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THE ROLE OF PHYSICAL STRUCTURE IN THE CONTROL OF SOCIAL CONTINGENCIES TO PRODUCE PROSOCIAL BEHAVIOUR IN A PLAY SETTING

by

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ABSTRACT

The purpose of this study was to test two hypotheses. The first hypothesis was that changes in physical features of a play environment that altered the structure of social contingencies between players would produce measurable effects on social behaviour. The rationale for this hypothesis was first, that social behaviour is learned in the same way that any other behaviour is learned and second, that there is an interaction between a player and the play environment, including playthings and other players, such that the feedback from that environment exerts at least partial control over the behaviours occurring in the player-environment interaction (Gehlbach, in press). Third, even in free play-- that is, without adult intervention-- behaviour can be effectively modified if the design of the plaything provides consistent contingencies of reinforcement for that behaviour.

The second hypothesis was that behaviour can be modified effectively with respect to a target behaviour, even when a competing non-target behaviour is reinforced.. One of the basic conventions in both pure and applied research in behavioural psychology is that continuous reinforcement schedules are utilized in the early, or acquisition, phase of attempts to systematically modify behaviour. Such schedules have two characteristics: 1) the target behaviour is reinforced upon every operant performance; and 2) competing non-target behaviours are never reinforced. In naturalistic settings, however,

learners are frequently reinforced for a variety of responses to a stimulus configuration. Nevertheless, certain responses typically emerge as dominant. This study tested the hypothesis that the frequency of a target behaviour could be increased simply by reinforcing it more powerfully than competing, non-target behaviours.

The first hypothesis was joined with the second hypothesis in the design of a sand-play machine which could be modified to structure the contingencies of reinforcement for social behaviours in three different ways: 1) in the baseline condition prosocial and nonsocial behaviours were reinforced equally; 2) in the second, or "hard-contingency" condition interaction with the machine was only possible if prosocial behaviour occurred, therefore only prosocial behaviour was reinforced; and 3) in the third, or "soft-contingency" condition both nonsocial and prosocial behaviours were reinforced, but reinforcement of prosocial behaviour was delivered more powerfully.

A single-case, analysis-of-variance design with two replications was employed, with conditions randomly assigned over time. Player dyads were used as the principal unit for data analysis. Subjects were six five-year old boys. The experiment was conducted over 9 weeks, with conditions randomly distributed within 3-week units of time. The following dependent variables were measured and subjected to analysis: 1) filling sand into one's own part of the machine; 2) filling sand into the partner's part of the machine; 3) cranking the machine; 4) requesting a fill from a partner; and 5) verbal contracting for mutual fills.

Results indicated that changes in those physical features of the play environment that alter the structure of social contingencies between players produce measurable effects on social behaviour. Results also indicated that the frequency of occurrences of a target behaviour can be increased, even when both non-target and target behaviours are reinforced, if the reinforcement of the target behaviour is the more powerful.

The behavioural results of interactions with the sand machine provide evidence that playthings can be designed to produce a specific target behaviour. The major implication for such evidence is that to the degree that instructional play produces target behaviours, a teacher is freed to concentrate on other objectives not met by instructional play.

To Roger Gehlbach, who guaranteed exposure par excellence, an abundance of practice, and very reinforcing feedback for research and writing behaviours; to Ron Marx and George Ivany, who brought different perspectives, each from his own area of expertise; to Susan Hargraves and Paddy McGrath, who assisted with testing and coding, and to my husband, Bruce, for his unflagging support and encouragement.

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CHAPTER 1

Statement of the Problem and Review of the Literature

The value of social skills in personality development has been addressed by many educators, social learning theorists, developmental psychologists and therapists (e.g., Bandura, 1977; Harris, Wolf and Baer, 1964; Harlow, 1969; Kohlberg, 1968). O'Connor (1969) lists several reasons for attention to social instruction.

> First, a child who is grossly deficient in social skills will be seriously handicapped in acquiring many of the complex behavioural repertoires necessary for effective social functioning. Second, children who are unable to relate skillfully to others are likely to experience rejection, harassment, and generally hostile treatment from peers. Such negative experiences would be expected to reinforce interpersonal avoidance responses which, in turn, further impede the development of competencies that are socially mediated (p. 15).

Much of a child's social interaction occurs during impromptu free play, or more accurately, during free social play. The cause-and-effect relationship between social play and social skills is not known. On the one hand, social play may enhance social skills. Clearly, the behaviour of the play partner has an effect on the social behaviour of the player. What is not so clear, however, is the role of the playthings themselves.

The purpose of this study is to examine that role, and to explore the possibility of designing playthings which, without adult intervention, will affect social behaviour during play.

