous activity. Behavior exhibited during Stage II was also recorded on video tape for later analysis.

Stage III: Piagetian Level

After ten minutes in the waiting room, the child was taken into the game room as the previous child left, introduced to the Assistant, trained in administering Piagetian tasks. While the Assistant demonstrated the features of the game, each child was told:

"(Name), this is a game that was built here at the Lawrence Hall of Science. We would like to find out if children of different ages like it... (proceeds to describe the operation of the game). Would you like to try it?"

The children were free to play the game for ten minutes or until they tired of it. When children tired of the game before ten minutes, the Assistant engaged them in conservation related to improvements which might be made in the game for future use, so that the child who was out in the waiting room would also be given ten minutes to explore, and solve the puzzle box problem.

Teacher Rating

In addition to data collected during Stages I, II and III, information was also sought from teachers asked to participate in the study by filling out Teacher Rating forms. A group evaluation of the amount of curiosity exhibited in normal classroom activity by the students was referred to as Teacher Rating; it was conducted in an effort to relate the findings of this study to findings of other investigators.

At the conclusion of the experimental phase of the study, the teachers of four respective classrooms used in the study were asked to rank all of the children in their classes, ranging them from "the most curious" to"the least curious". Each teacher was given a written set of instructions and criteria for ranking. The Teacher Rating scales which were used were developed by Maw and Maw (1965). A copy of the form is included in Appendix D.

Assessment Measures

Data from Stages I, II, III and Teacher Ratings were analyzed by separate measures which are described below.

Stage I: Curiosity

Analysis of curiosity behavior recorded on video tape followed a procedure developed by the author and described elsewhere (Peterson - Lowery, 1968; Peterson, 1969). Briefly the theoretical basis incompasses two assumptions:

1. a part of curiosity behavior can be viewed as a series of discrete and stereotyic motor responses which occur in a predictable sequence; and
2. motor responses which occur later in a sequence can be said to be dependent upon responses which precede them.

If curiosity behavior fits these assumptions, then one is justified in associating numerical values with responses depending upon their order in the sequence, and such numerical values can be translated into socres. (Note: For an example, see the illustration in the frontispiece.)

Proceeding from these assumptions, all exploratory motor responses were categorized; these categories were arranged hierarchically and referred to as response levels. The following model was the result:

Level 1 - Ss. approach the stimulus;

Level 2 - Ss. manipulate a part or all of the stimulus, using any or all forms of sensory input (e.g., touching, etc);

Level 3 - Ss. reorganize the stimulus by taking it apart or applying it to some other aspect of the environment. [See Frontispiece]

In order to apply this model to the curiosity behavior recorded on video tape, observations of each child were devided into twenty fifteen-second intervals. Within each interval, the highest level of response was noted as a subscore; then the average of the twenty subscores for each child became the final score or measure of curiosity for that child. Since the range of response levels extended from 0, (no response), to 3, (reorganizing), the range of curiosity scores extended from 0.00, or no exploratory behavior at all within five minutes, to 3.00, repetitive or continuous reorganization of stimuli throughout the twenty observations within five minutes.[1]

Stage II: Persistence and Problem Solving

A. Persistence was determined as the percent of time during an interval of five minutes in which a child actively engaged in trying to solve the problem, opening a puzzle box. Children who were successful in opening the box before five minutes were judged 100% persistent, just as children who worked continuously for five minutes but failed to open the box. Because behavior was recorded on video tape, careful attention could be given to the cumulative amounts of persistence exhibited by children who were intermittent in their efforts.

---

[1]The significance of two decimal places in curiosity scores is important for communicating fine lines of difference between children and groups. Only by viewing the behavior recorded on video tape can one recognize the need for isolating such differences: within any 15 second interval a child may respond to 1-10 stimuli; the highest response level for that interval represents 1/20 or .05% of his score. For a population of 125 Ss or 2500 observations, differences between individuals or groups may represent differences between 0-1250 responses.

Persistence is customarily measured to extinction (i.e., until subjects solve the problem or withdraw). Children in our study were given a limited rather than an exhaustive encounter with the problem; therefore, the conclusions drawn will be limited to the context of this investigation and not compared with other studies of persistence.

B. Problem solving was analyzed in two ways: (1) the degree to which subjects used chance or logical strategies, and (2) the degree of success subjects achieved in opening the box.

Problem Solving - 1

The lock box problem,or puzzle box, was designed by the author to provide a concrete situation in which children were confronted with two sets of variables: multiple locks and multiple keys. The physical distance between members of one set of variables, the locks, allowed one to follow the strategy being pursued by the subject. For example, if the child decided to try opening the red lock first, he would hold the box in one position while he tried several or all keys in it. Likewise, if he decided to test whether a particular key fit in any of the locks, he would rotate the box with each trial of key #1, without changing keys. In this manner, strategies could be observed.

Protocols were developed for the most efficient set of moves associated with all commonly observed strategies. The characteristics of all strategies included controlling one set of variables (i.e., concentrating on one lock or one key) while changing the members of the other set of variables. The degree of thoroughness a subject exhibited in following a strategy represented his tendency to use chance or logic in solving problems. Degrees of strategy development are described below:

Level 1 - Ss. show no pattern or strategy; different members from both sets of variables are combined on each trial; e.g., S randomly selects and tries key #1 in red lock, key #2 in blue lock, key #3 in yellow lock, etc.

Level 2 - Ss. exhibit fragmented patterns belonging to one or more strategies; Ss may or may not have a retrieval system (i.e., keep track of which keys have been tried in which locks); e.g., S. tries several but not all keys in one lock, then may switch to trying a key in some but not all locks, etc.

Level 3 - Ss. follow a recognizable strategy through to conclusion; Ss. usually always have an observable retrieval system (e.g., put keys in separate piles); Ss. rarely interrupt a strategy unless unexpected information is introduced (e.g., S. suddenly finds a key which has some property linking it with a lock other than the one he is working on; he leaves his strategy temporarily to try the new combination and returns to his former strategy: e.g., of a complete strategy --S tries all

keys in one lock, remaining keys in second lock and final remaining keys in third lock. (Note: This model for problem solving, like the model for curiosity assigns 0 to Ss. making No Response.)

Problem Solving - 2

Success in solving the lock box problem was simply designated by the number (0, 1, 2, or 3) of locks opened.

Stage III: Piagetian Level

As each child played the game, the Assistant analyzed the child's actions and explanations in terms of criteria described by Piaget for differentiating between intellectual stages of development.[1] All conversations of children were recorded on audio tape and later analyzed by the author. Assignments of each child to a Piagetian Stage or level based on his explanation of the game, were made independently by the Assistant and author, and resulted in complete agreement between the independent judgments of the Assistant and the Investigator in all but four of the one hundred and twenty-four cases. These latter differences were resolved by a re-evaluation of the tapes.

Teacher Rating

Each subject's rank score by his teacher(as described in the Teacher Rating Scale) was used directly in the statistical analysis described in the results.

[1]See Growth of Logical Thought, Inhelder and Piaget, 1958.

RESULTS

Four broad questions have been studied in this investigation. The results of the study are presented in the order outlined below.

Part 1. In what ways are curiosity, persistence and problem solving related to such variables as age, sex and race among elementary school children?

Part 2. How are curiosity, persistence, and problem solving behaviors related to each other?

Part 3. How is intellectual development, as determined by Piagetian levels, related to curiosity, persistence, and problem solving among elementary school children?

Part 4. Can different measures of curiosity be equated: specifically, is there a correlation between Teacher Ratings of curiosity and measures of exploratory motor activity?

Part 1. The Relationship of Curiosity, Persistence, and Problem Solving to Age, Sex, and Race Among Elementary School Children

In order to test the overall relationship of curiosity, persistence, and problem solving to age, sex, and race, a multivariate analysis of variance was performed. There was no evidence that behavioral variables were related to each other in a way that warranted a consolidation of variables. Therefore, each behavioral variable (e.g., curiosity) was subsequently treated in a univariate analysis of variance for further clarification of its relationship to demographic variables: age, sex, and race. The results of those analyses are presented on the following pages. Table I summarizes the overall relationship of these two sets of variables to each other. Table II provides the observed means and standard deviations for all behaviors in all groups.

TABLE I

Summary of the Relationship of Curiosity, Persistence and Problem Solving to Age, Sex, And Race Among Elementary School Children

Behavioral → / Demographic ↓	Curiosity	Persistence	Prob. Solv. Strategy	Prob. Solv. Success
Age	*	*	*	*
Sex	-	-	-	*
Race	*	-	-	-

(*) statistically significant at($p = 0.05$) level
(-) not significantly related

TABLE II

Matrix Showing Observed Cell Means* and Standard Deviations for Measures of Curiosity, Persistence, And Problem Solving Among Elementary School Children by Age (Grade**) Sex, and Racial Groups

		Male Black		Male Non-Black		Female Black		Female Non-Black	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Curiosity	K	1.82	.65	2.11	.60	1.96	.40	1.35	.95
	2	2.62	.22	1.87	.88	2.47	.65	2.24	.35
	4	2.94	2.12	2.40	.47	2.26	.66	1.96	.69
	6	2.60	.31	2.07	.72	2.34	.67	2.38	.51
Persistence	K	0.91	.21	0.84	.27	0.70	.29	0.65	.44
	2	0.98	.05	1.00	0.00	0.92	.19	1.00	0.00
	4	1.00	.31	1.00	0.00	1.00	0.00	1.00	0.00
	6	1.00	0.00	0.88	.35	0.97	.08	1.00	0.00
Prob. Solv. Strategy	K	2.00	.53	2.43	.53	2.00	0.00	1.44	.88
	2	2.11	.33	2.40	.52	2.00	0.00	2.40	.55
	4	2.30	.48	2.33	.52	2.29	.49	2.13	.35
	6	2.14	.38	2.25	1.04	2.57	.53	2.27	.47
Prob. Solv. Success	K	1.50	1.41	1.57	1.13	0.66	.81	0.44	.73
	2	2.22	.83	2.50	1.08	1.43	1.27	1.60	1.52
	4	2.50	.71	2.83	.41	2.71	.76	2.00	.93
	6	2.86	.38	2.25	1.16	2.29	.76	2.18	.87

*Behavioral performances represented by Means is interpreted in footnotes on pp. 33, 38, 40

**Grade levels: K(Kindergarten), 2,4,6 (Grades 2,4,6)

Hypothesis 1

There is no significant difference in the amount of curiosity exhibited by children of different (a) age, (b) sex, or (c) racial groups.

