# THE ROLE OF PLAY AND DIRECT INSTRUCTION IN PROBLEM SOLVING IN 3 TO 5 YEAR OLDS

by

Beverly Ann Keizer

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Name: Beverly Ann Keizer

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Examining Committee

Chairman: Jack Martin

Roger Gehlbach
Senior Supervisor

Ronald W. Marx
Associate Professor

Mary Janice Partridge
Research Evaluator
Management of Change Research Project
Children's Hospital
Vancouver, B. C.
External Examiner

Date approved March 14, 1983

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THE ROLE OF PLAY AND DIRECT INSTRUCTION IN PROBLEM SOLVING

IN 3 TO 5 YEAR OLDS

Author:

(signature)

BEVERLY ANN KEIZER

(name)

March 14, 1983.

(date)

ABSTRACT

Children's play, as observed in this study, can be divided into two categories-- exploratory behavior and ludic behavior. Exploratory behavior occurs when the child asks "What can this object do?" Such play behavior is termed epistemic, as it is concerned with the acquisition of information. Ludic behavior, in contrast, is seen as a time during which there is a temporary suspension of information processing. Previous studies have described initial contact with a novel object as being predominantly exploratory.

Direct instruction is characterized as academically focussed and teacher-centered, providing little student choice of activity, and consisting largely of factual questions and controlled practice with feedback. The purpose of this study was to compare the effectiveness of play and direct instruction on problem solving in young children.

Two hypotheses were tested. It was predicted that participants who received direct instruction would outperform those who played. Secondly, it was predicted that those who played would be more successful than those who received no treatment.

Three treatment conditions and a control were used. One group played with the materials used in the test task. A second group played with a different set of materials designed to focus the children's attention on the principles involved in the solution of the

problem. A third group received direct instruction with verbal description and demonstration of the problem solution using the materials of the task. The children in the control group were read a story. All participants (mean age four years nine months) were individually pretested on the problem task and only those who were unsuccessful became part of the experimental sample. The pretest was followed immediately by treatment and the posttest. Three dependent variables (whether or not the participant solved the problem, the time to solution and the number of hints required) were recorded and the resulting data analyzed.

The hypothesis that direct instruction would produce greater treatment effects than play was supported. The hypothesis that play would improve performance was not supported.

An important educational implication derived from this study is that quality direct instruction which provides accurate and immediate feedback focussed on specific learning objectives is more effective in achieving specific cognitive learning outcomes, than are less structured play experiences.

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# CHAPTER ONE

## Introduction

### The Problem

This study examines the effects of play and direct instruction on problem solving in young children. The relationship between different types of prior experience and specific learning outcomes with preschool children has been examined in numerous studies in the past. The problem of providing the most effective possible learning environment for young children is of great concern to teachers and curriculum planners in preschool and kindergarten programs. There is a longstanding controversy between those who view unstructured play as the most important activity in early childhood educational programs, and others who believe that direct instruction is the most effective and most appropriate teaching technique to promote learning in children of any age.

There are many factors which contribute to the resolution of the problem of how to provide an effective learning environment for four and five year olds, including the goals of instruction, how the outcomes are measured and the historical development of programs for young children. Those responsible for designing that environment and planning instructional activities for kindergarten age children are also influenced by various theories of play and the empirical evidence which supports these theories. The value of play as an instructional

activity is not known. While some think it is the child's way of "learning to learn" (Scarfe, 1966) and others hold it to be the essential core of programs for young children, few studies have shown it to produce measurable learning outcomes.

It seems obvious that if a teacher has a specific piece of information or skill to teach, the most efficient method is to simply instruct the child. Yet preschool and kindergarten teachers and curriculum developers are reticent to develop programs which emphasize teacher centered direct instruction methods, or even incorporate such methods as an important component of their programs. This study is designed to provide empirical evidence relevant to the controversy outlined above by improving our understanding of the relationship between two distinctly different types of prior experience and children's ability to solve problems.

While the focus is on variations in experience which may be viewed simply as play and non-play, a continuum which stretches from one to the other can be observed in the treatments of the experimental groups. The intent here is to allow for close examination of particular factors in the play environment that may influence the learning which occurs. The factors which are hypothesized as relevant are:

1. whether or not the child actually handles the materials used later in the problem solving task;
2. whether or not the child receives direct training in

using the materials, and what particular form that training takes;

3. whether interaction with a carefully designed experimental play thing (toy) affects performance on a problem solving task.

# CHAPTER TWO

## Review of Related Literature

The first section on this review is divided into two parts. In the first part, the problem of defining play is considered. In part two theories of play are outlined, including those developed by Piaget, Bruner, Berlyne, Sutton-Smith, Vandenberg and Hutt. This is followed by a section which describes in detail the methodologies and results of relevant empirical studies.

### Defining Play

Before outlining the various theories which attempt to explain the role of play in development and learning, it is essential that the term be defined. Vandenberg (1978) attempts to achieve this difficult goal. He points out that "part of the difficulty in defining play arises from its application to a number of diverse activities across a wide range of ages and species" (p. 725). He suggests that the category of behaviors called play be subdivided, and that the play of presymbolic organisms be considered as a category separate from that of symbolic animals. He points out that purely behavioral definitions are not useful for defining play in young children (symbolic organisms) and that once symbolic abilities are present, play must be redefined. Most definitions do seem to list characteristics, blend

behavioral descriptions with mentalistic ones, and further subdivide the behaviors which are broadly termed play into a number of categories.

Characteristics of play. Hutt (1971, p. 234) lists three defining characteristics of play:

1. It carries an emotional element of pleasure.
2. It is characteristic of the immature animal rather than the adult.
3. It differs from non-playful responses in having no relatively immediate biological result.

Weisler and McCall (1976), in separating exploration and play, as is often done in the literature, add that "play consists of behaviors and behavioral sequences that appear to be intrinsically motivated and apparently performed for their own sake, and that are conducted with relative relaxation and positive effect" (p. 494). They go on to outline four other important defining characteristics of play behavior.

First, the content of the play varies considerably from child to child and across situations. Second, Weisler and McCall emphasize, as does Hutt, that play behavior is performed for its own sake, and that the playing organism is not governed by appetitive drives or extrinsic goals. If the child does not appear to have an obvious task orientation, goal, or purpose, he is said to be playing. Third, play occurs only when the child feels safe, free from subjective

uncertainty and is sated with respect to basic physiological needs. Fourth, play is characterized by pleasure. Although this last characteristic is mentioned by a number of authors, it is one that needs to be examined critically. Children who presumably are playing do not always show pleasure. Some play involves concerted physical effort (climbing a ladder or a playground slide, for example). Even frustration and disappointment are observed as a carefully built block tower falls down. This is not to say that play is not often fun, it is just that pleasure is not necessarily the only affective state observed.

To define play still further, in this case emphasizing the cognitive activity involved when play behaviors are exhibited, Piaget's explanations are considered next. According to Piaget (1962), "play begins as soon as there is a predominance of assimilation." He lists the following six criteria. Play is: an end in itself, spontaneous, engaged in for pleasure, devoid of organized structure, free from conflicts, and characterized by over-motivation. The meaning of this last term is not clear. As Piaget provides one of the most extensive theoretical analyses of play, it is difficult to separate his attempts to define the concept from the theory whereby he outlines its mechanism and function. The latter will be described in detail in the next section.

Sylva, Bruner and Genova (1976) outline five characteristics of play.

1. During play, means or process dominate ends or product. Play is the stringing together of bits of behavior borrowed from non play modes in unusual sequences. This can occur because the player is not goal oriented.
2. Play occurs in a simulative mode, and is therefore a sort of rehearsal where the child can be unconcerned about failure.
3. Play affords a moratorium on frustration.
4. Play facilitates a state of free attention, an opportunity to notice the possibilities inherent in things and events.
5. Play is self-initiated, voluntary, and occurs when the player is "free from environmental threats and urgent needs." (p. 244)

Gehlbach (1975) provides yet another definition of play, in this case attempting to avoid the mentalistic content of other definitions. The four distinguishing features of play, each of which he characterized behaviorally, are that it is (1) voluntary, (2) self centered, (3) purposive (with either process or product objectives) and (4) casual (not essential to survival). He continues, "play is an iterative interaction between a child and a part of his physical environment which is a) independent of authoritative directives from other persons and b) not related to the direct satisfaction of biological needs or to the achievement of goals beyond the interaction

itself" (1982, p. 4). Gehlbach (1980) further subdivides play, referring to educational play and instructional play, and outlines a theoretical explanation of how play relates to development, both of which will be discussed below. He suggests that a negative definition (what play is not) be combined with Bijou's (1976) characterization, which simply states that: "Play is any activity of a child when he or someone else says he is playing" (p. 28).

For the purposes of this study, Bijou's definition is the most suitable. The children were told to "play". It can therefore be assumed that the activities they engaged in were those which they themselves would call play. A lay observer of the video tapes of the children's activities would likely classify them as play.

The various lists of characteristics given above can be easily applied to the behavior observed in this study, with one possible exception. Most lists describe the activity as voluntary. In this experiment the experimentor played a role initiating the child's interactions with the materials. The length of the interaction was however controlled by the child. Further consideration of which particular definition is applicable in this case is left for the discussion chapter.

Types of play. Various authors have attempted to divide the category of behaviors termed play into smaller more definable units, and, as well, to fit play into broader classification schemes which include other types of behavior (Berlyne, 1960; Flavell, 1977;

Gehlbach, 1975; Hutt, 1971; Piaget, 1962; Vandenberg, 1978). Berlyne (1960) has developed a hierarchy where the most inclusive category is termed ludic behavior. In this category he includes any behavior that does not have a clearly recognizable biological function. While this sounds like one of the most frequently mentioned characteristics of play, Berlyne (1969), after lengthy discussion of the various meanings that have been assigned to play, dismisses the term "play" altogether, as he feels it is of little practical value to psychology. Instead, he prefers to talk about exploratory behavior which he distinguishes from epistemic responses, or those responses through which knowledge is acquired. Yet, he does not explicitly contend that knowledge is not acquired by the exploring organism. He describes exploratory behavior as any response which provides the organism with information from the environment which was not previously available. This is accomplished by altering or changing the stimulus field. It is clear that learning does occur during exploration. His earlier work (1960) discusses the relationship between exploratory behavior and learning. The confusion arises from the fact that it is unclear whether he considers exploratory behavior to be ludic or epistemic, or both. Hutt (1979) attempts to resolve the problem by including exploration in the broader category of epistemic responses - and yet she emphasises that exploratory behavoirs can be carried out in a ludic mode.

Berlyne's taxonomy continues with the subdivision of exploratory

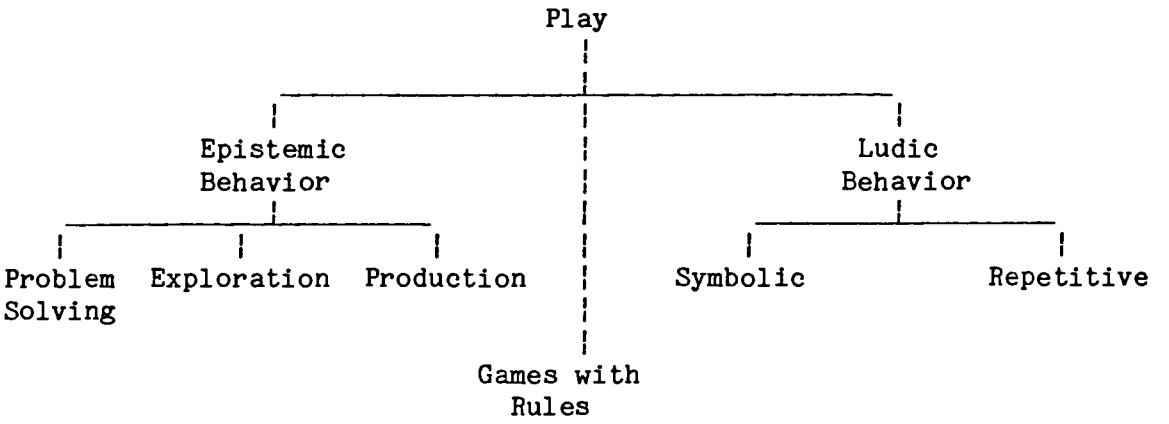
behavior in four distinctly different ways. First, if one focuses on the nature of the responses exhibited by the organism, three categories can be described -- orienting responses, locomotor responses and investigatory responses. Orienting responses are those which change the position or state of the sense organs which receive the stimuli. Locomotor responses are those by which the organism explores by moving its whole body, changing its location. Investigatory responses are those during which the organism manipulates or otherwise alters external objects.