The two major areas of theory and research that will be addressed are learning and play. Studies comparing social behaviour in different age groups suggest that social skills are learned, but they do not satisfactorily address how that learning occurs. For example, Bar-Tal (1976) reports several studies which confirm the fact that "prosocial" behaviours such as giving, helping and sharing steadily increase during the first ten years of life (Eckerman, Wheatley and Katz, 1975; Green and Schneider, 1974; Hanlon and Gross, 1959; Langlois et al, 1978; Urugel-Semin, 1952). Bar-Tal cites these studies as "proof" that prosocial behaviour is learned, but provides no theories for, or evidence of, the actual learning process. Throughout the following discussion, the term "prosocial" will be understood in the way Bar-Tal (1976) employs it, as behaviour that is at the opposite end of a continuum from antisocial behaviour. In the present study, traditional behavioural theory will provide the framework for a general discussion of learning in general, and of the learning of prosocial skills in a play setting in particular. Existing theory and research on play will be discussed and evaluated in an effort to distinguish those variables in the structure of playthings that have a predictable effect on the initiation and maintenance of specific player behaviours.

Learning

According to behavioural theory (Bijou, 1976; Skinner, 1974) a learned behaviour is a behaviour which occurs as a result of an organism's experience with the environment, wherein a consistent relationship is established between a stimulus (S_d) and a response (R). That relationship is established as a result of the presentation of a subsequent reinforcing stimulus (S_r), contingent on that response to the first stimulus event. Following reinforcement, the response is more likely to occur than other non-reinforced responses to the same stimulus.

In the normal course of events, it is often the case that a stimulus, an operant response and a contingent reinforcement are not a discrete set of events. Instead, they are a part of a contingency network, which may be defined as a set of contingencies with common elements such as shown in Figure 1.

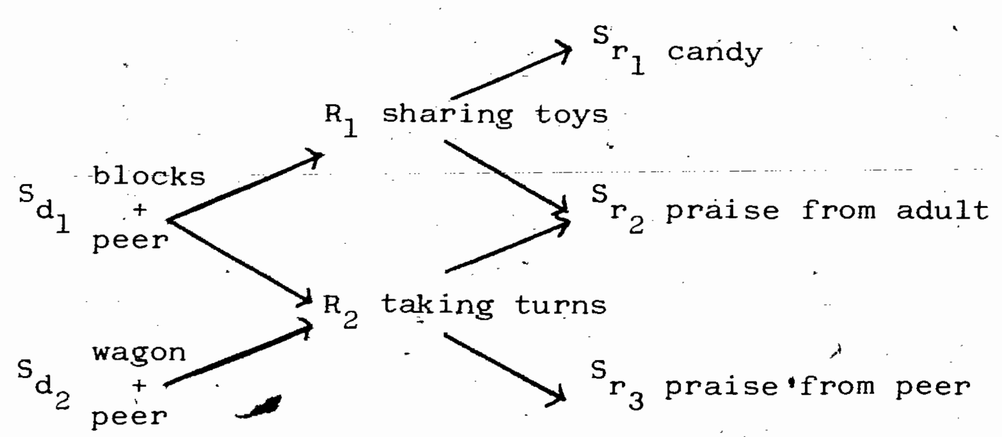


Figure 1. Example of a Contingency Network

Note: Arrows indicate direction of occurrence over time.

For example, praise from an adult (S_{r_2}) may reinforce both taking turns (R_2) and sharing toys (R_1). Also, either a social reward such as praise (S_{r_2}) or a material reward such as candy

(S_{r_1}), if contingent on sharing behaviour (R_1), may be an effective reinforcement stimulus for sharing behaviour. In this example, the discriminative stimulus (S_d) might be a composite of a set of blocks and the presence of a peer (S_{d_1}) or the peer and a wagon (S_{d_2}). The reinforcement may be dispensed either by an attending adult, or by the peer who is the recipient.

The importance of traditional contingency analysis for the present study is in its application to prosocial play behaviour. According to behavioural theory, if specific prosocial behaviours are to be produced through play, it is necessary to provide: 1) stimuli which prompt the target operant behaviour, 2) reinforcing stimuli in the play environment, and 3) a contingency network which relates the reinforcing stimuli systematically to the target, or prosocial behaviour.

Behaviour modification. When a reinforcing stimulus and a schedule of reinforcement are deliberately planned and provided for the purpose of altering a subject's behaviour, the procedure is called behaviour modification (Ullman and Krasner, 1965). Behavioural theory has been successfully applied in the modification of human behaviour for over 50 years (Agras, 1972; Bandura, 1969; Ferster and Skinner, 1959; Mikulas, 1972; Ross, 1975; Schwitzgebel and Kolb, 1974; Ullman and Krasner, 1965).