Decision: Reject (a) and (c)

Results: Curiosity, as determined by the amount of exploratory motor activity in a waiting room is found to be significantly related to the age ($p = 0.05$) and the race ($p = 0.05$) of children but not to their sex.

Exploratory behavior increased in a linear trend ($p = 0.05$) with age from kindergarten to sixth grade; mean scores in curiosity were: Kindergarten = 1.77; Grade 2 = 2.28; Grade 4 = 2.42; and Grade 6 = 2.36.[1]

Black children exhibited significantly greater amounts of exploratory motor activity than non-Black children; mean scores in curiosity were: Black = 2.41; non-Black = 2.02.

The analysis of variance table is presented in Table III. The relationship between curiosity scores and age, sex, and race is illustrated in Figure 2 on page 35. A histogram showing the actual distribution of curiosity scores is included in Appendix C.

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[1]Mean scores are based on the average level of exploratory motor responses (Level 1 - Approach, Level 2 - Manipulate, Level 3 - Reorganize) over all observations (20 per S.) over all Ss per grade level (N=30). Therefore, a mean of 1.77 for Kindergarten implies that on the average, the typical response of a 5-6 year old was to approach objects and sometimes, but not always, reach out to manipulate them.

TABLE III

Analysis of Variance Table Showing Relationship of Curiosity to Age, Sex, and Racial Groups

Source	df	MS	F
Sex	1	1.2841	1.73
Race	1	4.2985	5.80*
Grades (Age)	3	2.5206	3.40*
Linear	1	5.6386	7.62*
Quadratic	1	1.8905	2.55
Cubic	1	0.0326	0.04
Sex & Race	1	0.2185	0.30
Sex & Grades (Age)	3	0.8364	1.13
Race & Grades (Age)	3	0.2345	0.32
Sex & Race & Age	3	0.8833	1.19
Error	109	0.7404	-
Total	124	-	-

*Significant at $p = 0.05$; $F_{3,109}(.95) = 2.69$; $F_{1,109}(.95) = 3.93$

Relationship of Curiosity Scores
To Age, Sex, and Race Among
Elementary School Children

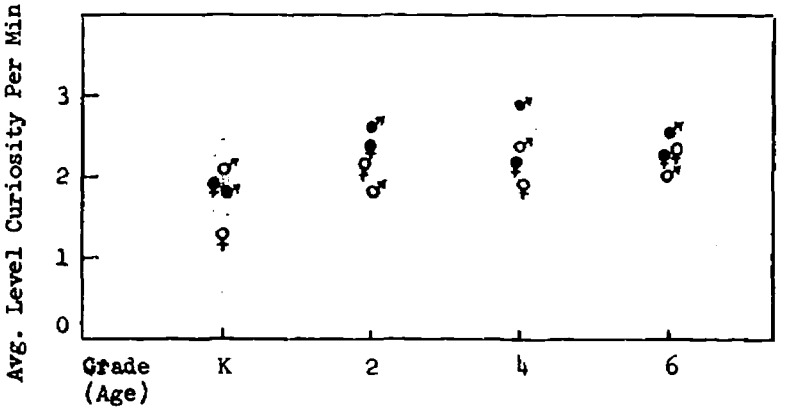

Fig. 2

Relationship of Persistence Scores
To Age, Sex, and Race Among
Elementary School Children

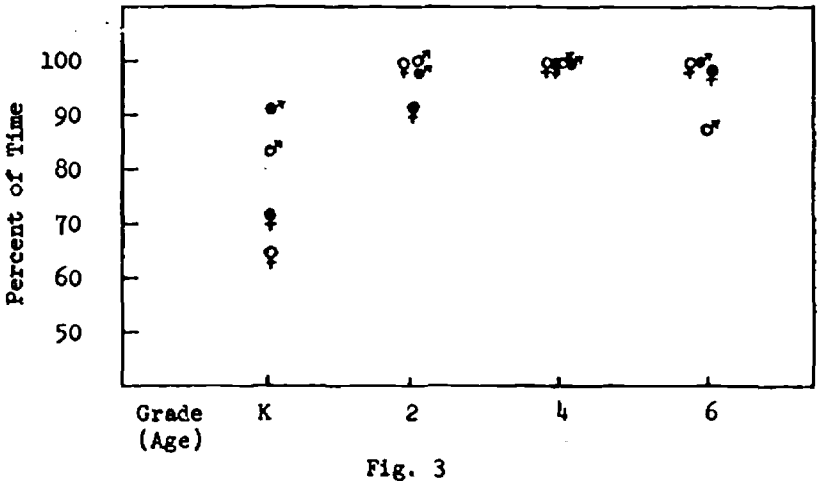

Fig. 3

Key: ♂ Black Male
♂ White Male
♀ Black Female
♀ Non-Black Female

Hypothesis 2

There is no significant difference in the amount of persistence exhibited by children of different (a) age, (b) sex, or (c) racial groups.

Decision: Conditionally reject (a).

Results: Persistence was identified as the amount of time spent actively trying to solve a problem. Children were given a puzzle box to open as an alternative to spending the time as they wished while waiting alone in a waiting room. Persistence scores were based on the percent of a five minute interval in which children had access to, and worked on the problem.

In an analysis of variance, persistence was found to be significantly related to the age ($p=0.05$) of children but not to their sex or race. Kindergarteners were noticeably less persistent than second, fourth or sixth graders. Mean scores in persistence were: Kindergarten = 0.78; Grade 2 = 0.98; Grade 4 = 1.00; Grade 6 = 0.96 with both linear and quadratic trends ($p=0.05$) [See Fig. 3]. Black pupils (mean = 0.93) and non-Black pupils (mean = 0.92) showed no significant differences; and further boys (mean = 0.94) and girls (mean = 0.91) showed no significant differences. The analysis of variance table is presented in Table IV.

Because our findings exhibit an unusual positive skew (88% of the children persisted for the full five minutes, 12% persisted for approximately two and one-half minutes) a most conservative estimate of their significance is warranted. This effect of positive skewing[1] is undoubtedly due to the brevity of the test period. In spite of earlier evidence that five minutes was adequate for distinguishing differences in persistence among individuals,[2] such a time allowance was not realistic for distinguishing differences among these particular children or for the enthusiasm created during investigation. However, the results as they have occurred do have some important implications when considered in relation to measures of curiosity taken from the same sample. A discussion of these implications will be presented under Discussion - Part 2.

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[1] See Table II , Observed Cell Means for Persistence

[2] Early evidence consisted of ten individuals, adults and children, who encountered the puzzle box in their daily surroundings and began trying to solve the problem. Between three and four minutes distinguished between seven of the individuals' persistence.

TABLE IV

Analysis of Variance Table Showing Relationship Of Persistence to Age, Sex and Race

Source of Variation	df	MS	F
Sex	1	0.0358	0.82
Race	1	0.0016	0.04
Grades (Age)	3	0.2810	6.4,*
Linear	1	0.4724	10.84*
Quadratic	1	0.3048	6.99*
Cubic	1	0.0658	1.51
Sex x Race	1	0.0058	0.13
Sex x Grades (Age)	3	0.1198	2.75*
Race x Grades (Age)	3	0.2478	0.83
Sex x Race x Grades (Age)	3	0.0207	0.47
Error	109	0.0436	-
Total	124	-	-

*Significant at p = 0.05

$F_{3, 109}(.95) = 2.69$; $F_{1, 109}(.95) = 3.93$

Qualitatively, all children between the ages of seven and thirteen years appeared to be completely immersed in solving the problem for the full time allotted. Even when frustrated, children continued without hesitation.

The exceptions to this profile of continuous persistence were a few kindergartners. Among five and six year olds many children would try one or two keys in one or two locks, call out for help from the Investigator in the hall, and then sit on a chair to wait even when no help was forthcoming. Some kindergartners actively sought help by carrying the box, which was quite heavy, in search of an adult. Yet, in spite of the fact that over all age groups kindergartners were least persistent, they were the most reluctant to leave the puzzle box when it was time to go. After a number of children literally held onto the box and desk in a friendly but determined way, the children were promised that the box would be brought to their classroom for further tries.

Another qualitative indication of the persistence of older children was illustrated by children who successfully opened the box in two or three minutes, closed and locked the box, and began trying to open the box again. This happened so often among successful problem solvers that it was a common place occurrance.

Hypothesis 3

There is no significant difference in measures of problem solving abilities among children of different (a) age, (b) sex, or (c) racial groups.

Decision: For Problem Solving - 1, reject (a); For Problem Solving - 2, reject (a) and (b).

Results: Two aspects of problem solving were considered. Problem Solving - 1, as determined by the presence of an observable strategy[1], was found to be significantly related to the age of the child ($p=0.05$), but not to his sex or race. (See Figure 4).