Berlyne's remaining distinctions cut across the above categories. The second divides exploratory responses into those which are extrinsically motivated, and those which are intrinsically motivated. Thirdly, he speaks of specific and diversive exploration. If the stimuli yield information about one particular event or thing, the response is termed specific exploration. If the stimuli are from a wide range of sources, and responses are made in an effort to relieve boredom, seek entertainment or enjoy new experiences, the response is termed diversive exploration.

The fourth and final categorization divides inspective exploration, or looking at, from inquisitive exploration, or looking for. In this last case, the distinction made is between exploration of an object or stimulus field already acting on the sensory receptors, and exploration which changes the stimulus field such that new objects are introduced.

Since the work of Hutt (1971) builds on that of Berlyne, her classification is described next. Like Berlyne, she refers to specific and diversive exploration. Specific or investigative exploration asks, "What does this object do?" As a result, specific exploration is described as stimulus referent, and information is acquired as it occurs. By contrast, diversive exploration or play is response referent and occurs only when the child feels s/he knows the properties of the objects in a known environment. The question being asked is, "What can I do with this object?" Interestingly, she claims that learning is largely incidental during diversive exploration or play, and states that "by being repetitive, play is by definition a highly redundant activity and can actually prevent learning" (p. 246).

Hutt's later work (1979) further clarifies her position on the role of play in learning. Figure 1 illustrates her taxonomy.




(Adapted from Hutt 1979, p.177)

Figure 1. Hutt's Taxonomy of Play Behaviors.

Hutt has made "play" the superordinate category here. However, she later states that she when she refers to play she is referring to ludic behavior. "But since ludic refers as much to the manner in which an activity is performed as to the nature of the activity, epistemic behaviors may also be performed in a ludic mode." (p. 178) If play must be ludic perhaps her classification should be redrawn as in Figure 2.


Figure 2. Hutt's Taxonomy - Revised

Bijou (1976) divides play into the following five categories in an attempt at a functional, behavioral analysis of the activity:

1. orientation-knowledge play (exploratory behavior);
2. behavior-differentiation play (practice of skill play);
3. reinforcement-heightening play (repetitious behavior, sense-pleasure play, exercise play);
4. imaginative play (fantasy play, symbolic play, make-believe play, dramatic play, day dreaming);
5. problem solving play (constructive play -- adding to abilities and knowledge).

Each category is separated from the others by the dominant behavioral process or mode involved in the play observed. Each category can, as well, be either solitary or social. He draws one further distinction which is of interest, in that he also discriminates free and structured play. He defines structured play as "the behavior a child engages in when he is presented with a situation in which space, materials, sometimes other children, and explicit or implicit instructions and guidance are provided in order for him to achieve some objective" (p. 33). If the instruction is simply "Play", the activity is defined as unstructured or free play. He points out, however, that the form of even free play is determined by such factors as the setting, the playthings provided, the child's genetic and personal history, and the behavior of others in the setting.

Piaget divides play into three categories, each of which is described as occurring during a specific developmental stage. He refers to practice play, symbolic play, and games with rules. During the sensory motor stage the child involves him/herself in playfully repeating a movement pattern simply for the sake of functional pleasure (practice play). This is followed, in the preconceptual stage, by symbolic play which includes make believe, fantasy, and imaginary games and progresses through a number of phases. Games with rules begin at about the intuitive stage, progressing through four phases, and predominate during concrete operations.

Flavell (1977) describes Piaget's classification scheme in

detail, providing an analysis which contrasts play with adaptive intelligence and imitation. Cognitive development occurs through equilibration, and the complimentary processes of assimilation and accommodation. While these two processes are said to occur together, if assimilation predominates, the child is, according to Flavell's interpretation of Piaget, playing. If assimilation and accommodation are in balance, the form of cognitive functioning which is occurring is labelled adaptive intelligence. Interestingly, Flavell includes exploratory behavior in this category. Imitation is at the opposite end of the continuum from play. When the child is simply modelling or copying the behavior of someone else, accomodation predominates.

Gehlbach (1980) differentiates natural play, educational play and instructional play. His definition of natural play, as stated in the preceding section, includes any activity which is voluntary, self-centered, purposive and casual. Educational play is contrasted with instructional play in that the former guarantees only opportunity to learn, while the latter results in predictable and specifiable learning.

Sutton-Smith (1967) separates exploratory behavior and play, pointing out that while both are intrinsically motivated, exploratory behavior is less active and precedes play developmentally. He describes play as different from exploration "in its greater emphasis upon the novel variation of responses according to internal criteria; play is an activity accompanied by the traditional and often-mentioned

affective accompaniments of playfulness, fun and the enjoyment of the activity for its own sake." (p. 363-364).

Vandenberg (1978b) discusses types of play and the position of play in the broader context of behavior generally. Like Sutton-Smith, he differentiates exploration and play, but adds an additional category that he calls application. His model includes a continuum on which play lies between exploration and application. He postulates that ontogenetic development in symbolic organisms progresses through a process whereby exploration, play, and application occur in sequence. Vandenberg also refers to different types of play such as social, solitary and object play. The first two of these are similar to Parten's (1932) classification of play activities based on the degree of social interaction which occurs. Berlyne (1969) defines four types of play from Parten's list -- solitary, parallel, associative and co-operative. Developmentally, these types of play seem to occur in the order listed.

## Theories of Play

The present study is concerned with the effects of play on learning. Hence, the following examination of the theoretical literature is limited to recent theories which attempt to delineate the role of play in cognitive growth and functioning. Some of the classical theories (Rousseau, Froebel, Montessori) attempt to explain the relationship between these variables. However, the theoretical

and empirical work of the last ten years provides a framework which is much more relevant. The following discussion separates the theoretical explanations of how cognitive growth takes place from those which describe cognitive functioning. It includes theorists whose approach is developmental (Piaget, Sutton-Smith), cognitive (Vandenberg), and, behavioral (Berlyne, Bijou, Gehlbach).

Piaget's developmental theory provides a detailed and complex explanation of how cognitive growth takes place. The question to be answered here is, "What effect, if any, does play have on cognitive development?" According to Ginsberg and Opper (1969), Piaget claims that genuine learning is explained by or based on development, not the other way around. Development is, in turn, influenced by four factors, none of which can be said to encourage development without due consideration being given to the effect of the others: 1) maturation, 2) experience or contact with objects, 3) social transmission (instruction and reading) and 4) equilibration. Piaget describes in detail the ways in which each of these factors acts to influence development. The fourth factor, equilibration, is the Piagetian construct which explains how development progresses from one stage to the next, and, as well, one of the processes through which cognitive functioning is explained.

Flavell (1977) describes Piaget's model as one which "makes childhood cognitive growth a logical outcome of repeated cognitive functioning" (p. 11). His explanation focuses on assimilation and

accommodation. He describes a slow, step-by-step procedure where the cognitive system evolves (or schema of increasing complexity are developed) as the child assimilates stimuli from the environment and accommodates existing mental schema to incorporate the new data. Flavell includes as well an explanation of the role of equilibration in development. He describes Piaget's model as one in which cognitive progress is impelled by cognitive conflict or disequilibrium. Equilibrium at a lower developmental level is followed by disequilibrium which results from nonassimilable data. The final step is the achievement of equilibrium at a higher level as the child "reconceptualizes the problem in such a way as to harmonize what had earlier been seen as a conflict" (p. 242). While Flavell relates this model to assimilation and accommodation, as described earlier, this last step is somewhat confusing in its emphasis on reconceptualizing the problem. It would seem though the final step as described is equivalent to accommodation, or the altering of existing schema in light of new and incongruous data, so a higher state of equilibrium is achieved, and development progresses.

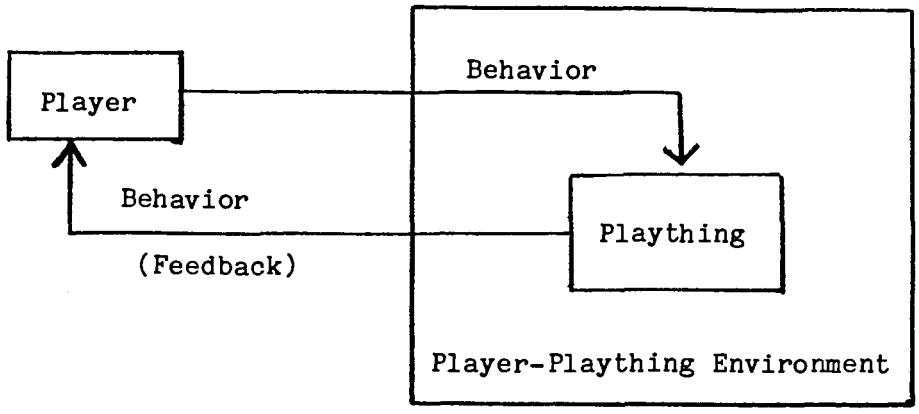
It may appear that the argument has strayed from the original concern about the role of play in cognitive development. To link the preceding logic to that original question, it is important to remember that Piaget describes play as pure assimilation. As such, children's play becomes a necessary but not sufficient condition for cognitive development. Cognitive development requires accommodation. The

schema must be altered in some way before cognitive development can be said to have taken place. Piaget stresses the interdependence of assimilation and accommodation. Play may therefore be seen as one facet of the process. While cognitive development may not occur during such purely assimilative functioning, it can be said to occur, at least in part, as a result of assimilation. This explanation resolves what seems to be a logical inconsistency in Piaget's model. Purely assimilative behavior (i.e. play) does not on its own, facilitate cognitive growth. It does, however, have the previously described role in the complex process which leads to development. It is important to reemphasize that Piaget describes development as the basis of genuine learning.

Vandenberg (1978b) outlines a theory of play which was briefly described in the discussion of types of play. His model postulates an exploration-play-application sequence in explaining the contribution of play to development. In discussing the animal studies upon which much of the relevant work with humans is based, he points out that play facilitates effective application. That is, it seems that play with an object is necessary as an initial activity before more mature practical use of the tool or object can be expected. While there does seem to be some empirical evidence to support such a link between play and more practical applications or uses of objects (Silva, et al., 1976; Vandenberg, 1978b), it is important to note that there are no guarantees that the player will in all cases choose to or be required

to exhibit behaviors which would be seen as examples of application. In this model, play is seen as important in that it develops a large number of skills which are potentially useful in adult life. Vandenburg further suggests that play functions to develop this array of skills by providing the practice which is required with a given tool before enough proficiency is achieved to enable the organism to use the tool in an effective way. The suggestion is that in both phylogenetic and ontogenetic development, the amount and structure of play activity is related to the adaptive needs of the organism. In complex, symbolic organisms (such as children) and where considerable adaptation is required for successful functioning (such as in adult human society) play bcomes an important activity in developing competence.

The role of practice is an important element in the explanation of play outlined by more behaviorist theories. Gehlbach's explanation of the function of play postulates a sequence whose steps are exposure, practice, and feedback. He describes the interaction between the player and the toy in terms of the cybernetic model illustrated in the following diagram.




(adapted from Gehlbach, 1980 p. 116)

Figure 3. A cybernetic model of a simple play event.