Bijou (1976) defines behaviour modification as, "the application of behavioural concepts and laws to the practical problems of education, therapy...(and) child rearing practices" (p. 193). In education, the common practice is to identify certain goals, such as reading skills, and then to arrange contingencies of reinforcement around those goals. In therapy, an existing maladaptive behaviour such as selfishness or extreme egocentricity is modified or changed to meet a criterion behaviour, using the same basic principles of contingent reinforcement. According to the theory of behavioural analysis, there are two possible reasons for the prevalence of a maladaptive behaviour such as antisocial behaviour: 1) antisocial behaviour may have been previously learned as a result of reinforcement of antisocial responses; and/or 2) the alternative behaviour of prosocial responses may not have been learned--that is, there may have been insufficient reinforcement of prior prosocial behaviour. Consequently, the application of behaviour modification principles for the purpose of altering social behaviour may combine both educational and therapeutic procedures. Treatment may take the form of extinguishing an existing behaviour by removing the reinforcement of it, by reinforcing behaviour which is incompatible with an already learned antisocial behaviour, or by reinforcing a totally new prosocial behaviour.

The positive results of contingent reinforcement have been well documented in regard to the development of prosocial behaviour in young children (e.g., Ullman and Krasner, 1965). However, there are serious problems and limitations when that reinforcement must come from personal intervention. One problem in applying behaviour modification procedures in ordinary school settings is that they require either high levels of training in teachers, or the use of trained therapists, lest the implementation be subject to high levels of teacher error. The detection of minute changes in behaviour, essential to behaviour modification, is extremely difficult when a teacher is attending to 25 or 30 children. Therefore, opportunities may be missed or non-target behaviours may be inadvertently reinforced. An additional problem is that behaviour modification is often opposed on ideological grounds. Many educators perceive extrinsic reinforcers as bribes. Some argue that children are being "manipulated" (Bersen, Eisler and Miller, 1976). Whether opposition to behaviour modification can be supported or not, the fact remains that many educators choose not to use rigorous behaviour modification procedures, and some others, who do use behaviour modification programs are not as rigorous as necessary. In the classroom, therefore, effective use of behaviour modification procedures is limited. In the absence of reinforcement which is dispensed by another person, such as a teacher or therapist, the only other sources of reinforcement are peers or the physical environment.

<u>Natural learning</u>. The fundamental characteristic of learning in a natural setting is that much of the learning is not <u>deliberately</u> effected by planned or systematic human intervention. Both the information and the reinforcement may be provided by a person other than the learner, or by the stimulus object itself, but not with a behavioural objective in mind. For example, in a child's interaction with a ball, the ball, if dropped, may bounce. The response of the ball may reinforce the

child's behaviour. That is, the bouncing of the ball (S_r) may predictably increase the likelihood of ball-dropping behaviour (R) in response to the stimulus of a ball (S_d). The important feature of this example is that it is the behaviour of the ball, rather than the action of another person, which reinforces. If the physical properties of the ball and environment remain constant, the reinforcement is contingent on the specific operant behaviour of releasing the ball from some point above a surface. The ball will bounce if, and only if, the releasing behaviour occurs. However, the ball responds not "in order to" change the child's behaviour, but by virtue of its own physical properties in relation to the physical properties of the surrounding environment (e.g., a hard as opposed to a soft surface) and the behaviour of the child.

Although behavioural theory explains some learning which occurs in natural settings, there is also much learning in natural settings which is not explained by conventional behavioural theory. In natural settings, it is often the case that both target behaviours and non-target behaviours are reinforced. Nevertheless, the target behaviour ultimately and predominantly occurs. For example, a child may open containers and be reinforced by immediate acquisition of the contents. However, the child might also acquire the contents as a result of crying for help. Both behaviours may be reinforced, yet the child ultimately tends to open containers without conventional aid.

Behavioural theory does not adequately explain this latter phenomenon. It accounts for the bouncing ball example, but does not attend to examples such as that of learning to open containers. The reason for this is that virtually all theoretical accounts of the initial acquisition of behaviours presume continuous reinforcement of target behaviours (Ferster and Skinner, 1957). Such a schedule rarely occurs in natural learning environments. Gehlbach (note 1) refers to continuous reinforcement networks as "hard-contingency networks", since reinforcers are delivered if, and only if, the target behaviour is performed. In the container-opening example, reinforcement does not occur if, and only if the child opens the container, therefore the dependency is not a hard-contingency network. Nevertheless, container-opening emerges as the predominant behaviour. On the other hand, when reinforcement is not contingent on the occurrence of a target behaviour-- that is, when both target and non-target behaviours are reinforced, one might infer from behavioural theory that learning of the one behaviour is as likely as learning of the other behaviour. In the previous example, therefore, there should be no predictability of container-opening behaviour on the part of the child-- that is, if acquisition of the contents occurs both in response to crying and to opening by the child, opening behaviour should be no more likely than crying behaviour when the child is subsequently faced with containers. Gehlbach (note 1) suggests a third contingency network which might explain learning that occurs when (a) both target and incompatible non-target behaviours are reinforced, but (b) the target behaviour emerges as dominant. He labels it a "soft-contingency network".