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[1]Problem Solving - 1, scores are based on the following levels of performance: (1) attempts to solve problems without observable strategy; (2) exhibits fragments of strategies in solving problem (e.g., tries one key in several locks or several keys in one lock); (3) follows one strategy more less faithfully (e.g., tries all keys in one lock or one key in all locks). Means above reflect these levels.

Relationship of Problem Solving - 1 (Strategy)
To Age Among Elementary School Children
(numbers refer to number of children)

Strategy Levels	Grade Levels			
	Kindg'n.	Grade 2	Grade 4	Grade 6
0	2	0	0	0
1	2	0	0	0
2	23	24	22	20
3	3*	7	9	12

Fig. 4

Relationship of Problem Solving - 2 (Success Opening Locks)
To Age Among Elementary School Children
(numbers refer to number of children)

Number of Locks Open	Grade Levels			
	Kindg'n	Grade 2	Grade 4	Grade 6
0	13	6	0	0
1	8	4	5	5
2	4	5	6	8
3	5	16	20	19

Fig. 5

*It is doubtful that these 3 Ss used a logical strategy; the ease of their solution (in 3 trials) suggests they had learned the solution from others.

Problem Solving - 2, as determined by the successful solution of the problem[1], was significantly related to both the age ($p=0.05$) and the sex ($p=0.05$) of the child but not to his race. (See Figure 5). As the development of strategies for solving problems increased with age (mean scores were, Kindergarten = 1.93; Grade 2 = 2.23; Grade 4 = 2.26; Grade 6 = 2.30), likewise success in solving the problem increased with age (mean scores were, Kindergarten = 1.03; Grade 2 = 2.03; Grade 4 = 2.48; Grade 6 = 2.36). Over all ages boys solved the problem more often than girls (Boys = 2.27; Girls = 1.68). Analysis of variance tables showing the relationship of Problem Solving -1 and -2 to age, sex and race are presented in Tables V and VI.

Part 2: The Relationship of Curiosity, Persistence, and Problem Solving Behaviors to Each Other

Hypothesis 4

There is no significant correlation between measures of curiosity, persistence, and problem solving behaviors.

Decision: (Withheld)

Results: Curiosity, persistence and problem solving are three behaviors perhaps more closely identified with science and research than any other behaviors. Consequently, a knowledge of the relationship of these behaviors to each other would be useful in predicting future success in science among elementary and high school students.

As a part of this investigation, scores from behavioral assessments of curiosity, persistence, and problem solving were compared. In an initial multivariate analysis of variance, no association was found between these sets of scores. Afterward, separate tests for correlation (Spearman[2]) were performed for three different grade levels. The results of those tests are presented in Table VII. Meaningful correlations are lacking in all but one comparison: curiosity and success in problem solving at Grade 2 ($r_s = .46$) shows significant correlation. The overall failure to find meaningful correlations may be attributed to difficulties of different orders. These will be discussed later.

In a t-test comparing the curiosity scores of 15 non-persistent subjects (persistent less than 100%) with curiosity scores of an equal number of 100% persistent subjects, no significant differences were found between the two groups in curiosity behavior (t ratio = 0.24, df = 28). Tentatively, it was concluded that within the parameters of this test situation, curiosity and persistence are not likely to be correlated behaviors.

[1] Problem Solving - 2, scores are derived from the number of locks (0,1,2,or 3)successfully opened; means reflect these scores.

[2] Spearman Rank Correlation Coefficient tests are reported in Siegel, 1956.

TABLE V

Analysis of Variance Table Showing Relationship Of Problem Solving - 1, To Age, Sex and Racial Groups

Source of Variation	df	MS	F
Sex	1	0.5231	1.75
Race	1	0.0087	0.03
Grades (Age)	3	0.8616	2.90*
Linear	1	2.1032	7.07*
Quadratic	1	0.3942	1.33
Cubic	1	0.0875	0.29
Sex x Race	1	1.1840	3.98*
Sex x Grade (Age)	3	0.7129	2.40
Race x Grades (Age)	3	0.0240	0.55
Sex x Race x Grades (Age)	3	0.3898	1.31
Error	109	0.2974	-
Total	124	-	-

* Significant at $p = 0.05$; $F_{3, 109}(.95) = 2.69$; $F_{1, 109}(.95) = 3.93$

TABLE VI

Analysis of Variance Table Showing Relationship Of Problem Solving - 2, To Age, Sex and Racial Groups

Source of Variation	df	MS	F
Sex	1	10.9933	11.93*
Race	1	0.3163	0.34
Grades (Age)	3	13.3050	14.44*
Linear	1	32.1625	34.91*
Quadratic	1	7.7125	8.37*
Cubic	1	0.0400	0.04
Sex x Race	1	0.5334	0.58
Sex x Grades (Age)	3	1.0799	1.17
Race x Grades (Age)	3	0.4045	0.44
Sex x Race x Grades (Age)	3	0.7858	0.85
Error	109	-	-
Total	124	-	-

*Significant at $p = 0.05$; $F_{3,109}(.95) = 2.69$; $F_{1,109}(.95) = 3.93$

When the problem solving strategies of all children were dichotomized according to the use, or failure to use, an organized strategy in problem solving (Level 0, 1, 2, vs. Level 3), only 35 out of 93 children, or 38%, succeeded in solving the problem by using fragmented strategies or chance, while 25 out of 32, or 78%, succeeded by using an organized strategy. When a Chi Square test was applied to these results, problem solving strategies were found significantly related to problem solving success ($X^2 = 15.64$, df = 1, p = .001).

TABLE VII

Summary of Correlation Coefficients Showing Relationship of Curiosity, Persistence, and Problem Solving Scores to Each Other

	Curiosity	Persistence	Prob. Solv. -1	Prob. Solv. -2
Curiosity				
Grade 2	-	0.29	0.26	0.46*
Grade 4	-	-0.19	0.16	0.29
Grade 6	-	-0.10	-0.07	0.15
Persistence				
Grade 2	-	-	-0.18	0.29
Grade 4	-	-	0.05	-0.12
Grade 6	-	-	0.29	-0.16
Problem Solving 1				
Grade 2	-	-	-	0.14
Grade 4	-	-	-	-0.07
Grade 6	-	-	-	0.11
Problem Solving 2				
Grade 2	-	-	-	-
Grade 4	-	-	-	-
Grade 6	-	-	-	-

*Significant at p = 0.01

TABLE VIII

Relationship of Problem Solving Strategies to Problem Solving Success

	Failure Opens 0, 1, 2 locks	Success Opens 3 locks
Chance: Strategy Fragmented or Absent (Levels 1, 2)	58 children	35 children
Logic: Strategy Well Organized (Level 3)	7 children	25 children

$X^2 = 15.64$, df = 1, p = .001

Part 3: The Relationship of Intellectual Development to Curiosity, Persistence, and Problem Solving Behaviors

Hypothesis 5

Intellectual development determined by Piagetian tasks is not significantly related to (a) curiosity, (b) persistence, or (c) problem solving.

Decision: Reject (c) Problem Solving - 2.

Results: A separate analysis of variance was performed to establish the relationship between intellectual development, as determined by Piagetian task, the billiard game[1], and each behavioral variable: curiosity, persistence and problem solving. The results of these analyses are presented in Tables IX, X, XI, XII.

Our findings suggest a strong association ($p = .001$) between intellectual development and performance in Problem Solving - 2, specifically getting the box open. Intellectual development appeared to be positively but weakly associated with curiosity ($p = 0.09$) and persistence ($p = 0.13$). Perhaps the most surprising result is the lack of association between Piagetian levels and the use of chance or logic in problem solving designated strategy level in Problem Solving -1. While this latter association was expected to be positive (i.e., that children who used a logical strategy in solving the lock box problem would also perform higher on the Piagetian task), it may be noted that Piagetian levels were not normally distributed in terms of hypothetical norms for Piagetian theory. The distribution of performance levels on the Piagetian task are reported in Table XIII.

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[1] See Growth of Logical Thought, Inhelder and Piaget, 1968.

TABLE IX

Analysis of Variance Table Showing Relationship Of Piagetian Levels to Curiosity Scores

Source	df	MS	F
Between Groups (I, II, III)	2	1.0893	2.44
Within Groups	122	0.4458	
Total	124		

Decision: Not Significant, ($p = 0.09$)

TABLE X

Analysis of Variance Table Showing Relationship Of Piagetian Levels to Persistence Scores

Source	df	MS	F
Between Groups (I, II, III)	2	0.0862	2.04
Within Groups	122	0.0423	
Total	124		

Decision: Not Significant, ($p = 0.13$)

TABLE XI

Analysis of Variance Table Showing Relationship Of Piagetian Level to Problem Solving - 1 (Strategy)

Source	df	MS	F
Between Groups (I, II, III)	2	0.4803	1.45
Within Groups	122	0.3314	
Total	124		

Decision: Not Significant, (p = 0.24)

TABLE XII

Analysis of Variance Table Showing Relationship Of Piagetian Level to Problem Solving - 2 (Success)

Source	df	MS	F
Between Groups (I, II, III)	2	8.3942	7.20*
Within Groups	122	1.1656	
Total	124		

Decision: Significant at (p = 0.001)
$F_{2,122}$ (.95) = 3.07

TABLE XIII

Distribution of Performance of 124 Elementary School Children On A Piagetian Task "The Billiard Game"(1)

Age By Grade Levels	Piagetian Levels		
	Stage I (Preoperational)	Stage II (Concrete)	Stage III (Formal)
Kindergarten	30	0	0
Grade 2	24	7	0
Grade 4	13	17	1
Grade 6	6	23	4

[1] See Growth of Logical Thought, Inhelder and Piaget, 1958.