The player, exposed to and attracted by the plaything, interacts with it, practices repetitively certain behaviors and receives feedback from the plaything in the sense that it responds in certain ways to the child's manipulation. A loop is set up where the child's further manipulations are then altered in response to the feedback from the play environment.

Sutton-Smith (1967) theorizes about the functional relationship between play and cognitive development. He concludes that there is indeed at least a loose relationship between these two variables. He indicates that the adaptive value of play activities is related to the fact that play increases the child's repertoire of responses or produces a superabundance of cognitions which are potentially useful in future situations. In relating play to learning he describes research which examines the effect of structured games with rules on learning, citing empirical evidence that such activities can, for

example, result in significant improvement in a five year old's ability to conserve number. He refers as well to the child's ability to adopt an "as if" representational set, citing Sigal's research (1966) which found a correlation between impoverished play (high frequency of motoric activity, minimal role playing, and block play of lower elaboration) and an inability to categorize in representational terms. He makes no attempt, however, to link what could be called "free play" and problem solving, but rather emphasizes the link between such play and creativity. He reports the results of a study which showed that children could generate longer lists of uses for a toy they had played with than they could for a toy that they had not played with (Sutton-Smith, 1967).

Bruner (1972) theorizes that play, in combination with observational learning, is most important if an individual is to develop competence in using tools. He details the mechanism whereby play serves this function. First, play provides an opportunity for the player to experiment in a situation where the consequences of his actions are of little concern. He is freed from restrictions that fear of consequence places upon his actions. Second, the player tries new combinations of behavior, because he is not restricted by functional pressure. Third, the player is able to master features of the task, breaking a complex function or process into more manageable subroutines. Fourth, the player, by engaging in many repetitive enactments of the skill, routinizes each segment of the more complex

process required when the tool is used in a functional context. Fifth, the player uses the new skill in a variety of contexts as he plays, and therefore learns more about its effectiveness.

Specific and diversive exploration previously defined and described, are seen by Hutt (1971) as two distinctly different types of behavior serving different -- indeed, almost opposite -- functions. She explains that during specific exploration, which occurs before diversive exploration (or play), the child is attempting to reduce the uncertainty produced by novel stimulation. In contrast, during diversive exploration, the child is attempting to avoid boredom and monotony by varying the stimulation or increasing sensory input. She states that the later activity (play or diversive exploration) may function as preparation for adult life, like any other motor activity. She emphasizes that the two types of behavior have very different roles in cognitive development. She sees investigative or specific exploration as the activity whereby the child acquires information or learns and play as a redundant activity which may even prevent learning. This position is difficult to reconcile with her claim that the playing child is asking, "What can I do with this object?" While in Piaget's terms this indeed would fit as a question suitable to the purely assimilative function of play, it seems improbable that the child seeking an answer to such a question is not learning. The investigating explorer learns what an object can do. There is no reason to assume the knowledge s/he acquires in this mode is more

informative than that acquired by the diversive explorer. Indeed, knowledge of what can be done with an object would seem as significant as knowledge of what an object can do. It may be that the quality of the player's learning is more influenced by variables which describe the player (cognitive competence, existing knowledge, etc.) since the focus is less on the object and more on what the player can do with it. In specific or investigative exploration the focus on the object and the learning which occurs is limited by variables such as the object's complexity and design.

The concept of an instructional or educational toy is based on the premise that it is possible to design play objects which will produce specific learning outcomes. Montessori's work demonstrates that such goals are achievable. The explorer (specific or diversive) may become preoccupied with activities which do not result in learning anticipated by or predictable by those who design the toy. Schiller's work with chimpanzees illustrates this point. After a play period, during which the chimp manipulates the sticks he was given by weaving them together, Schiller presented the animal with a problem which required him to use the sticks as a rake. The animal was unsuccessful. One would however expect more success if the post test problem involved weaving, about which the chimpanzee may have learned something. To claim that an exploring child learns nothing is ridiculous, but in educational settings, where very specific learning objectives are set by the teacher, specific and diversive exploration

may indeed be inefficient methods for achieving those learning objectives.

Bijou (1976) separates play into the five categories previously described, labelling exploratory behavior "orientational, knowledge play." He explains the child's motivation to engage in this type of activity from three theoretical perspectives -- state theory, drive theory and behaviorist theory. In the first instance, he concludes that, "This notion that exploratory behaviour or curiosity is motivated by an emotional state has little scientific promise." (p. 15). He considers Berlyne's theoretical position representative of the drive theories, and criticizes it on a number of counts. He favors the third theoretical position, which views exploratory behavior as "a sequence of operant interactions strengthened by contingent ecological stimuli, under specifiable setting factors" (p. 18). His analyses focus on each of these two (the ecological stimuli and the setting factors) in turn. He describes ecological reinforcers as various sensory stimuli which have been found to strengthen exploratory behaviors (citing Hutt's work with auditory and visual stimuli, for example). Second, he describes setting factors under which ecological reinforcers are functional (e.g., novelty, complexity). He sets two types of conditions which are necessary for exploratory behavior. First, since exploratory behavior is inhibited by setting conditions which increase the probability of more powerful behaviors such conditions must therefore be absent. He details some

setting factors which would result in behavior other than orientational knowledge play, e.g., hunger, thirst, tiredness, illness, anger, fearfulness, etc. Second, he describes certain setting factors which increase the reinforcing function of the ecological or sensory stimuli, such as lack of prior exposure or deprivation of opportunity to engage in exploratory behavior.

The second type of play described by Bijou is response differentiation play (skill play or practice play). This type of behavior is defined in terms of its effect, which is to extend the child's repertoire of abilities, resulting in successively more effective behavior.

Reinforcement-heightening play, Bijou's third category, is less relevant here. The function of this type of behavior is to increase the intensity or frequency of reinforcing stimuli, and it is therefore also called sense-pleasure play.

Imaginitive play, is Bijou's fourth catagory. This includes dramatic play, which involves objects and/or people, and day dreaming, which does not.

Problem solving play, or constructive play, is Bijou's fifth and final category. The dominant activity in this type of play is experimentation. Experimentation is defined as doing something and watching to see what happens. This type of play serves to develop competence by increasing the child's level of ability and knowledge.

Bijou's final distinction, common in the literature, is between

free and structured play. These two types of play are not distinguished by degree of structure imposed by space, materials, or other children. Structured play is defined as play which is preceded by explicit or implicit instructions or guidance intended to help the player achieve some objective. Free play is said to occur when the child is directed only to play.

Given the diversity outlined above, with respect to definitions of play and the various lists of characteristics in the literature, as well as the various theoretical positions and numerous labels applied to this behavior, it would seem almost impossible to achieve consensus as to whether or not a given child is playing -- and what results one could expect such play to have. The behavior of interest in the research here reported is clearly play. It is adequately described by all the definitions and lists of characteristics in the preceding discussion. Various of the other labels described above also are of more particular relevance than others. A thorough discussion of which labels are most suitable, and the logical implications of each in terms of the theoretical positions attached to each type of play is included in the discussion chapter.

## Empirical Research

The study of most direct relevance to the one reported here is by Sylva, Bruner and Genova (1974). In this case, the task required the children to recover a piece of coloured chalk from a transparent box

by making a tool from sticks joined together with a C clamp, unlatching the box, and taking the chalk out. In the first experiment the three treatment conditions "play", "no treatment" and "observe principle" were as outlined in Table 1. A series of five hints was given during the administration of the task. A hint was given if: (1) the child got up and walked through the door, (2) the child ignored the problem for at least 1 minute, (3) the child repeatedly asked to leave. Group performance was measured in terms of: 1) number of spontaneous solvers (no hints required), 2) number of eventual solvers, 3) number of goal directed manual responses, and 4) the number of learners versus non learners. This last measure was determined by comparing the means used to obtain the goal. Table 2 lists the six means observed. Learners began lower than Means III, but eventually reached Means IV or higher. Non learners remained at the level of simple means or began with very complex means. The study hypothesized that the play group would perform better on the task. The results indicate the following differences between the groups:

Table 1. Treatment conditions in Sylva, Bruner and Genova (1974), Experiment 1

| Name | Nature of experience prior to presentation of problem | Duration of prior experience | Manipulation of sticks and clamps? |
|---|---|---|---|
| Play | Adult demonstrates one clamp tightened onto middle of one long stick<br>Child allowed free play with 10 blue sticks and 7 clamps | 10 min. | yes |
| Observe | Adult demonstrates one clamp tightened onto middle of one long stick<br>Adult demonstrates construction of elongated tool by rigidly joining two long sticks with clamps | 2 min. | no |
| No Treatment | Adult demonstrates one clamp tightened onto middle of one long stick | 1 min. | no |

Table 2. Six means to obtain goal by children in Sylva, Bruner and Genova (1974)

| Means | Description |
|---|---|
| I | Use of hands/arm to attain goal |
| II | Use of single object as tool to extend the arm. (This is always one stick or clamp). |
| III | Use of two unco-ordinated tools. (Usually child held stick in either hand). |
| IV | Assembly and use of an elongated but disjointed tool construction. (Usually child used one stick to push the other forward). |
| V | Assembly and use of rigidly jointed tool but one which is not sufficiently elongated. |
| VI | Assembly and use of an elongated tool consisting of two long sticks, rigidly joined by clamp at point of overlap. |

(1) Significantly more spontaneous solutions occurred in the "play" group (14 spontaneous solutions) than in the no treatment group (3 spontaneous solutions).

(2) There was no significant difference between the play group and the observe principle group in terms of number of spontaneous solvers.

(3) There were more learners in the play group than in the observe principle group.

(4) there were more immediate solvers in the observe principle group. (Immediate solvers were those whose first goal directed response was the correct one.)

Sylva et al.'s second experiment added two groups to the study, as outlined in Table 3. Play richness was controlled in this experiment by a yoking procedure. Each child in experiment two was yoked to a child in experiment one's play group. The specific content of the puppet show and the training session was determined by the play richness observed in the play group yoke mate. Play richness, also called configurational richness, was a measure of the complexity of the configurations the child constructed with the sticks and clamps. Children in the "observe components" condition watched an adult play as their yoke mate had. Children in the "training on components" condition were instructed to copy the play of their yoke mate. There were no significant differences between the groups in experiment two. There was, however, a significant correlation between the scores for

Table 3. Treatment conditions in Sylva, Bruner and Genova (1974), Experiment 2

| Name | Nature of experience prior to presentation of problem | Duration of prior experience | Manipulation of sticks and clamps? |
|---|---|---|---|
| Observe components | Adult and child sit at table and adult creates a 'puppet show' in which sticks and clamps become characters in a drama. Mr. Clamp and his brothers 'eat' members of the Stick Family by clamping their 'jaws' around the 'waists' of the sticks. | 10 min. | no |
| Training of components | Training consists of demonstration, specific commands (e.g. 'Turn the handle the other way') and verbal encouragement (e.g. 'you're getting it tightened; dont give up'). | 10 min. | yes |

number of hints of the experiment two children and their yoke mates in experiment one. This is taken as support for the hypothesis that play richness affects the child's subsequent performance. When the frequency of spontaneous solutions was compared, the children in play and observe-principle groups of experiment one outperformed those in experiment two. In discussing their results, the authors list three reasons for apparent superiority of the players. First, the players actions were involved in self initiated actions, and problem solving, they contend, requires self-initiation. Second, the players had an opportunity to practice alternative ordering of the various acts required for problem solution. Third, it is claimed that players were less stressed, less concerned with success or failure, and more goal directed. The specific relevance of this study to the one here reported is outlined in the last section of this chapter.