Part 4: The Equivalence of Measures of Curiosity

In an effort to compare two different methods of assessing human curiosity, tests of correlation were administered. Curiosity scores based on amounts of motor activity were compared with ranks assigned by teachers in a Teacher Rating form, which was designed to assess curiosity behavior of children in their classrooms. It was decided that a comparison of Teacher Rating ranks of curiosity with other behavioral variables of the children as well, namely persistence and problem solving scores would be useful.

Hypothesis 6

There is no significant correlation[1] between assigned ranks from Teacher Ratings of curiosity and other measures of (a) curiosity (motor responses), (b) persistence, or (c) problem solving.

Decision: Do not reject

Results: Results from the Spearman Rank Correlation Coefficient failed to reject Hypothesis 6 for (a) curiosity[2], and (c) problem solving but only slightly for (b) persistence.

The finding that teachers' estimates of children's classroom curiosity behavior are not significantly correlated with amounts of children's curiosity in a waiting room supports our previous findings. It is reasonable to expect actual differences in curiosity behavior of children when they are in these two different environments; but the fact that the Teacher Rating form (Maw and Maw, 1964) is used as an assessment of curiosity in other studies (Day, 1968) suggests a need for reconsidering the nature of curiosity behavior which this instrument measures.

The finding that Teacher Ratings are closely correlated to persistence scores may or may not be a spurious out come based on the unnatural distribution of persistence scores. No correlation was expected or found between Teacher Ratings and problem solving abilities; this finding suggests that teachers must have successfully refrained from thinking of the most able children as also being the most curious .

The results of the four Spearman Rank Correlation Coefficient tests are presented in Table XIV.

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[1] For this analysis only positive scores were of interest, not both positive and negative.

[2] Kindergarten curiosity scores were negatively correlated with Teacher Rating scores and therefore not of interest.

TABLE XIV

Summary of Correlation Coefficients for Teacher Ratings of Curiosity with Behavioral Measures of Curiosity, Persistence and Problem Solving(1)

	Curiosity	Persistence	Prob. Solv -1 (Strategy)	Prob.Solv -2 (Success)
Kind'gn (N=25)	r_s = -0.43*	r_s = -0.26	r_s = 0.01	r_s = 0.12
Grade 2 (N=24)	r_s = -0.29	r_s = 0.24	r_s = 0.14	r_s =-0.08
Grade 4 (N=24)	r_s = -0.29	r_s = 0.51*	r_s = 0.30	r_s = 0.13
Grade 6 (N=30)	r_s = -0.08	r_s = 0.54*	r_s = 0.29	r_s = 0.12

*Significant at (p = 0.01)

(1) Teachers were asked to rank the pupils in their classes from the most curious to the least curious, according to pupils' curiosity behavior within the classroom. Teacher Ratings were examined for correlation with other behavioral measures.

DISCUSSION

Part 1: The Relationship of Curiosity, Persistence and Problem Solving to Age, Sex, and Race Among Elementary School Children

Curiosity and Age

Exploratory behavior, in this analysis, appears to increase rather than decrease with age among elementary school children. This finding is contrary to expectations based on earlier studies carried out by Woodruff and Pielstick (1964) and Peterson (1969). Likewise it is contrary to expectations based on the research of animal behaviorists. All current information points to a gradual decline in exploratory behavior with age, among primates (Welker, 1961; Loizos, 1967). If exploratory behavior expressed through motor responses also declines with age among humans, then future research must include older subjects.

In the previous investigation (Peterson, 1969), children of different age groups exhibited equal amounts of exploratory motor activity but unequal amounts of quasi-exploratory behavior.[1] The inverse relationship of these two latter behaviors (i.e., Kindergartners asked more questions and exhibited less quasi-exploratory while the reverse was true for sixth graders) led to the speculation that age differences in exploratory motor activity might be found if (a) question-asking behavior could be eliminated, and (b) quasi-exploratory behavior could be studied more closely on film.

Thus, in this current investigation, question-asking behavior was eliminated by removing the adult from the waiting room and video tape provided close analysis of quasi-exploratory behavior. The result, in the presence of this change, was that significant differences were found between age groups but with an increase in curiosity with age rather than a decrease. When question-asking was eliminated from the repertoire of behavioral responses, Kindergartners failed to exhibit more exploratory motor activity, casting doubt on the speculation that question-asking represented a response-substitute for action. In addition, quasi-exploratory behavior disappeared. The unexplained disappearance of quasi-exploratory behavior deserves further investigation. Still unanswered is the question of what accounts for a decline in motor activity among Kindergartners once

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[1] "A group of motor responses which appeared transitional in nature (i.e., gradually shifting from investigation to play or satiation) was identified as quasi-exploratory behavior, due to the predominant appearance of being investigatory. Examples include rhythmic tapping on the cage of the kangaroo rat, or shuffling pages in a book" (Peterson, 1969).

question-asking behavior has been eliminated. The most likely explanation, based on the findings of Berlyne, 1960; Hutt, 1966; and Lucco, 1967, is that the absence of an adult introduced a measure of anxiety for Kindergarteners that inhibited exploration.

Curiosity and Race

The finding that Black children exhibited more exploratory behavior than non-Black children is particularly noteworthy since it duplicates previous findings (Peterson, 1969):

	Black	Non-Black
1969 Mean Scores	2.73	2.40
1970 Mean Scores	2.41	2.02

That these differences were preserved in spite of the presence or absence of an adult, while age differences were sensitive to such manipulation, suggests a substantial and reliable difference.

One interpretation of these results is that the difference in curiosity between racial groups is a function of time and experience. Given different sets of experiences, the two groups of children may have viewed the stimulus objects in quite different ways, i.e., the objects or the entire situation may have represented an optimum degree of novelty for one group and not for the other group. This hypothesis could be tested. A second interpretation involves the relationship between curiosity and anxiety. Penney (1965) has found curiosity and anxiety scores to be inversely related. A third interpretation is that the increased exploratory motor activity of Black children is related in some way to a general superior development of motor activity such as described by Bayley, (1965). Studying the exploratory motor activity of infants and preschool children of both racial groups in a constant environment should shed light on this question. All of these interpretations may in fact be related to the outcome reported here.

Curiosity and Sex

When the environment offers sufficient variation, exploratory behavior appears to be exhibited in equal amounts by boys and girls of elementary school age. This finding is also a replication of earlier results (Peterson, 1969) and suggests that regardless of the presence or absence of an adult there seems to be no observable difference in the amount of curiosity expressed by boys and girls through motor activity. Although these results conflict with those which have found girls more curious than boys in paper-and-pencil tests (Penney and McCann, 1964), it is common to find girls scoring higher on many kinds of written tests.

Persistence: Age, Sex, and Race

It was noted earlier that the distribution of persistence scores was unnatural and positively skewed, suggesting a ceiling effect in measurement. Consequently, a meaningful discussion of the relationship of persistence to age, sex, and race must await further investigation.

Some discussion of measurement error is warranted, however. Two sources of distortion are believed to contribute to that error. First, limited (5 minutes) rather than exhaustive measures undoubtedly masked individual differences in persistence, which in turn, may have disguised between-group as well as within-group differences.

A second source of distortion may be identified with the manner in which the problem was presented. Specifically, it was suggested that the assortment of 15 keys for the 3-lock problem might overwhelm younger subjects and possibly inhibit problem solving altogether. Because studying problem solving strategies held a higher priority than assessing persistence or actual success/failure at opening the puzzle box, it was decided that the difficulty of the problem should be varied with age groups to maximize observations of actual problem solving strategies. Therefore, Kindergartners and Second graders were given 6 keys, Fourth graders were given 8 keys and Six graders were given 14 keys.

By effecting this change in design, two possible outcomes were acknowledged: persistence and Problem Solving - 2 (the number of successes) would probably increase,[1] thereby possibly decreasing differences between age groups. (It is interesting to note that age was the only demographic variable which was linked with both persistence and Problem Solving - 2 scores, in spite of this change.

Although the results of persistence measures failed to provide the insights hoped for, the decision to adapt the difficulty of the problem to the age group was the "correct choice," not only from a theoretical position, but also from the standpoint of the children. To design a problem that extinguishes all differences in persistence between sexes and races, regardless of differences in successful solution, is a heartening experience.[2]

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[1] Increase, among younger children.

[2] Reference is to 90 children, Grades 2-6, excluding Kindergarten.

Problem Solving: Age, Sex, and Race

Problem solving strategies used by elementary school children to open a locked box are closely related to age but not to sex or race. With regard to age, these findings lend support to work done by Odum (1967) and Bourne (1969) and derive their original justification from the extensive research of Piaget (1958). The failure to find significant differences in problem solving strategies between racial groups appears to be in conflict with the findings of Jensen (1969) and Cohen (1969); however, no attempt is intended to equate the manipulation problem used in this investigation with written, pictoral or symbolic problems used by those cited. Yet, it is worth noting that evidence of problem solving strategies, when applied to this manipulative problem, appear to be equally well developed between both racial groups.

Success in problem solving, identified as Problem Solving - 2, was significantly different between children of different age groups in spite of a simplification of the problem for younger children. (See Discussion: Persistence) A reduction in the number of members in one set of variables (i.e., the number of keys) undoubtedly accounted for some success among younger children but did not alter the outcome of significant differences between age groups.

The finding that boys were more successful than girls in opening the box may perhaps be attributed to some increased experience with mechanical problems. The boys' success did not have a noticeable affect on the persistence exhibited by girls in the interval assessed. It seems likely that this latter effect may have been due in part to an interference-free environment. Behavior recorded on video tape provides evidence that when another child enters the waiting room, a child's persistence and strategy for problem solving changes.