Vandenberg (1978) examined the effect of age, personality factors, and play on tool-using abilities in four to ten year olds. Children were divided into three age groups (4 to 5, 6 to 7, and 8 to 10) and two treatment conditions (a play group and a didactic group). The children in the play group played with the materials used in the task until they volunteered that they were finished or responded that they were finished when asked after thirty seconds of not playing. The children in the didactic group were asked questions about the materials for the same length of time that their yoke mate in the play group played. Yoke mates also showed similar ability on the WISC

block design subtest. Two tasks were used. The first, a variation on Sylva's "stick as rake" problem, required the child to tie two notched sticks together with pipe cleaners and use the tool thus created to rake a coloured block out of a transparent box by raising the front face of the box. The second required the child to tie several pipe cleaners together to dislodge a piece of sponge in a transparent pipe. A series of hints was used as needed. Points were given for not needing hints. The hints were scored differentially, so that more points were given for hints which revealed more of the solution. Task one had six hints (which were scored 1, 2, 3, 4, 5, 9). Task two had four hints (which were scored 1, 2, 3, 5). It was hypothesized that: the play group would perform better than the non-play group, younger children would be more influenced than older children by the play experience, play richness would be positively related to task performance, and task specific play would improve performance on the more difficult task (task one). None of the above hypotheses were supported, except the first, which was only supported for task one in the middle age group.

Smith and Dutton (1979) used four groups and two tasks to examine the effect of play and training on innovative problem solving. They hypothesized that the main advantage of play over non-play might be in a slightly more innovative problem solving situation. The two tasks were again "stick as rake" problems. In this case blocks with holes in them were used to join sticks to construct an elongated tool and

retrieve a marble in a box with a transparent door. Task one required the child to join two sticks with one block. Task two required the more innovative problem solving in that the child had to join three sticks with two blocks. All participants watched a one minute demonstration of the use of the block and had two minutes of exploratory manipulation of the sticks and blocks. The play group had an additional eight minutes of free play. The trained group spent eight minutes copying experimenter demonstrations of various configurations of block and sticks, and then practicing joining sticks with blocks with no further experimenter direction. The two control groups (one for each task) proceeded to task one or task two immediately after their three minute familiarization session. A system of hints was used during the posttest.

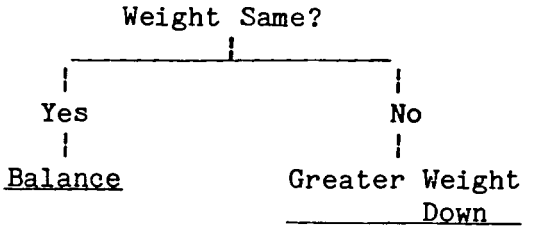
The principal measures compared the groups on the following outcomes: The number of spontaneous solvers (no hints required), solution time, and number of hints required. For task one, solution time was significantly faster for the play and training groups over control. No significant differences between play and training were found. Task two results indicated superior performance by the play group over the training group in solution time, number of hints, and number of spontaneous solvers. In discussing their results, Smith and Dutton note that task two (which required innovative application and transfer) separated play from training as a more superior treatment. They relate this to the theoretical position of Sylva, et al. (1977),

which describes play as flexible combinational activity which may be most effective preparation for problem solving which requires innovative sequences of behavior (as task two did).

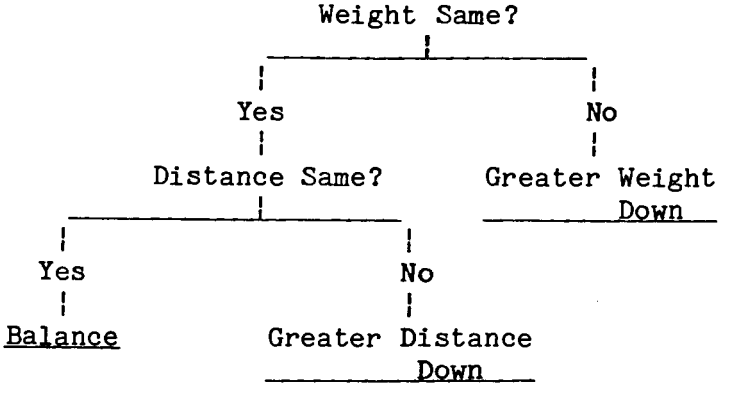
Siegler (1976) reported a study which changed the problem type from "stick as rake" to balance scale. Four age groups participated in the study: five and six year olds, nine and ten year olds, thirteen and fourteen year olds and sixteen and seventeen year olds. The balance scale used had four pegs on either side of the fulcrum, on which metal weights could be stacked. Weights and two wooden blocks were provided. The blocks could be placed under the arms of the balance scale to prevent it from tipping. A thirty item posttest was used to assess the children's knowledge and determine which of four rule models they were using. Each item on the test required them to predict which side of the balance scale would go down.

Figure 4 diagrams the decision process of a child using each of the four rules. Each rule is seen as an advance over the previous rules, as all of the questions posed in the more advanced rule are included in the preceding rules. Six different types of problems were used to determine the level at which a child was functioning.

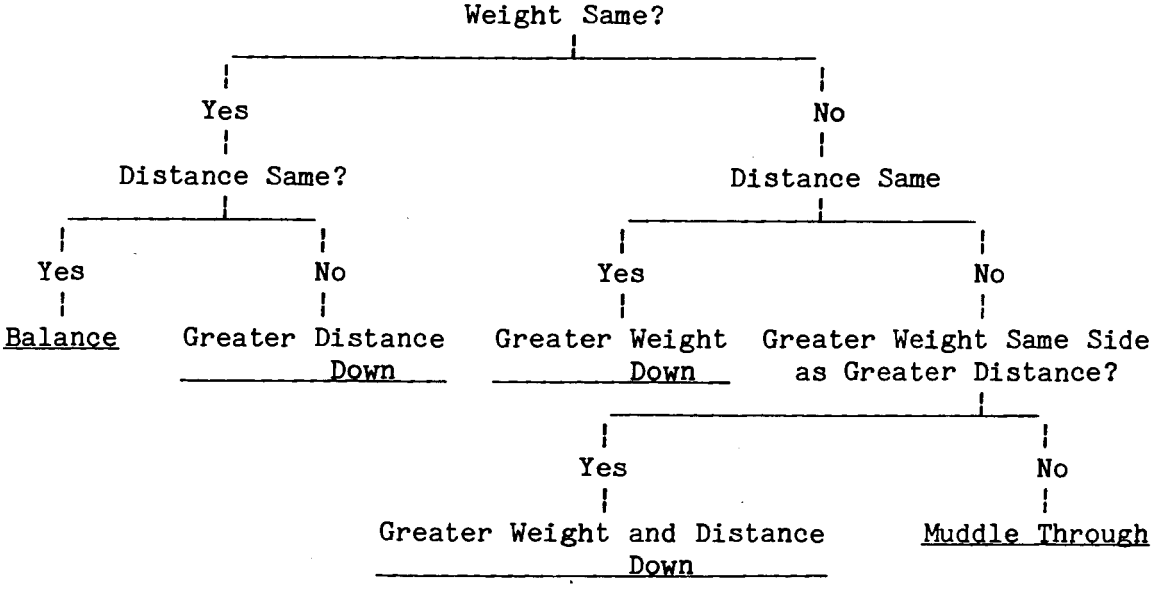
a Model of Rule I




b Model of Rule II




c Model of Rule III




Figures 4a - 4d. Decision Tree Model of Rule for Performing Balance Scale Task. - Adapted from Siegler (1976)

d Model of Rule IV

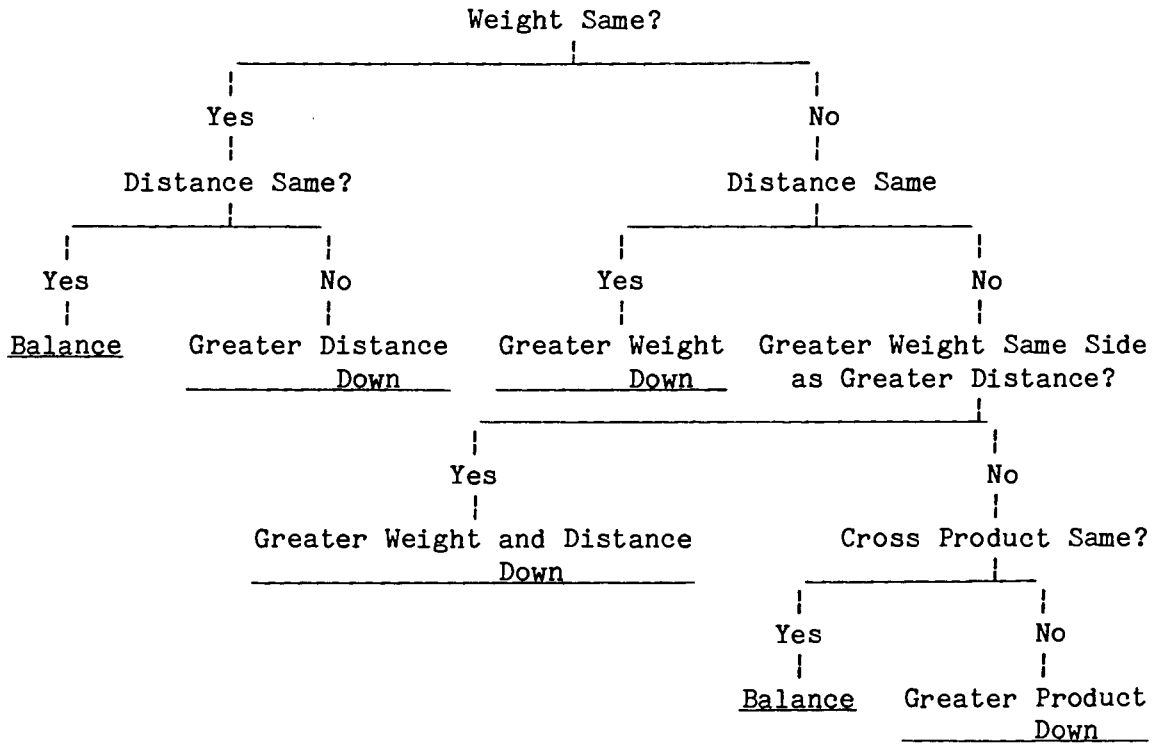



Figure 4a - 4d. (continued)

Three different experiments were designed to examine children's thinking and problem solving abilities and the ways in which these are affected by three different treatments: a priori, experimentation and observation. In all groups, the session was begun with the explanation "Today we are going to play with this balance scale." Children in the a priori condition were simply presented with the posttest problems. The experimentation group was told to try to figure out the rules which govern the behavior of the balance scale by experimenting with it. The observation group (also told to try to figure out the rules) simply watched the experimenter demonstrate a series of 36 configurations specifically ordered to require the application of increasingly complex rule systems.

The first experiment showed that it was possible to characterize the children's behavior in terms of rule type. The age and treatment groups were compared on number of correct predictions, as well as rule level used. As developmental changes are not relevant to the concerns of the research here reported, only the performance of the five and six year olds will be discussed. No significant treatment effects were found in the data on number of correct predictions, and the treatments did not cause an anticipated movement to more complex rule models. Experiment two attempted to determine the effect of two different training experiences on posttest performance. The effects of the observation and experimentation procedures in experiment 1 were small. How do children using one rule come to develop new more

complex rules? It was theorized that training which was close to the learners' current level would be most effective. Five and eight year olds were classified to determine the rule they applied to solving the problems. One treatment group experienced problems which focused on applying a rule one step above that which they are using. The second treatment group were presented with problems which required the application of the most complex rule. The older children benefited from the later treatment. The younger children did not. An encoding hypothesis was developed to explain this phenomena -- and tested in experiment three. It stated that "Five year olds are less able to acquire new information than eight year olds because their encoding of stimuli is less adequate" (p. 504). In this case both weight and distance must be encoded to solve the balance scale problems successfully. In the first of five experiments it was determined that the younger children encoded only one dimension, while the older children encoded both. The second experiment in this series determined that lack of time -- a possible explanation for the inferior performance of the five year olds -- was not relevant. The third experiment changed the instructions to be sure that the reported difference was not a result of the younger children not having understood the directions. The instruction in this case told the children to encode on both the weight and distance dimensions. Their performance remained unchanged. The fourth experiment provided instruction in what to encode -- as in experiment three -- and also in

how to encode. In this case age related differences in encoding were substantially reduced. In the final experiment of the series, the children trained in experiment four were tested to determine the degree to which the five year olds would benefit from the training which had previously aided only the eight year olds. It was found that qualitative differences were eliminated by prior training in encoding. The relevance of these findings and the theoretical analysis of these findings is related to the research findings reported here in the last section of this chapter.