The finding that success in problem solving was not related to racial differences in problem solving strategies or persistence over a brief span, make the finding of racial differences in exploratory behavior all the more interesting.

Part 2: The Relationship of Curiosity, Persistence And Problem Solving Behaviors to Each Other

The overall failure to find meaningful correlations between curiosity, persistence and problem solving behaviors may be attributed to difficulties of different orders. The most problematic lies in the failure of the data to meet the assumptions of the statistical model: the assumption of continuous data. While some scores met this assumption (curiosity), others did not (Problem solving - 1 and -2.) A change in measurement could overcome the difficulty which was created by an attempt to keep the intervals in Problem Solving - 1, comparable with Piagetian levels.

A second difficulty which could be corrected is in the assessment of persistence. With exhaustive measures (i.e., until all subjects withdraw from the problem), persistence scores could be used in correlation studies of these related behaviors.

Such a correlation study of curiosity, persistence and problem solving behaviors needs to be carried out. Understanding the relationship of these behaviors to each other has important implications for education as well as for science.

In spite of the limitations imposed by the weakness of the statistical analysis, several relationships can be observed from the data, and are reflected in the raw scores (See Appendix B). For example, although there were great variations among elementary school children in curiosity, all children between the ages of 7 and 13 years were eager to solve a problem when presented with one, and persisted until they solved it or were forced to leave. This finding suggests that some children benefit more than others from undirected discovery, (i.e., exploring in a waiting room), but guided learning can be motivating for all children.

Some differences in problem solving strategies were subtle and therefore lost in the final analysis, but deserve further discussion. For example, some children developed hierarchical retrieval systems of information: one pile for keys which were tried and regarded as absolute mismatches; another pile for keys which were tried and failed, but regarded as "hopefuls". The "hopeful" pile paid off for many sixth graders who recognized that key failure might be attributed to their own manipulation rather than a key-lock mismatch. Some children used audible self instruction or sign language in place of the retrieval systems above. Still others discovered, while on video tape, the specificity of keys, i.e., that one key did not open two locks. Having made the discovery, they applied it on future trials by casting out keys which had been successful on one lock.

Part 3: The Relationship of Intellectual Development To Curiosity, Persistence, and Problem Solving Behaviors.

For a number of reasons the relationship of Piagetian levels to curiosity, persistence, and problem solving was of particular interest. Curiosity behavior as assessed here has not previously been compared with Piagetian levels; and the intervals of scaling described by Piaget are better suited to scaling intervals used with exploratory motor responses than those associated with I.Q. tests. In addition, the technique associated with Piagetian testing is more compatible with the technique used here for assessing behavior. Finally, the basis for developing strategy levels in problem solving was derived in part from Piagetian theory.

The finding that curiosity and Piagetian levels are weakly but positively associated is worthy of further investigation. Because reliability between different Piagetian tasks varies[1], the association between curiosity and Piagetian levels found here may be more or less significant using other Piagetian tasks.

Results which link Piagetian levels with success in problem solving, as determined by the number of locks opened (p=.001), show a stronger association than was found between age and Problem Solving - 1, or - 2. This finding makes it possible to draw additional inferences regarding the demographic variables of the population sampled (e.g., Piagetian levels; race, sex).

The lack of association between Piagetian levels and Problem Solving - 1 (i.e., strategy development), remains unclear. Evidence of a well organized strategy, Level 3, was expected to correlate with the Piagetian Stage III, Formal Operations; it was hypothesized that both tasks required the ability to anticipate the need for testing all possible combinations in an orderly fashion.

Part 4: Equivalence of Measures of Curiosity

In an attempt to integrate the results of this investigation with those found in other research, a comparison was made between two different techniques for assessing curiosity, namely the Teacher Rating form (Maw and Maw, 1964) and the current assessment of exploratory motor activity described in this study.

In spite of the lack of correlation found between these instruments in a previous study (Peterson, 1969), they were compared here with the view that providing recorded evidence of exploratory motor activity through video tape would facilitate a comparison of these two techniques.

Teacher Ratings of curiosity were also compared with behavioral measures of persistence and problem solving, in case correlations were not found between Teacher Ratings and exploratory motor activity. The outcome of these comparisons for correlations suggests no observable basis for the choices made by teachers in ranking children according to classroom curiosity behavior.

It is acknowledged that curiosity behavior as it exists in the classroom and as observed by teachers may have other characteristics than those studied in this investigation; but is is disturbing to

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[1] In a pilot study with the same Sixth grade , two additional Piagetian tasks were given following the current investigation: reliabilities were .30 and .26 for N=27 and N=25, respectively on tasks with Floating Objects and Ratio, also described in Inhelder and Piaget (1958).

find no overlap within these populations. If exploratory behavior within the classroom undergoes a metamorphosis as children progress through school, (hypothetically from motor responses as measured here to behaviors identified by Maw and Maw and others), then Teacher Ratings should correlate most closely with assessments of exploratory motor responses at Kindergarten levels. Yet, the results show a negative correlation ($r_s = -0.43$) at the Kindergarten level.

Teacher indifference has not been a factor in this comparison; clear understanding and open cooperation have characterized the participation of the four teachers involved.

SUMMARY AND CONCLUSIONS

The curiosity, persistence, and problem solving behaviors of 125 elementary school children were recorded on video tape and later analyzed in relation to the age, sex, race, and Piagetian level of intellectual development of these children. The results of that investigation have provided evidence which suggests that some changes in opinion and perhaps changes in research practice are needed. A brief summary of those findings is presented below.

Curiosity was analyzed in terms of the amount of exploratory behavior or motor activity exhibited by children during the first five minutes they spent in a waiting room. At 15-second intervals their behavior was assigned to one of three levels: (1) approaching; (2) manipulating; (3) reorganizing parts of the environment. The strongest variable associated with differences in exploratory behavior was racial groups. In the present investigation as well as in a previous study (Peterson, 1969), Black children exhibited a greater amount of exploratory behavior than non-Black children. Whether this implies a deficit of first hand experience with specific objects on the part of Black children and/or implies a more generalized behavioral difference is not clear. Further investigation regarding the origins of such differences is certainly desirable.

Within the classroom environment, such differences in exploratory behavior between racial groups may be manifested in various ways. Curricula or classroom procedures which provide for some exploration through activity may have an equalizing effect on differences in exploratory behavior. However, classroom situations which inhibit exploration or reward nonexploratory behavior may add to a teacher's problems by forcing exploratory behavior to be redirected into behaviors less meaningful to the individual. Assuming that exploratory behavior is a search for information, then thwarting exploration is antagonistic to the teacher's goals, as well as to the child's, and may result in discipline problems or at least decrease the ease of learning.

The amount of exploratory behavior exhibited by children aged five to eight years was found to be affected by the presence or absence of an adult in the waiting room, i.e., the laboratory setting for studying exploratory behavior. This finding that waiting alone in a room inhibited curiosity among five- to eight-year olds extends the age range affected by this factor first reported by Hutt (1967) with regard to nursery school children aged three to five years. The fact that the level of curiosity expressed by children aged nine to thirteen years remained the same in both the present and previous investigations (Peterson, 1969; 1970) is interpreted as a reflection of their lack of anxiety at being left along in the waiting room as well as their lack of inhibition when an adult is present. The curiosity level was also found unchanged between sexes: no significant differences in exploratory behavior were found between boys and girls while they waited alone or with an adult in the waiting room.

When exploratory behavior served as the basis for assessing curiosity, no correlation was found between that measure and traditional Teacher Ratings, i.e., estimates made by teachers of the relative amounts of curiosity exhibited by these same children during normal classroom activities. The absence of any correlation suggests that different aspects of curiosity, or perhaps entirely different behaviors, were being assessed. The implication of this finding is that the use of the Teacher Rating method of assessing curiosity is not justified if it is used as the sole predictor of curiosity, until the differences between teacher estimates and observations of actual exploratory behavior are understood.

Problem solving behavior was analyzed in terms of (1) the strategy used to open a locked box, i.e., chance or logic, and (2) according to the degree of success in solving the problem regardless of the strategy used, i.e., the number of locks opened on a 3-padlock box. Under the first analysis, the age of the child was the only factor significantly related to the development of strategies based or chance or logic. Under the second analysis age, sex, and Piagetian levels all served as predictors of ultimate success in opening the box.

Two predominant patterns characterized the development of strategies based on logic: (1) there was visible evidence of an information-retrieval system or means of keeping track of which keys had been tried in which locks; and (2) individual trials were organized around the control of one set of variables (e.g., either the locks or the keys) while members of the other set of variables were changed one at a time. These patterns were almost non-existent among Kindergartners, exhibited in fragments among Second, Fourth, and some Sixth graders, and appeared in more or less complete form among a few Fourth and Sixth graders.

Performance in problem solving has often been used as a part of tests designed to measure intelligence. When the problems to be solved were presented in writing, pictorial, or symbolic material, Black subjects were reported to perform below levels of non-Black subjects (Jensen, 1969). In the present investigation which provided a manipulative problem, Black and non-Black children were found to exhibit equal abilities in problem solving strategies and in ultimate success in solving the problem regardless of the strategy used.

Evidence of logical strategies on one task does not necessarily imply transfer to or from other tasks. If transfer were assured, greater correlation should be observed between similar tasks, but is not (Almy, 1970). Still more remote is the implication that strategies used on concrete manipulative tasks, such as the lock box, readily transfer to abstract conceptual tasks such as those used in the standardized tests referred to by Jensen. However, until the strategies involved in problem solving tasks have been identified, and experimental evidence has demonstrated that these strategies are not learned, the practice of assuming that such performance represents intelligence should not be tolerated.

Persistence was determined by the percent of time spent actively trying to open the lock box, during the interval of time in which each child had access to the box. The persistence of the children exceeded the most conservative estimates of this study: 86% of the population persisted with enthusiasm for the entire test interval (5 minutes); 12% persisted for an average of 2 1/2 minutes. Because of the unexpected "ceiling effect," information relating the nature of persistence to age, sex, and racial groups must await further investigation. However, within the parameters of this investigation, it was observed that persistence was exhibited in equal amounts by both sex and racial groups during the test interval but in unequal amounts between age groups. The reduced persistence of children aged five to eight years corresponded to their reduced amount of exploratory behavior during the absence of an adult in the waiting room.

In an effort to understand more about the nature of the relationship of curiosity, persistence and problem solving behaviors to intellectual development, children individually played a game, i.e., Piagetian task, following their wait in the waiting room. When Piagetian levels (assigned from the billiard game) were examined for associations with scores from curiosity, persistence, and problem solving, Piagetian levels were found to have a strong positive association with problem solving success, i.e., the number of locks opened, and a weak but positive association with curiosity and persistence. The absence of any association between problem solving strategy level and Piagetian level suggests further refinement is needed in abstracting the most critical elements that differentiated between strategy levels.

Finally, the relationship of curiosity, persistence, and problem solving behaviors to each other was explored. Although the data did not lend themselves to extensive statistical analysis, a number of observations were derived from the data. Curiosity behavior expressed through motor activity was less commonly exhibited among all elementary school children than was persitence. One implication of this finding is that the use of a single method of teaching (e.g., open-ended exploration) may not benefit all students equally, while problem solving which involves some degree of structure appears to motivate more children to action. Further, curiosity behavior was found to be exhibited in equal amounts by persistent and non-persistent problem solvers. And last, problem solving strategies based on logic led more often to successful solution of the problem than strategies based on chance.

This behavioral study has focused on one aspect of learning: the assessment of motor responses associated with curiosity, persistence, and problem solving behaviors. The results of the investigation have provided some evidence which conflicts with common beliefs and, in some ways, conflicts with results of other studies which have assessed these same behaviors through the use of printed material, or through the study of motor responses of animals.[1] The growing evidence that different but equally important aspects of behavior are being assessed through these different approaches, makes improved communication between researchers crucial.

Learning behaviors, such as curiosity, can be recorded on video tape and be subjected to multiple analyses, impartial jurists, and reliability tests. Such a procedure represents a step in the direction of improving communication between researchers and integrating their work. Ultimately, this procedure represents an economic gain as well, by eliminating costly duplication incurred when multiple baselines or frames of reference are used. Data banks need to be established containing prototypic learning behaviors recorded on tape. Such documentation is as important to future research as reference collections of books.

It has been shown that curiosity expressed through motor activity has a character of its own. It is composed of observable responses to concrete objects, responses which can be measured. The occurrence of these responses has been found to vary among individuals and groups, and under different conditions. The next step is to learn how this distinguished aspect of curiosity is related to man's conceptual or intellectual curiosity, to his exploration of ideas.

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[1] Differences between our findings and those in animal behavioral research have not been discussed in this paper.

Apart from curiosity, the study of persistence and problem solving were just begun under this investigation. Methods developed for measuring curiosity were applied to these latter behaviors. With refinement in measurement procedures, additional information regarding the relationship of these behaviors to curiosity can be gained.

The behaviors treated herein appear to many people to form a natural cluster. It seems unreasonable that we should proceed in educational research which is concerned with how children learn, before we understand how the exploratory and problem solving behaviors of children,which are expressed through action, are related to exploration and problem solving which are entirely conceptual. Language is at the heart of most of man's activity, but temporarily deprived of communication[1] man stills explores and solves problems. As unseen observers, we can learn something about these behaviors from just watching.

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[1] "temporarily deprived of communication", in the sense that the children in the present investigation were temporarily prohibited from communicating with others while they explored and solved problems.

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APPENDIX A

The Nature of Exploratory Behavior: a descriptive analysis (1)

Motor Responses: Curiosity Expressed Through Action

Children are very curious beings. When asked to wait in a room with strange and novel objects, 120 children actively explored, through motor responses, for 83% of 20 hours. During 1200 minutes of observation these children made 1110 separate investigations of their environment. Translated into individual behavior, the average elementary school child shifted his focus and reacted to a different phase of his surroundings approximately every 67 seconds, or 9 times during the 10-minute wait. Explorations varied: some were as short as 15 seconds while others were as long as 600 seconds. Initial investigations were sometimes briefest and limited to an approach, with succeeding investigations extending in duration, proceeding at a more rapid pace, and involving more complex levels of motor responses. At other times, initial investigations were longest, with succeeding encounters decreasing in duration, pace, and complexity as measured by levels of curiosity.

Order, sequence, and stereotypy were the predominant patterns which characterized all behavior. Although individual and group behavior varied considerably, the overall pattern was one in which constant, sequential responses were repeated over and over by the same and different individuals to the same or different stimuli. The conclusion was inescapable that curiosity as seen in the situations to be described was a highly stereotypic form of behavior; and Hypothesis 1 was unequivocally.

In such a context of order and sameness, individuals were studied for the variations they presented within the pattern. All children explored to some extent. Only four subjects spent half of their time (5 minutes) or more in non-exploratory behavior,

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[1] In the initial proposal for this grant, one of the major questions related to learning more about the nature of curiosity. Because that study was concluded prior to the funding of this grant, and presented as part of a dissertation, a condensed version of that work is presented here.

behaviors such as sitting and wiggling, talking about previous experiences, walking back and forth, playing hide-and-seek, or activities somewhat like grooming. Forty-seven subjects spent no time at all in non-exploratory behavior. Among the most curious children (i.e., the upper 10%, as measured by the amount of motor activity), four asked eighteen questions while eight asked none. And among the least curious children (lowest 10%), five asked no questions while seven asked forty-six questions. Bothethe most curious and the least curious children shifted investigations from one stimulus to another. less often than the average (9.25 shifts was average; 8.08 shifts among the super-curious; 7.75 shifts among the sub-curious). These dimensions only begin to suggest a pattern.

A close look at the specific behaviors observed supports the notion that exploratory behavior can be graded or analyzed in terms of prerequisite behaviors. The margins or breaking points between the three levels described here are suggestive of thresholds to activity levels.

Level 1: Approach _ As the subjects approached the table which held the four objects (kangaroo rat, scales, fish, and rock collection), they came with different postures, but the most common among them was a rather quick walk to the table as soon as it was noticed. Eyes were usually fixed on a particular object or scanning the table during the approach. Walking itself appeared to be unconsciously directed (i.e., the subjects appeared to be concentrating on the object, giving the impression that they were unaware of their own body movement). Hands frequently hung limply at the subjects' sides, or were poised with elbows slightly flexed and hands in a pre-grasp position with thumbs forward--a hand position that could be described as "ready-for-action." The hands of a few subjects were preoccupied with other kinds of activity, such as clutching a pencil or other object, or holding part of the clothing or body (e.g., pockets, buttons and buttonholes, shirts, hemlines, or even an ear).

When the subject's approach had advanced to within touching distance of the object, the most common response was to reach for the object and touch it in some way. Infrequently subjects would glance at the Investigator before touching an object. If the subject asked any questions at all, he usually asked his first question at this moment. The four subjects below illustrate the typical approach-ask question sequence as their first responses were recorded upon entering the room:

Subject K-8[1]
Approaches kangaroo rat and says, "What's that animal?"

Subject 2-26
Approaches kangaroo rat, looks in back and says, "Is that a rat?"

Subject 4-6
Approaches scales and says, "What's this--a weight?"

Subject 6-21
Approaches kangaroo rat and says, "Oh, what is this?"

Most students explored beyond the Approach Level (Level 1). Those who did not were conspicuous (see Subjects K-20 and 2-29 in Appendix A). Many subjects, however, explored in general beyond the Approach Level, but in response to a particular object only approached and left (see Subjects: 6-4, 6-6, 6-20 responding to stimulus, fish, in Appendix A).

Level 2: Manipulative - The responses which immediately followed the approach distinguished between subjects in a very subtle way. The speed with which subjects picked up or manipulated an object gave the distinct appearance of reflecting the subject's previous experience with similar stimuli. This speed-factor, which might be referred to as an approach-contact interval (i.e., the number of seconds to elapse between completed approach and actual body contact with some part of the stimulus), was discriminative in a range of approximately 1-10 seconds. The subtlety of this discrimination would escape casual observation and would have been undetected in the 15-second observations used in the study, unless an investigator were looking for differences of this small magnitude. Descriptions of these differences (i.e., the speed with which the subjects picked up or manipulated objects after approaching), do not show up in the data recorded because of their briefness, but could be recorded on film or video tape for finer analysis. The examples below, however, do illustrate the more noticeable differences in four subjects as they each approach the balance for the first time, and decide whether or not to explore further.

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[1]Subject K-8: the first symbol denotes Grade Level-K, 2, 4, or 6; the second symbol denotes the order in which the subject was observed in his class--1st, 2nd, 3rd,...30th.

Subject 4-8

Approaches balance and stands looking without touching (30 seconds).

Subject 4-30

Gets up from chair, approaches balance, looks and touches scales, goes back to chair (15 seconds).

Subject 4-3

Approaches balance, touches styrofoam balls, and leaves (15 seconds).

Subject 6-10

Approaches balance and touches one side; watches as it moves (15 seconds).

Subject 4-25

Approaches balance; examines balls as he takes them out of cups. Feels balls and lays them down (30 seconds).

Subject 6-19

Approaches balance, touches one ball; picks it up and puts it on balance pan (15 seconds).