The results of previous studies are summarized in the following tables.

Table 4. Summary of results of previous studies, play groups compared to controls

| Study | Results |
|---|---|
| Sylva et al. (1974) | Experiment 1 - play and observation superior to no treatment. |
| Vandenberg (1978) | no control group |
| Smith and Dutton (1979) | play and training superior to control |
| Siegler (1976) | Experiment 1 - no significant treatment effects for experimentation (play) or observation groups. Experiment 2 - no experimentation group |

Two studies (Sylva, 1974; Smith and Dutton, 1979) support the hypothesis that play experience improves performance in problem solving. The fourth study (Siegler, 1976) does not.

Table 5. Summary of results of previous studies - play groups compared to more structured treatment conditions

| Study | Results |
|---|---|
| Sylva et al. (1974) | Experiment 1 - more learners in play group, more immediate solvers in observation group, no differences in number of spontaneous solvers Experiment 2 - play and observe principle groups both superior to "observe components" and "training on components" groups. |
| Vandenberg (1978) | play superior to didactic for 6 and 7 year olds |
| Smith and Dutton (1979) | play superior to training on task requiring "innovation" |
| Siegler | Experiment 1 - no treatment effects for either play or observation groups Experiment 2 - no play condition. Significant treatment effects for observation groups. |

This Study and the Research to Date

The research done to date on the relationship between play and problem solving suggested a number of methodological modifications which motivated the present study. An analysis of those studies suggested that the treatment conditions be modified in the following ways: 1) Prior studies have not attempted to determine participants' existing knowledge of the problem presented in the posttest. Such knowledge would serve to confound interpretations of results. Although one would expect such children (who had nothing to learn from treatment) would have been evenly distributed amongst the groups in previous experiments, the elimination of this factor as an error variable, however, provides a stronger test of the effects of play on learning. 2) The play group should be exposed to and have an

opportunity to explore and manipulate all of the materials of the task. The transparent box used in both previous experiments (Sylva et al., 1974; Vandenberg, 1978) was not included as part of the play equipment during treatment; 3) The didactic and observation groups should provide instruction which is more direct, which provides for more specific feedback from the student about his level of understanding, and which ensures that the instructed student reaches a level of understanding which would enable him/her to solve the problem posed in the posttest. Knowledge of what effective direct instruction involves was applied to provide a more powerful treatment; 4) A new play group is added. This group is included to test the hypothesis that an experimental play thing could be designed which would perhaps engage the children longer and focus their attention on the principles relevant to the solution of the problem task better than the materials of the task.

Some differences in the analysis of the results are also relevant. Vandenberg modified Sylva's scoring of hints to address the differential nature of each hint. This is not done in the experiment here reported. Since the length of time each participant takes to solve the problem is closely tied to the number of hints given, and since it is difficult to determine logically or empirically just how helpful each hint was to each child -- Sylva's simpler scoring method is used.

Both Sylva and Vandenberg used a "stick as rake" problem. The

task used in this experiment is more similar to that used by Siegler, although balance scale problems require encoding which can be seen as more complex than that required by the present teeter totter problem. Another important modification in the equipment used was the addition of an experimental toy. The reason for this change was discussed above.

Siegler focussed his experiments on what can be seen as variations of the direct instruction provided in this study. He told all of his subjects that they were going to "play" -- and his experimentation condition is roughly equivalent to the play condition. His observation group received direct instruction -- the nature of which he systematically varied in his series of experiments. If a continuum were drawn with free play at one end and direct instruction (of the type used in the research reported here) at the other, Siegler's observation groups could be placed mid way.

The mixed results outlined above generally support the hypothesis that play treatment conditions are more effective than more structured treatment conditions but in rather limited areas. It is therefore predicted that well designed instruction will produce greater treatment effects than play.

# CHAPTER THREE

## Method

### Participants

Thirty-two boys and 32 girls from day care centers and recreation programs participated in this study. Their ages ranged from 4.0 to 6.0 years (Mean=4 years 9 months, S. D.=5.8 months) and all were from English speaking homes in the Greater Vancouver area of British Columbia, Canada. Children were selected on the basis of their performance on the pretest described below. Of the 125 children who were pretested, 58 (31 male, 27 female) solved the problem, one was eliminated because of a hearing problem and one was eliminated because of a language problem, leaving a total of 65 possible subjects. One participant, recorded as an extra, was not used. The remaining 64 participants were randomly assigned in equal numbers to one of the following four treatment groups: play with the materials used in the test task, play with an instructional plaything, direct instruction in the solution to the problem using task equipment, and no treatment control. Groups one and four were balanced for sex, while group two contained seven boys and nine girls, and group three contained nine boys and seven girls.

### Materials

Test materials. A miniature wooden teeter-totter was developed

to test children's ability to solve a physical manipulative problem. The device, illustrated in Figure 5, consisted of a wooden board with a single groove down the center of its length and balanced on a fulcrum. A piece of dowelling was glued to the underside of the board at right angles to the groove, to form the fulcrum. Each end of the board had two circular depressions into which weights could be placed. The teeter-totter was designed to tip when a marble was placed in the groove. When two weights were placed in the other end, the balance shifted and the marble would move down the groove to the newly weighted end. The ends of the groove were blocked so the marble would not roll out. These materials were used in the screening procedure, posttest, and one of the treatment conditions.

Experimental plaything. The experimental plaything consisted of a roadrace set illustrated in Figure 6 and three toy vehicles. It was the same basic shape as the task equipment but was designed to teach the principles which need to be understood to solve the problem presented in the pretest and posttest. The plaything consisted of a wooden board with a black roadway painted down its center. A strip of wood was glued on both sides of the road surface, so that the road became a channel down the middle of the toy. A dotted yellow line was painted down the middle of the road. Two parking spaces were made at one end and a metal toy car was placed in each one. A toy double decker bus, heavier than the cars, was placed in front of the toy. The bus would run the full length of the road only if both cars were

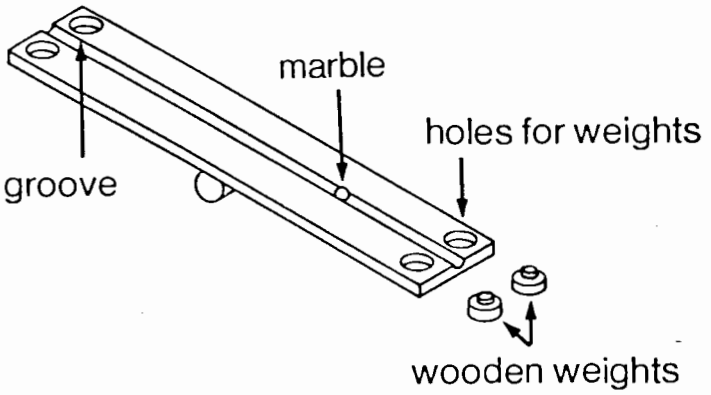



Figure 5. Test materials

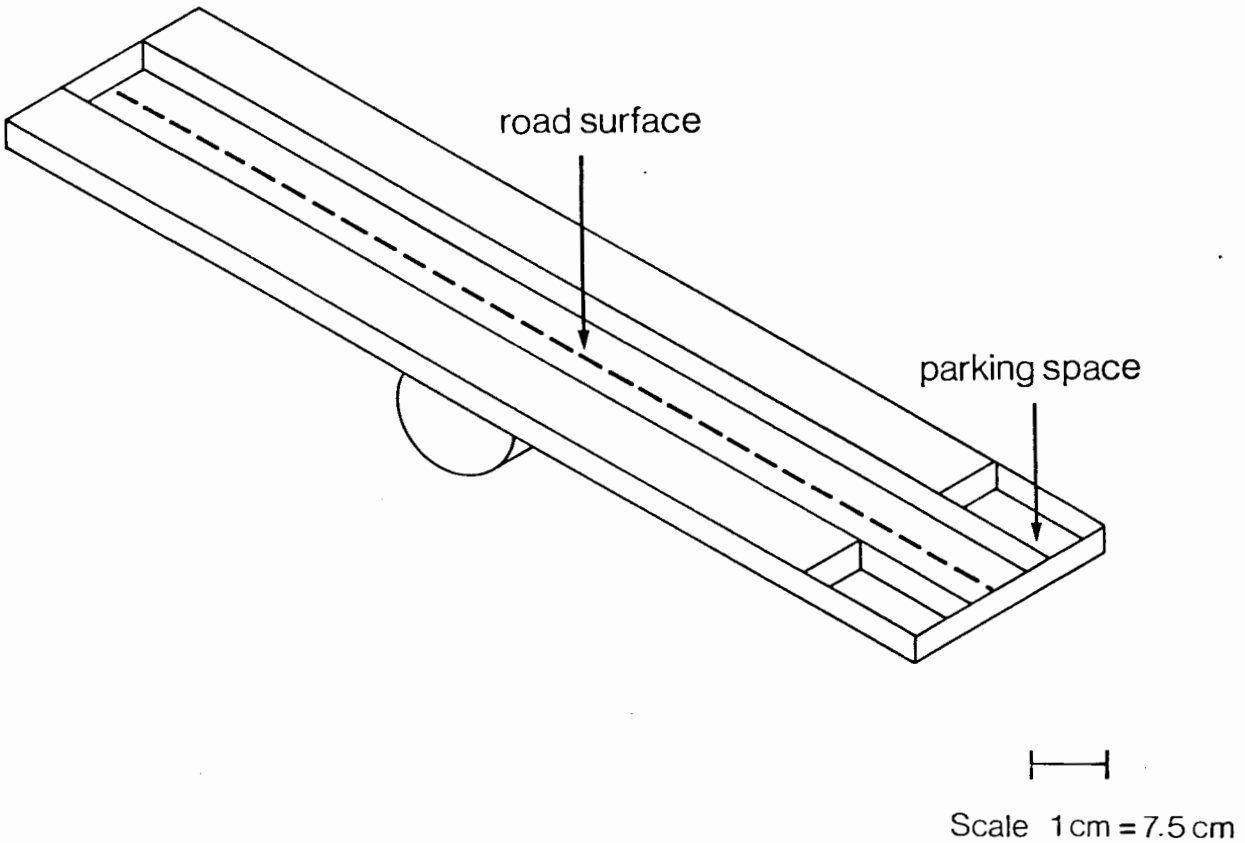



Figure 6. Experimental Plaything (toy vehicles not shown).

in place in their parking slots. When the bus was in a parking space, the cars could be raced the length of the road. The ends of the roadway were blocked so that the cars did not run off the board. The cars were identical, and each was heavy enough to trip the balance of the roadway if placed at one end when the parking spots were empty.

Procedure

Screening pretest. Each subject was pretested with the apparatus using the following verbal instructions:

> "I have a job for you to do. This is a teeter-totter for a marble. Show me a way to make the marble go from this end (point to the lower end) to the other end. There are two rules. First, you may not push the marble. Second, you have to use these (point to weights) to make it happen. If you can do it, you may keep the marble. Go ahead."

The experimenter then put the weights into the child's hand and started the stop watch. If the child broke a rule (e.g., used his hand to move the teeter-totter or pushed the marble) the experimenter gently enforced the rule (e.g., removed the hand) and repeated the relevant instruction. If the child asked a question concerning the solution (e.g., Do I put the weights here?), s/he was told "You are supposed to figure it out." If the question was relevant to the procedure (e.g., "May I use my hand?"), the experimenter repeated the

relevant instructions. The children were given 30 seconds to solve the problem. Only those who failed the screening pretest participated in the experiment.