Subject 2-18

Approaches balance; begins adjusting screw on empty scales; adds balls to cup (45 seconds).

Level 3: Reorganization - The final responses in the sequence were most discriminative of individual differences. The variety which characterized different versions of rearranging or reorganizing stimuli was enormous; yet most subjects maintained nearly the same general posture (i.e., eyes were still fixed on the stimulus, movements were ordered and sequential, with some tension remaining in the movements). The examples below only suggest in the briefest way some of the variety characteristic of Level 3 responses to a single stimulus, the balance:

Subject 2-3

Approaches balance; puts small ball on one side; puts petri dish on other side; [scales do not balance]; tilts entire balance by picking up one end...

Subject 2-14

Approaches balance; puts one cup of balls on each side; adds can of fish food to one side; watches; takes cup of balls off; puts one large rock [from rock collection] on same side; watches; finds adjusting screw and turns it...

Subject 2-24

...puts fish food on one side of balance; puts kanga-oo rat food on other side; waits and watches; says "This [fish food] is heavier."

Subject 4-7

Approaches balance; puts two balls of equal size on each side; adjusts top screw; waits; uses hands on each side to balance...

Subject 4-12

...[has been rearranging for several seconds]... puts large ball on one side and medium ball on other [they don't balance]; reverses balls putting large and medium balls on opposite sides...

Subject 4-17

puts a petri dish on each side; sits cups in petri dishes; begins to fill cups with balls...

An interesting difference among Level 3 responses was reflected in the persistence with which some children explored. The temptation to equate persistence with increased curiosity was common. However, it was apparent that subjects who left one stimulus to investigate another[1], exhibited the same characteristics of exploration with the new stimulus as those subjects who remained and persisted to explore the original stimulus. Repeated comparisons of this sort lead to the conclusion that the link between curiosity and persistence may lie in the eye of the beholder. Until such behavior can be analyzed more closely, as might be possible with the use of film, a distinction between persistence and curiosity was dependent upon observable differences in motor responses.

The attention-span of the subject toward a particular stimulus varied slightly with age. Among kindergarten subjects the average attention-span was 10.5 seconds; second grade subjects averaged 7.9 seconds per stimulus while fourth and sixth grade subjects averaged 9.1 and 9.5 seconds, respectively, per stimulus.

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[1]At Level 3 (i.e., more than Level 1--approaching, or Level 2--manipulating).

Motor Responses of a Quasi-Exploratory Nature

A group of behaviors which were of transitional nature deserved special treatment. Because these behaviors resembled exploratory behavior more than they resembled any other behaviors described in this study, they have been classified as quasi-exploratory responses. Although exhibiting most of the characteristics of exploratory behavior, in one or more ways the responses differed slightly. The general level of activity remained high (usually Level 3), but eye-hand coordination faded and general muscle tone became relaxed (see Subjects 2-24 and 6-28). Manipulative movements frequently became simultaneously accelerated and abbreviated. This latter characteristic can be illustrated by subjects who flicked or turned the screw adjustment of the scales with a casual jerk when previously they had turned it with care. In ethological terms, subjects were approaching satiation; in educational terms, learning was becoming incidental.

Quasi-exploratory behaviors varied according to age groups. Among kindergarteners curiosity evolved more often to pure play (using Hutt's distinction described earlier). Children played games with the balls or filled and emptied food dishes for the rat. Among sixth graders there was some play of this sort but more often, when subjects began to show signs of indifference toward a stimulus, they left the objects on the table and went over to sit and read. For some, reading appeared to be an escape (subjects turned pages without looking); for others it appeared to offer exploration (subjects used index to find information). Whether the activity of reading can be classed with quasi-exploratory behavior is not certain. The criterion used to place it in this category was that reading, like investigatory play, had some of the characteristics of seeking "surplus" information: eyelids drooped a little, coordination began to fade, and muscles were more relaxed. Table 3 shows how quasi-exploratory behaviors were distributed in time by age groups. It is important to realize that this kind of activity represented 9.9% of the total observation time.

An interesting relationship began to emerge as quasi-exploratory behavior was compared with question-asking behavior. Figure 3 illustrates the inverse ratio of this relationship. The importance of the relationship will be discussed later.

Non-Exploratory Behavior

A final group of behaviors clearly differed from exploration. The group consisted of such activities as sitting or standing without other apparent motor responses, talking about personal experiences, and general grooming including care of clothing, fingernails, and so forth. The children who exhibited non-exploratory behavior to any great degree were easily noticed among the others: if they were "talkers" it was difficult to continue taking notes during their chatter; if, on the other hand, they simply sat, or sat and examined a scratch or folded a sweater for several minutes, it was equally difficult enduring the 10-minute observation period. Only two children fit this latter description.

APPENDIX B

Summary of Raw Scores from Curiosity, Persistence and Problem Solving (1-strategy; 2-success) Measures, Piagetian Tasks and Teacher Rating Scale

Age (Grade) Subject	Sex	Race	Curiosity	Persistence	Problem Solv.-1	Problem Solv.-2	Piaget-Level	Teacher Rating
k-1	F	NB	1.00	0.00	0	0	1	24
k-2	F	NB	0.30	0.30	2	0	1	21
k-3	M	B	2.83	1.00	2	3	1	9
k-4	F	NB	2.83	1.00	2	1	1	11
k-5	F	B	2.45	0.85	2	0	1	22
k-6	M	B	0.81	1.00	2	0	1	7
k-7	M	B	2.21	0.90	2	1	1	8
k-8	F	NB	0.25	0.00	0	0	-	26
k-9	F	B	1.93	0.60	2	0	1	2
k-10	F	NB	2.13	0.60	1	0	1	10
k-11	M	B	1.66	1.00	2	2	1	17
k-12	M	NB	0.88	1.00	3	3	1	15
k-13	F	B	2.33	1.00	2	1	1	18
k-14	F	NB	1.50	1.00	2	0	1	14
k-15	M	NB	2.46	0.50	2	1	1	4

Age (Grade) Subject	Sex	Race	Curiosity	Persistence	Problem Solv. -1	Problem Solv. -2	Piaget. Level	Teacher Rating
k-16	F	NB	1.06	1.00	2	1	1	13
k-17	M	B	1.60	1.00	1	0	1	6
k-18	M	B	2.10	1.00	2	3	1	23
k-19	M	NB	2.45	1.00	2	1	1	5
k-20	M	NB	1.93	1.00	2	1	1	19
k-21	M	NB	2.35	0.40	2	0	1	3
k-22	M	B	1.68	1.00	2	2	1	20
k-23	F	NB	0.58	1.00	2	2	1	16
k-24	F	B	1.36	0.45	2	0	1	12
k-25	F	B	2.47	1.00	2	0	1	25
k-26	M	B	1.16	0.40	2	0	1	.1
k-27	F	B	2.00	0.30	2	1	1	*
k-28	M	NB	2.06	1.00	3	3	1	*
k-29	M	B	2.22	1.00	3	3	1	*
k-30	M	NB	2.65	1.00	2	2	1	*

*Student Not Rated by Teacher

Age (Grade) Subject	Sex	Race	Curiosity	Persistence	Problem Solv. -1	Problem Solv. -2	Piaget. Level	Teacher Rating
2- 1	F	B	2.76	1.00	2	3	1	5
2- 2	M	NB	2.00	1.00	2	0	1	15
2- 3	M	NB	2.81	1.00	2	1	1	*
2- 4	M	B	2.64	1.00	2	3	1	14
2- 5	M	B	2.81	1.00	2	1	1	9
2- 6	M	B	2.78	1.00	2	3	1	2
2- 7	F	B	1.00	1.00	2	3	1	12
2- 8	F	B	2.73	1.00	2	1	2	*
2- 9	F	B	2.75	-	2	1	1	7
2- 10	F	NB	2.00	1.00	2	2	1	*
2- 11	F	B	2.73	0.95	2	0	2	4
2- 12	F	NB	1.85	1.00	3	3	1	3
2- 13	F	B	2.72	1.00	2	2	1	22
2- 14	M	B	2.36	1.00	2	2	1	6
2- 15	F	NB	2.65	1.00	3	3	1	10

*Students Not Rated by Teacher

Age (Grade) Subject	Sex	Race	Curiosity	Persistence	Problem Solv. -1	Problem Solv. -2	Piaget. Level	Teacher Rating
2-16	F	NB	2.55	1.00	2	0	1	18
2-17	M	NB	0.55	1.00	2	3	2	13
2-18	F	NB	2.16	1.00	2	0	1	23
2-19	M	B	2.95	0.85	2	2	1	1
2-20	M	NB	2.25	1.00	3	3	2	*
2-21	M	B	2.75	1.00	2	3	1	*
2-22	M	NB	2.56	1.00	2	3	2	*
2-23	M	NB	1.15	1.00	2	3	1	16
2-24	F	B	2.57	0.50	2	0	1	24
2-25	M	B	2.64	1.00	2	2	2	17
2-26	M	NB	0.80	1.00	2	3	1	20
2-27	M	NB	2.50	1.00	3	3	2	8
2-28	M	B	2.26	1.00	2	1	1	*
2-29	M	NB	2.93	1.00	3	3	1	21
2-30	M	B	2.43	1.00	3	3	1	19
2-31	M	NB	1.11	1.00	3	3	1	11