Treatment one: Play-task materials. After the pretest, those children assigned to this condition received the following instructions:

> "You may play with this toy for a while, but you must keep it on the table. After you have played for as long as you can, you may try the job again."

The timing of the session began as soon as the instructions were given. If the child solved the problem during play with the equipment, no recognition of the solution was made by the examiner. If any of the following occurred, the child was given a prompt to play a bit longer:

a) 30 seconds without interaction with the play thing,

b) a request by the child to stop playing,

c) a motion to get up from the play table,

d) a request by the child to do the posttest.

If any of the above occurred after the prompt, the session was terminated and the posttest was administered. If the child was still playing after 10 minutes the experimenter said, "You may play as long as you want, but don't forget to tell me when you are finished." This procedure was repeated after 15 minutes of play. If the child was still playing after 20 minutes, the session was terminated by the

experimenter saying, "That's all the time we have. I'd like you to do the job you tried earlier." The posttest was, in all cases, administered blindly by a trained research assistant who was not informed of the treatment the subject had received.

The children participating in this treatment, as well as treatment two, were videotaped. The procedures used are described in the section below entitled Observation of Play, Treatments One and Two. Appendices A and B show the coding sheets used to record data and the calculations employed on these data, respectively.

Treatment two: Play-Experimental plaything. After the screening pretest, those children who were assigned to this condition received the following instructions:

> "I have on the table some new toys for you to play with. You may play with these toys for a while, but please keep them on the table. After you have played for as long as you can, you may try the job with the other toy again."

The session was timed from this point. The length of the play session was determined in the same manner as for group one (Play-task materials). The videotapes of the subjects' play were analyzed using the same code sheets and behavior categories as described in the preceding section. The code sheets were used as for group one (a sample code sheet is in Appendix C; calculations are in Appendix D).

Treatment three: direct instruction. After the screening

pretest, those children who were assigned to this condition were given a verbal explanation and modelled demonstration of the solution to the task. The child did not at any time during the lesson handle the equipment. The session was timed from the point where the experimenter said:

> "I am going to teach you how to get this marble to roll all the way from this end of the teeter-totter to the other end. I can't push it and I have to use these weights to make it happen. I will put the weights into these round holes in the high end of the teeter-totter. They will make this end (point to the higher end) heavier. It will go down. As it goes down the marble end will go up and the marble will roll. I'll show you what I mean."

The solution was then demonstrated. The experimenter then said,

> "The marble rolled all the way to the other end. That's exactly what we wanted to happen."

The experimenter then asked the child, "Tell me what you would do to get the marble to roll to the other end of the teeter-totter?" If the child asked a question, it was answered. If not, the explanation, demonstration and question were repeated until criterion was reached. The explanation was judged adequate if the child mentioned where the weights had to be put. The session was timed from the beginning of the experimenter's explanation to the end of the child's correct

criterion response.

Treatment four: Control. After the screening pretest, those children who were assigned to the control condition were told:

> "I am going to read you a story now. After the story you may try the job with the toy again."

They were read a story entitled, "How Tom Beat Captain Najork and His Hired Sportsmen" by Russell Hoban, (1974) which took approximately five minutes.

Posttest. Following treatment, the test materials described above were used in the posttest. The tester's instructions to the child were:

> "I would like you to try the job you tried earlier. Show me a way to make the marble go from this end (point to the lower end) to the other end. There are two rules. First, you can't push the marble. Second, you have to use these to make it happen (point to the weights). If you can do it you may keep the marble. Go ahead."

The weights were then handed to the child, and the stop watch was started. Questions were handled as for the pretest. The following recorded hints were used:

1. See if you can find a way to make this end (point to the upper end) of the teeter-totter go down without using your hand to push it down.

2. See if you can do it with the weights (point).
3. See if you can do it by putting a weight (point) in each of the holes at one end.

The posttest session was terminated at the first successful solution at which time the child was given the marble. If the child had not solved after thirty seconds, the first hint was given. The second hint was given at sixty seconds, and the third at ninety seconds. If the child had not solved after two minutes, the tester thanked the child and gave him/her the marble for trying.

The videotape of the posttest was coded noting three variables: whether the subject successfully solved the problem, the number of hints required, and the time to solution in seconds. Solution time was that which elapsed between the point at which the child was handed the weights and the point at which the marble rolled down the teeter-totter and struck the other end. For non solvers, the value entered for time to solution was 120 seconds.

Observation of Play, Treatments One and Two.

The child's play was videotaped for analysis. All videotapes were coded in the following manner. Using a stop watch and code sheet (Appendices A and B) the child's behaviors during play were classified as either on-task play, off-task play, or non-play. The first category included any play in which the teeter-totter was upright and the child was using at least three of the four toy items (two weights,

one marble, teeter-totter). Off task play included all other play with the toys, for example using the teeter-totter upside down or in some other position, and/or using fewer than three of the toy items. No attempt was made in coding the children's activities to separate exploratory behavior or fantasy play from other types of play. Non-play behavior was any behavior in which the child was not touching any of the toy items (e.g. looking around the room, going to the bathroom, rocking on his chair). As the coder watched the videotape, changes in behavior were noted on a time line as they occurred. The code sheets were used to determine the total length of the play period, and the total amount of time the subject spent engaging in each of the above behaviors (sample calculations are in Appendix B). The number of problem solutions performed during the play period was also coded. Two steps, in sequence, were required for problem solution. The child had to place the weights in the upper end of the teeter-totter and the marble had to roll from the other end, travelling the full length of the groove.

# CHAPTER FOUR

# RESULTS

## Qualitative Analysis

All subjects selected for the experiment completed the tasks as specified. No formal coding was done utilizing analysis such as Hutt (1971). Informal analysis of video tapes, however reveals that the bulk of the activity engaged in by the "play" groups was specific exploration, although some diversive exploration also occurred.

## Quantitative Analysis

Interrater reliability in coding of the children's activities during the play sessions and their performance on the posttest was determined by coding these sessions twice using a different coder each time. Table 6 contains the Pearson correlations on the various dependent variables. The coding of the experimenter was utilized for all analyses. The number of solvers in each treatment group is shown in Table 7. Means and standard deviations for group data on the other dependent variables are shown in Table 8.

The hypothesis that direct instruction would produce greater treatment effects than play was supported. The posttest performance of those participants who received direct instruction was such that no statistical analysis was required to determine its significance. All sixteen children solved the problem, required no hints in order to do

Table 6

Pearson correlation coefficients for interrater reliability - play groups

| | Play with Materials of the Task | Play with Experimental Plaything |
|---|---|---|
| Seconds of Treatment | .99 | .99 |
| On Task Play | .99 | .99 |
| Off Task Play | .98 | .92 |
| Off Task Behavior | .88 | .98 |
| Solve/not Solve | 1.00 | 1.00 |
| Time to Solution | .99 | .99 |

Table 7

Number of posttest solvers in each of four conditions

| | Play-Task Materials n = 16 | Play-Experimental Plaything n = 16 | Direct Instruction n = 16 | Control n = 16 |
|---|---|---|---|---|
| Number of Solvers | | | | |
| 0 hints | 3 | 1 | 16 | 2 |
| 1 hint | 1 | 0 | 0 | 2 |
| 2 hints | 0 | 0 | 0 | 1 |
| 3 hints | 5 | 9 | 0 | 8 |
| Total | 9 | 10 | 16 | 13 |

Table 8

Means and standard deviations for number of hints and time to solution in each of four conditions - all participants

| | | Play-Task Materials | Play-Experimental Plaything | Direct Instruction | Control |
|---|---|---|---|---|---|
| Number of hints | M | 2.75 | 3.19 | 0 | 2.5 |
| | S.D. | 1.57 | .98 | 0 | 1.32 |
| Time to Solution (sec.) | M | 93.69 | 102.06 | 7.0 | 85.0 |
| | S.D. | 42.61 | 26.34 | 1.59 | 35.87 |

so, and were able to achieve their solutions in a mean time of seven seconds (S. D. 1.6 seconds). In the group which played with the task materials, three children successfully solved the post test problem without hints, one child did so after one hint and five children were successful after three hints, for a total of nine solvers. The group which played with the experimental plaything produced a total of ten solvers, one after the first hint and nine after the third hint. In the control group, thirteen children solved the post test problem. Two children solved without any hints, two after one hint, one after two hints and eight after three hints. The mean time to solution for these three groups was vastly longer than that for the direct instruction group.

The hypothesis that play would improve performance on the problem solving task was not supported. When the two play groups and the control group were compared, no significant differences were found on any of the three dependent variables -- time to solution, number of hints required, or number of solvers per group (see Appendix E, tables 1, 2, and 3). The mean time to solution for the group which played with the task materials was 93.7 seconds (S. D. 42.6). Those who played with the experimental plaything solved in a mean time of 102.1 seconds (S. D. 26.3) while the control group mean was 85.0 seconds (S. D. 35.9).

The children who played with the experimental plaything were compared to those who played with the task materials on a number of

measures. The play of these groups was coded as reflected in Table 9. The other two treatment conditions were of course not included in this analysis because they did not play. The mean length of time spent in play by the two groups was 598.69 seconds (S. D. 459.73) for those playing with the task materials, and 628.12 seconds (S. D. 389.89) for those playing with the experimental plaything. This difference was not significant. Both sets of materials involved the children in comparably long play periods. There were, as well, no differences in the comparative mean lengths of time spent in on task play, off-task play, and non-play by the two groups. The relatively high standard deviations observed on all of the above measures resulted from the fact that the children decided, without any interference, how long they would play and what they would do as they played.

The direct instruction group mean treatment time was 79 seconds (S. D. 35 seconds). The instruction period for 14 subjects lasted between 57 and 76 seconds, with most of the variance contributed by two subjects who were instructed for 179 and 158 seconds. The direct instruction treatment was not only more effective in terms of all dependent measures, it was also much shorter.

As previously stated, the play behavior of the children was also coded in terms of the number of times each child solved the problem during play. The mean number of solutions during play for the group which played with the task materials was 2.44 (S. D. 4.43). One child, who played with the task materials for 11 seconds before

Table 9

Means and standard deviations of various qualitative measures during two play conditions in seconds

| | | Play-Task Materials | Play-Experimental Plaything |
|---|---|---|---|
| Total Treatment Time | M | 598.69 | 628.12 |
| | S.D. | 459.73 | 389.99 |
| On Task Play | M | 408.00 | 499.37 |
| | S.D. | 371.58 | 309.39 |
| Off Task Play | M | 172.81 | 107.31 |
| | S.D. | 254.07 | 96.10 |
| Non-Play | M | 17.87 | 20.81 |
| | S.D. | 29.83 | 41.15 |

solving the "posttest" problem, went on to repeat the problem solution fifteen more times in a play session which lasted a total of 658 seconds. When presented with the posttest, he solved in 9 seconds, requiring no hints to do so. The mean number of solutions during play (2.44), median number of solutions during play (.50), and the high standard deviation associated with it (4.43) reported for his group resulted from his unusually high level of response.

The children who played with the experimental plaything solved during play significantly less frequently (mean .25, median .115, S. D. .58). A one way analysis of variance, shown in Table 10, yielded a marginally significant effect. (See appendix E, tables 5, 6, and 7 for other comparisons between the two play groups.)

Pearson correlations were calculated on all variables for the two play groups (Tables 11 and 12). In the Play with Task Materials condition significant correlations were found, as one would logically expect, between the three components of the dependent variable (i.e. whether the participant solved the problem or not, the number of hints required, and the time to solution). Similarly, on-task play and off-task play correlated with the total treatment time. A significant correlation was also found between solutions during play and solve, not solve ($r = -.35$, $p = .089$). The negative direction of this correlation results from the fact that for this variable solvers were coded as one, and non solvers were coded as two. Significant correlations were also found between solutions during play and number

Table 10

One-way analysis of variance on solutions during play by condition (play with task materials and play with experimental plaything)

| Source | d.f. | SS | MS | F | p |
|---|---|---|---|---|---|
| Between Groups | 1 | 38.281 | 38.2813 | 3.842 | 0.06 |
| Within Groups | 30 | 298.9370 | 9.9646 | | |
| Total | 31 | 337.2180 | | | |

Table 11

Pearson correlations for all variables for play with task materials condition. (N = 16)

| | Solve-not Solve[+] | Number of Hints | Time to Solution | Seconds Treatment | Solutions During Play | On Task Play - A | Off Task Play - B | Off Task Behavior | Sum A+B | Ratio $\frac{A+B}{A}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| Solve-Not solve | | | | | | | | | | |
| Number of Hints | .72*** | | | | | | | | | |
| Time to Solution | .55** | .89*** | | | | | | | | |
| Seconds Treatment | -.21 | -.22 | -.06 | | | | | | | |
| Solutions During Play | -.35* | -.65*** | -.73*** | .18 | | | | | | |
| On Task Play - A | -.21 | -.21 | -.21 | .83*** | .28 | | | | | |
| Off Task Play - B | -.07 | -.05 | .24 | .55** | -.09 | .00 | | | | |
| Off Task Behavior | -.10 | -.26 | -.37* | .32 | .09 | .34* | -.03 | | | |
| Sum A+B | -.21 | -.20 | -.04 | .998*** | .18 | .82*** | .57** | .26 | | |
| Ratio $\frac{A+B}{A}$ | -.25 | -.18 | -.27 | -.24 | .21 | .26 | -.81*** | .01 | -.24 | |

*p < 0.10 **p < 0.05 ***p < 0.01 [+]Solve/not solve coded as 1/2 respectively

Table 12

Pearson correlations for all variables for play With experimental plaything condition. (N = 16)

| | Solve- not Solve [+] | Number of Hints | Time to Solution | Seconds Treatment | Solutions During Play | On Task Play - A | Off Task Play - B | Off Task Behavior | Sum A+B | Ratio $\frac{A+B}{A}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| Solve-Not solve | | | | | | | | | | |
| Number of Hints | .66*** | | | | | | | | | |
| Time to Solution | .44** | .95*** | | | | | | | | |
| Seconds Treatment | .09 | .02 | -.04 | | | | | | | |
| Solutions During Play | -.12 | .03 | .01 | .57*** | | | | | | |
| On Task Play - A | .04 | -.08 | -.14 | .98*** | .53** | | | | | |
| Off Task Play - B | .09 | .26 | .25 | .82*** | .55** | .71*** | | | | |
| Off Task Behavior | .36* | .29 | .19 | .20 | .13 | .07 | .16 | | | |
| Sum A+B | .05 | .00 | -.05 | .99*** | .57** | .98*** | .82*** | .10 | | |
| Ratio $\frac{A+B}{A}$ | .00 | -.30 | -.38* | -.15 | -.14 | .02 | -.63*** | -.16 | -.14 | |

*p < 0.10 **p < 0.05 ***p < 0.01 [+]Solve/not solve coded as 1/2 respectively

of hints ($r = -.65$, $p = .003$), and time to solution ($r = -.73$, $p = .001$). These data indicate that for those children who played with the task materials, the content of their play was related to their performance on the posttest.

In the Play with experimental Plaything condition, significant correlations were found between solutions during play and seconds of treatment ($r = .57$, $p = .01$), on-task play ($r = 653$, $p = .017$), off-task play ($r = .55$, $p = .013$) and between off-task play and on-task play ($r = .71$, $p = .001$).

The results of a one way analysis of variance on time to solution for all participants are reported in Appendix E, table 8. Appendix E, table 9 reports the same analysis for solvers only. This analysis was done to provide a more direct comparison of those participants who solved the problem.

# CHAPTER FIVE

## DISCUSSION

This study raises more questions about the results of prior studies than it provides answers. Other studies have claimed support for the hypothesis that play improves performance on a problem solving task. The results here reported do not support such a claim. Other authors have developed complex explanations of the mechanism by which learning is facilitated by play. In this case however, it would seem that the results require an explanation which focuses on the reasons for the lack of measurable treatment effects observed in the play groups.

The first step in the analysis however, is to answer the more basic question, "Were the children in this experiment playing?". Bijou's rather broad and somewhat circular definition of play as any activity of which the child, or an observing adult would say "He is playing" certainly permits inclusion of the activity of the children in the category play. The play they engaged in included any behaviors they themselves defined as appropriate, since they were told they could "play" with the materials for as long as they wished, and do anything they wished to do with them.

Even given the above, it could be claimed that the manipulative activity the children engaged in is more appropriately termed, as Berlyne and Hutt would have it, investigatory, specific, inspective

exploration. Considering the previously described characteristics of such behavior, the label fits well. Since Hutt refers to diversive exploration as synonymous with play, it could be claimed that these children were not playing at all. While this may seem a trivial argument, it becomes particularly relevant when one begins to theorize about the role of play in cognitive development. It is important that play be operationalized according to replicable criteria, and that when a given behavior is mapped into these criteria, it is done with care. The hypothesis tested here deals with learning and how it is facilitated. If specific exploration facilitates learning, while diversive exploration may even prevent it, the accurate labeling of the children's behavior becomes relevant. By Hutt's criteria, diversive exploration seems a less appropriate label in this case than specific exploration. There were within subject and across subject variations in the amount of time spent in each of these two types of behavior.

Would Piaget and Flavell describe what is so far labeled specific exploration as play? Behavioral specifications of assimilation and accommodation are very difficult, if not impossible to delineate. If play, by definition, is the predominance of assimilation, I think both authors would categorize the behaviors observed in this study as adaptive intelligence rather than play. It may however be important to analyze the two play treatments separately. In one group, the equipment the children played with promoted fantasy or pretend play.

As the children played with a miniature roadway, toy cars and a toy bus, they were involved in behaviors which are, according to Piaget, assimilative rather than accommodative. The experimental plaything is much closer to what they were accustomed to thinking of as a toy, although in both groups the equipment was referred to by the experimenter as a toy. Both groups did, however, involve themselves in specific exploration of the equipment, during which time, by definition, they were involved in an act of adaptive intelligence. One would therefore assume, particularly for the group playing with the less literal toys, that cognitive growth was occurring, facilitated by the exploration that occurred.

Was the play of these children educational or instructional, according to Gehlbach's (1980) classification? As the toys were designed with the express purpose that play with them would improve the children's ability to solve a problem, it can certainly be claimed that the play was educational. Opportunity to learn was provided. The results show, however, that it was not instructional, as the specific planned type and level of learning was not produced.

What was happening as the children played? Why were there no measurable treatment effects in the play groups? A number of explanations are suggested by the preceeding analysis.

The content of the play period was structured by the player and the materials. No further control was built in. It was therefore quite possible for the children to engage in activities which were

unrelated to the solution of the problem task. The play of each child was governed by factors such as the child's level of interest in playing with the materials, and other characteristics of the child on which considerable individual variability would be expected. Even if the child did play with the intention of attemping to solve the problem, s/he had opportunity to discover and practice unacceptable solutions. The rules which limited the acceptable solutions were stated only once -- and if these were ignored or forgotten in the play period, the child may have spent his/her time practicing unacceptable solutions. For example, the child may have spent the play period tipping the balance with the weight of his/her hand, or pushing the marble along the groove from one end to the other. Such practice would not have provided the child with feedback relevant to a problem solution using the wooden weights.

Play treatments in other studies have produced measurable effects. There are a number of differences between previous studies and the one reported here which may explain this discrepancy. Design changes, such as the inclusion of a pretest to eliminate from the sample children who could already solve the problem, add rigor to the experiment by eliminating one source of variance. The direct instruction treatment was similarly affected by the addition of an instructional component which enabled the student to give feedback and indicate his level of understanding to the instructor. In previous studies the instruction was much less direct (e.g. puppet shows

intended rather obliquely to demonstrate the principle required to solve the problem) and the student had no opportunity to show whether he had achieved a criterion level of understanding which would enable him to solve the problem.

Why did the direct instruction group do so well? The instructor exerted a degree of control which greatly exceeded that exerted by the set of materials. The instructor set the goals, determined a direct route to achieving them, and monitored the child's level of understanding. The problem solution was modelled for the child using a combination of verbal description accompanied by physical demonstration. The lesson focussed on the acceptable solution. No distracting or unrelated information was given. Instruction continued until the child could direct the teacher in the acceptable solution to the problem, that is, until criterion was reached. Once the child had demonstrated the ability to solve the problem, the posttest was administered. Such a sequence of events would surely be expected to produce efficient and accurate performance on the posttest.

The correlational data reported in chapter four do show evidence that play can effect performance. Specifically, those children who solved the problem while playing with the task materials were more likely to solve during the posttest, requiring less time and fewer hints to do so. It would seem then, that if the child's play can be directed in some way, there can be benefits. This was the intent of the experimental plaything. If toys can be designed to focus the

child's attention and to make salient the important principles which are prerequisite to problem solution, then play with such toys can be, theoretically at least, expected to improve performance. Varying amounts of adult structuring of the play would serve the same function. If the child is given suggestions or even rules about how the equipment can be used, specific questions to answer about the equipment, or other limitations, his activities could be controlled in an attempt to focus his attention on the intended learning outcomes.

## Implications for Further Research

This study calls into question the efficacy of play as an instructional activity -- particularly where specific learning outcomes are predicted by those charged with planning curriculum for and guiding the learning of young children. Further research is obviously needed. The fact that the content of the children's play did seem to effect their posttest performance suggests that future studies could attempt to channel or direct children's play activities by modifications in the environment, that is, in the playthings children are provided with, or in the adult direction given regarding the use of the playthings. Specifically, if the unstructured play engaged in by the children in this study is seen as the opposite end of a continuum which has direct instruction at the other pole, treatment conditions which would fall between these extremes would be of interest. Such conditions might include various combinations of increased structure

provided by the teacher in terms of a short lesson prior to the play experience or questioning or modelling procedures during the relevant data. Such treatments would, as well, have ecological validity in that they are common practice in kindergarten and preschool settings. Structure can of course be provided by changes in the playthings themselves. The experimental plaything used in this study was as effective as the materials of the task. More work is needed to examine the potential of playthings specifically designed to focus the child's attention and provide feedback which would promote the acquisition of relevant understandings and the achievement of specific learning objectives.

The methodological modifications made in this study with respect to prior studies in the pretesting procedure used to select participants, the identification of treatment conditions, the provision of direct instruction which continues until a specified criterion behavior is achieved, and the inclusion of a control group are seen as improvements upon previous studies. It is therefore suggested that future studies incorporate such modifications.