*Students Not Rated by Teacher

Age (Grade) Subject	Sex	Race	Curiosity	Persistence	Problem Solv. -1	Problem Solv. -2	Piaget. Level	Teacher Rating
4- 1	M	B	2.88	1.00	3	2	2	6
4- 2	M	NB	2.47	1.00	2	3	2	*
4- 3	M	B	2.80	1.00	2	2	2	*
4- 4	F	B	2.90	1.00	3	3	1	20
4- 5	M	B	1.80	1.00	2	1	1	13
4- 6	F	B	2.45	1.00	2	1	1	17
4- 7	F	NB	1.36	1.00	2	3	1	15
4- 8	F	B	1.70	1.00	2	3	1	11
4- 9	F	B	3.00	1.00	2	3	2	12
4- 10	F	NB	2.31	1.00	2	3	2	4
4- 11	F	NB	1.77	1.00	2	3	2	9
4- 12	F	B	2.68	1.00	3	3	1	*
4- 13	F	NB	1.80	1.00	3	1	1	21
4- 14	M	B	2.68	1.00	2	3	1	2
4- 15	M	NB	2.11	1.00	2	3	1	16

*Students Not Rated by Teacher

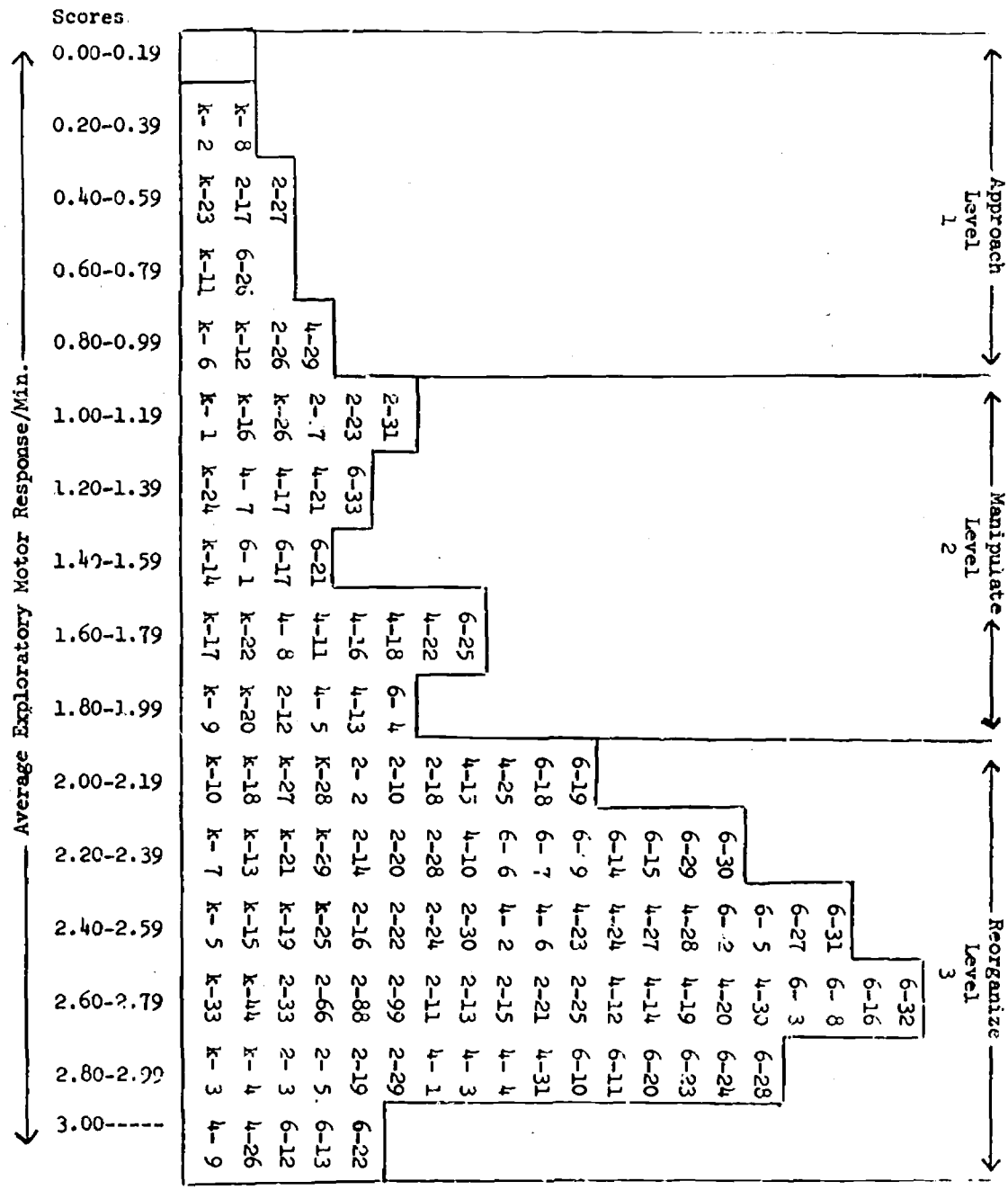
Age (Grade) Subject	Sex	Race	Curiosity	Persistence	Problem Solv. -1	Problem Solv. -2	Piaget. Level	Teacher Rating
4-16	M	NB	1.66	1.00	2	3	2	*
4-17	F	B	1.33	1.00	2	3	1	23
4-18	F	B	1.75	1.00	2	3	2	14
4-19	F	NB	2.75	1.00	2	1	1	7
4-20	M	NB	2.72	1.00	3	3	3	10
4-21	M	B	1.38	1.00	3	3	2	*
4-22	M	B	k.60	1.00	3	3	2	19
4-23	M	NB	2.44	1.00	2	2	1	1
4-24	M	B	2.53	1.00	2	2	2	5
4-25	F	NB	2.00	1.00	2	1	2	24
4-26	M	NB	3.00	1.00	3	3	2	*
4-27	M	B	2.55	1.00	2	3	2	18
4-28	M	B	2.50	1.00	3	3	2	3
4-29	F	NB	0.80	1.00	2	2	2	25
4-30	M	B	2.70	1.00	2	3	1	8
4-31	F	NB	2.85	1.00	2	2	2	22

*Students Not Rated by Teacher

Age (Grade) Subject	Sex	Race	Curiosity	Persistence	Problem Solv. -1	Problem Solv. -2	Piaget-Level	Teacher Rating
6-1	F	B	1.43	1.00	2	2	1	30
6-2	F	B	2.55	1.00	3	3	2	26
6-3	M	NB	2.64	1.00	3	3	2	28
6-4	M	NB	1.94	1.00	3	3	2	6
6-5	M	B	2.46	1.00	2	3	1	18
6-6	M	B	2.33	1.00	3	3	2	12
6-7	M	B	2.25	1.00	2	3	2	8
6-8	F	NB	2.70	1.00	2	3	2	29
6-9	F	B	2.35	1.00	3	3	1	31
6-10	F	B	2.95	0.80	2	1	2	1
6-11	F	B	2.95	1.00	2	3	2	3
6-12	M	B	3.00	1.00	2	3	3	13
6-13	M	NB	3.00	1.00	2	3	3	11
6-14	F	NB	2.23	1.00	2	1	2	7
6-15	F	NB	2.31	1.00	2	2	1	33
6-16	F	B	2.76	1.00	3	2	1	32

Age (Grade) Subject	Sex	Race	Curiosity	Persistence	Problem Solv. -1	Problem Solv. -2	Piaget. Level	Teacher Rating
6_17	F	NB	1.50	1.00	2	3	2	20
6_18	M	NB	2.10	1.00	3	1	3	19
6_19	F	NB	2.05	1.00	3	3	2	10
6_20	F	NB	2.85	1.00	2	1	2	22
6_21	F	B	1.40	1.00	3	2	1	5
6_22	M	B	3.00	1.00	2	2	2	4
6_23	F	NB	2.95	1.00	2	2	2	27
6_24	F	NB	2.85	1.00	3	2	2	24
6_25	F	NB	1.63	1.00	2	1	2	15
6_26	M	NB	0.75	1.00	2	3	3	23
6_27	M	NB	2.45	-	-	-	2	17
6_28	F	NB	2.85	1.00	3	3	2	9
6_29	F	NB	2.30	1.00	2	3	2	14
6_30	M	NB	2.30	1.00	3	3	2	25
6_31	M	B	2.40	1.00	2	3	2	21
6_32	M	B	2.75	1.00	2	3	2	2
6_33	M	NB	1.35	1.00	2	2	2	16

APPENDIX C



Distribution of Curiosity Scores for 125 Elementary School Children

APPENDIX D

Teacher Rating or "Teacher Appraisal of Curiosity".*

In terms of the description given below, will you please rate your pupils in the following manner:

1. Write the name of the child you consider to have the most curiosity on the first line.
2. Next, write the name of the child you consider to have the least curiosity on the line corresponding to the number of pupils in your class.
3. Next, write the name of the child you would rank second in curiosity on line 2.
4. Then write the name of the child you consider to have next to the least curiosity on the line above the name of the child having the least curiosity.
5. Continue ranking in this manner until you have ranked all of the children in your class.

Definition of Curiosity: A child may be said to have curiosity to the extent that he:

1. Scans his surroundings looking for new experiences. (For example, if there is something new in the room, he notices it.)
2. Moves toward new, mysterious, or incongruous elements in his environment, either physically or psychologically. (For example, he approaches and/or asks questions about a strange object found on the playground.)

*Maw and Maw, 1964.

3. Examines, explores, and/or manipulates new, mysterious, or incongruous elements in his environment, either physically or psychologically. (For example, he looks at and/or handles, studies, asks questions about, reads about, discusses a remote-control doll another child has brought to school.)

4. Persists in such examinations, explorations, and/or manipulations. (For example, keeps studying about the remote-control doll until he understands how it works.)

All of these may not be observable in any one child. It is reasonable to suppose that the more of these kinds of behavior a child shows, the more curious he is. The child who shows the most curiosity may or may not be the one who is making the best classroom adjustment.