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## Appendices

A. Sample Code Sheet - Group 1

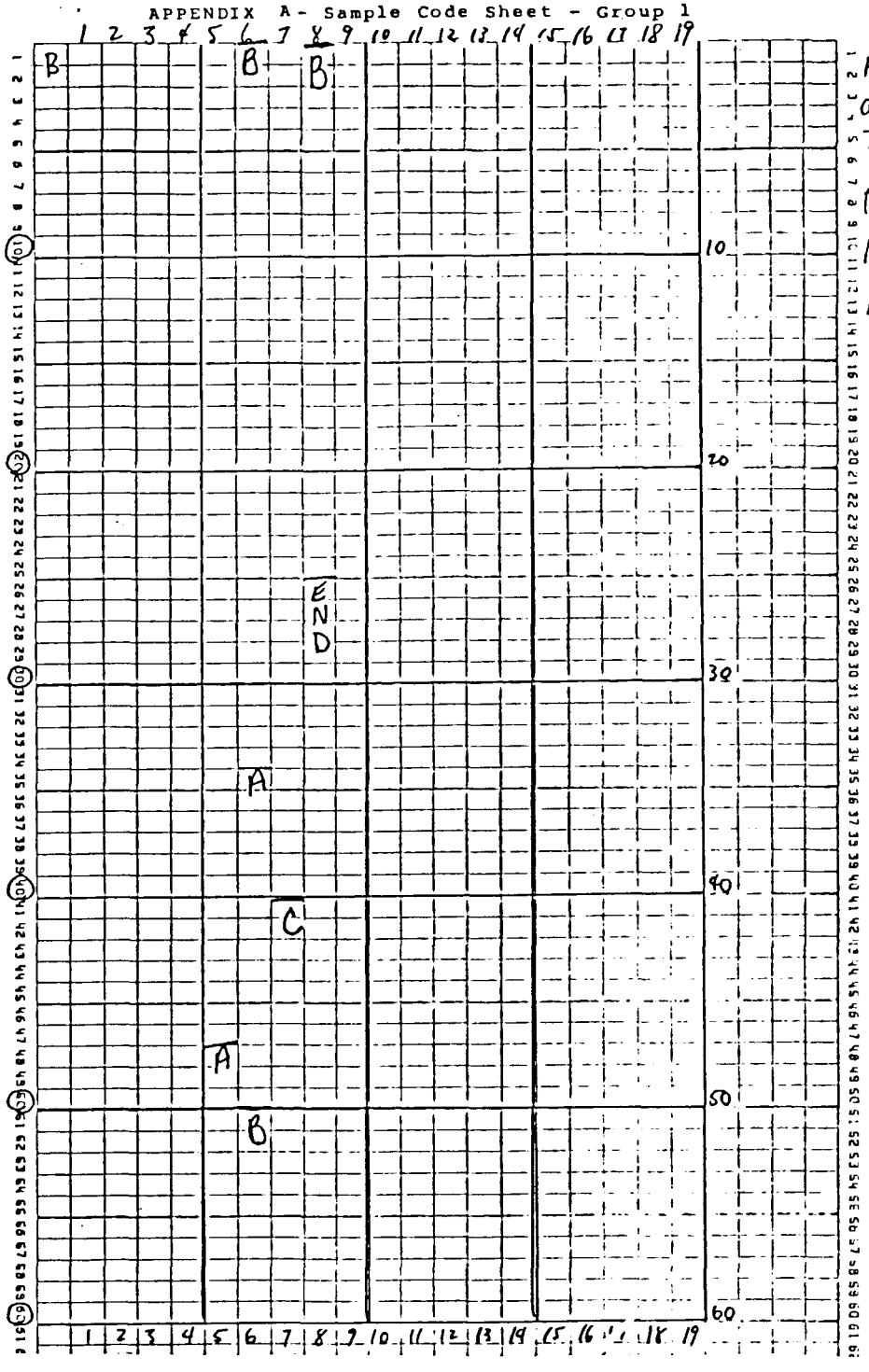
B. Sample Calculations from Code Sheet - Group 1

C. Sample Code Sheet - Group 2

D. Sample Calculations from Code Sheet - Group 2

E. ANOVA Tables

APPENDIX A - Sample Code Sheet - Group 1




Subject # 50 (131) M

Date videotaped August 8 coded August 19

Condition 1 time totals

Time to Solution nonsolver A = 29 seconds

# of solutions during play 0 B = 456 seconds

C = 20 seconds

total = 505 seconds

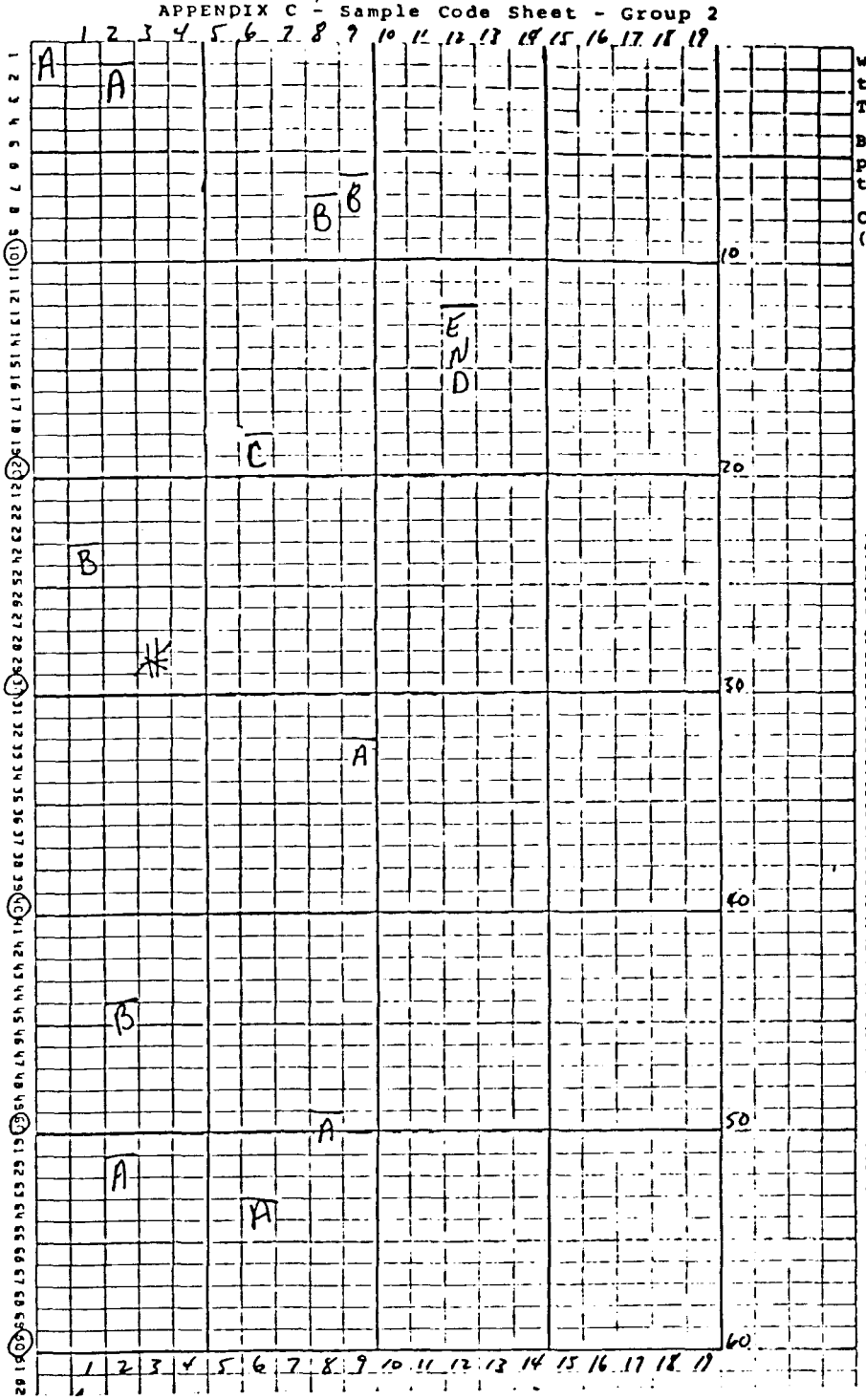
# Appendix B

## Sample Calculation from Code Sheet

| | | |
|---|---|---|
| Subject 50 | A = | 13 seconds |
| | | 16 seconds |
| | | 29 seconds |
| | B = | 347 seconds |
| | | 34 seconds |
| | | 50 seconds |
| | | 25 seconds |
| | | 456 seconds |
| | C = | 20 seconds |

Total = 505 seconds

APPENDIX C - Sample Code Sheet - Group 2




Subject # 28 (F) (072)

Date videotaped July 31 coded August 25

Condition 2

Time to Solution 1' 41.07"

Solutions during play 1

time totals

A = 584 seconds

B = 112 seconds

C = 35 seconds

total = 731 seconds

# Appendix D

## Sample Calculation from Code Sheet

Subject 28

A = 83 seconds
43 seconds
207 seconds
74 seconds
17 seconds
160 seconds

584 seconds

B = 37 seconds
7 seconds
42 seconds
26 seconds

112 seconds

C = 35 seconds

Total = 731 seconds

APPENDIX E - Table 1

One-way Analysis of Variance on Solve/Not Solve for Three Treatment Conditions (Play with Task Materials, Play with Experimental Plaything, and Control)

| Source | d.f. | SS | MS | F | p |
|---|---|---|---|---|---|
| Between Groups | 2 | 0.5417 | 0.2708 | 1.204 | 0.3095 |
| Within Groups | 45 | 10.1250 | 0.2250 | | |
| Total | 47 | 10.6667 | | | |

APPENDIX E - Table 2

One-way Analysis of Variance on Number of Hints for Three Treatment Conditions (Play with Task Materials, Play with Experimental Plaything, and Control)

| Source | d.f. | SS | MS | F | p |
|---|---|---|---|---|---|
| Between Groups | 2 | 3.8750 | 1.9375 | 1.126 | 0.3333 |
| Within Groups | 45 | 77.4374 | 1.7208 | | |
| Total | 47 | 81.3124 | | | |

APPENDIX E - Table 3

One-way Analysis of Variance on Time to Solution for Three Treatment Conditions (Play with Task Materials, Play with Experimental Plaything, and Control)

| Source | d.f. | SS | MS | F | p |
|---|---|---|---|---|---|
| Between Groups | 2 | 2329.3145 | 1164.6572 | 0.920 | 0.4057 |
| Within Groups | 45 | 56944.3164 | 1265.4292 | | |
| Total | 47 | 59273.6289 | | | |

APPENDIX E - Table 4

One-way Analysis of Variance on Seconds of Treatment for Three Treatment Conditions (Play with Task Materials, Play with Experimental Plaything, and Control)

| Source | d.f. | SS | MS | F | p |
|---|---|---|---|---|---|
| Between Groups | 2 | 110230.8276 | 55115.4102 | 0.455 | 0.6374 |
| Within Groups | 45 | 5451608.0000 | 121146.8125 | | |
| Total | 47 | 5561838.0000 | | | |

APPENDIX E - Table 5

One-way Analysis of Variance on On Task Play for Two Treatment Conditions (Play with Task Materials, and Play with Experimental Plaything)

| Source | d.f. | SS | MS | F | p |
|---|---|---|---|---|---|
| Between Groups | 1 | 66795.1250 | 66795.1250 | 0.571 | 0.4566 |
| Within Groups | 30 | 3506991.0000 | 116899.9875 | | |
| Total | 31 | 3573786.0000 | | | |

APPENDIX E - Table 6

One-way Analysis of Variance on Off Task Play for Two Treatment Conditions (Play with Task Materials, and Play with Experimental Plaything)

| Source | d.f. | SS | MS | F | p |
|---|---|---|---|---|---|
| Between Groups | 1 | 34322.0000 | 34322.0000 | 0.930 | 0.3425 |
| Within Groups | 30 | 1106825.4375 | 36894.1797 | | |
| Total | 31 | 1141147.0000 | | | |

APPENDIX E - Table 7

One-way Analysis of Variance on Off Task Behavior for Two Treatment Conditions (Play with Task Materials, and Play with Experimental Plaything)

| Source | d.f. | SS | MS | F | p |
|---|---|---|---|---|---|
| Between Groups | 1 | 69.0313 | 69.0313 | 0.053 | 0.8187 |
| Within Groups | 30 | 38748.1484 | 1291.6047 | | |
| Total | 31 | 38817.1797 | | | |

APPENDIX E - Table 8

One-way Analysis of Variance on Time to Solution for All Four Conditions - All Subjects

| Source | d.f. | SS | MS | F | p |
|---|---|---|---|---|---|
| Between Groups | 3 | 92289.3750 | 30763.1250 | 32.392 | <0.01 |
| Within Groups | 60 | 56982.3163 | 949.7051 | | |
| Total | 63 | 149271.6875 | | | |