The hypothesis of a soft-contingency network is a departure from classical behavioural theory. Behavioural theory attends only to the occurrence or non-occurrence of reinforcement in relation to a target behaviour, rather than to a possible change in the quality or quantity of that reinforcement in relation to the target behaviour and other behaviours. In a soft-contingency network, according to Gehlbach, it is the level or strength of the reinforcement which is differentiated in the environment and hence responsible for the emergence of a dominant response. As in the case of container opening previously described, some degree of the same form of reinforcement (i.e., acquisition of contents) may occur for both target and non-target behaviours, but the reinforcement for the target behaviour must in some way be more powerful for container-opening behaviour, if unassisted container opening usually emerges as the predictable response. The fact that learning of the target behaviour predictably occurs suggests that the result of the target behaviour is in some way more reinforcing to the behaving organism than is the result of the non-target behaviour. For example, contents-acquisition may occur sooner, or more frequently, in response to opening behaviour than in response to crying behaviour.

The adult is often an important part of a naturally-occurring soft-contingency network, since it is the adult who reinforces much of the non-target behaviour (e.g., the adult opens the container when the child cries). Typically, or at least frequently, the adult does not deliver the reinforcer as fast or as powerfully as the container itself if the appropriate opening behaviour is performed. While the adult delivers reinforcement for the crying behaviour, and the container itself delivers the reinforcement for the child's opening behaviour, the learning occurs naturally, in that neither reinforcement is delivered for the purpose of effecting opening behaviour.

In a hard-contingency network, learning of a target behaviour is predictable, provided that shaping is used if that behaviour is of low frequency, or is very complex. A problem arises when a hard-contingency network exists in a natural setting such as a play environment in which no adult is providing reinforcement. In such a setting, if the child has virtually no previous learning in the target behaviour, there is little likelihood that the target behaviour will occur. Therefore, with a hard-contingency network, there is little opportunity for the behaviour to be reinforced and consequently learned in a natural setting. It is possible that the child will cease to interact with the natural stimulus since the behaviour he is capable of performing is not reinforced. Alternatively, the child may interact with the stimulus in a way that is unrelated to the target behaviour. For example, a "fireman's pole" is frequently provided as a climbing apparatus in a play setting for the purpose of strengthening upper torso muscles. Unless some other person is available to provide social reinforcement or "shaping" procedures, a child who has not yet developed the appropriate physical strength and skill to ascend the pole is likely to use some other available route of ascent, such as a ladder. The child may not interact at all with the pole, or may use it only for descent, or for swinging around at ground level. Neither lack of interaction, nor alternative behaviours, will provide opportunity for reinforcement of pole-climbing.

Gehlbach (in press) hypothesizes a possible alternative. He suggests that for any given target behaviour, if a soft-contingency network exists by virtue of the physical structure of the natural setting, learning will predictably occur with little or no adult intervention. For example, the pole and ladder may be constructed in such a way that the ladder assists pole climbing for the unskilled, but is unnecessary for the skilled. If reaching the top unassisted, and via the pole, is a reinforcer, the unskilled child is not penalized by no reinforcement, as in the hard-contingency network. Instead, he is reinforced to the degree that he can ascend unassisted. Alternately, unlike a no-contingency network, the child is not equally reinforced for ladder-climbing and pole-climbing if unassisted pole-climbing is the child's goal. The important feature is that the adult is required only to make the environment accessible to the child. The physical structure of the environment, in conjunction with prior learner experience (e.g., ladder-climbing) guarantees the original practice of the target behaviour. The feedback of a reinforcer which is more powerful for target behaviour than for non-target behaviour is also inherent in the structure of the environment, and dependent on the child's goal, rather than being superimposed by another person.

One further point should be noted. In a play setting which is provided by an adult, the adult's goal, or reason for provision, is usually different from the child's goal. In the case of the climbing pole, the adult's goal is the child's physical development, whereas the child's goal may simply be ascent to a higher level. Similarly, the adult's goal in the provision of variously shaped building blocks may be the development of small-muscle control and balancing skill. The child's goal, on the other hand, may be the construction of a high tower. While use of the smaller, disparate shapes may be more effective in achieving the adult's goal of balancing skill, the child's goal (the tower) may be achieved solely with the large, flat, easily-balanced blocks. Without adult intervention, it is the physical structure of the blocks themselves which determines whether practice with, and reinforcement of balancing skill will occur. Therefore, if relatively fewer large flat blocks are provided, the child's achievement of a high tower will reinforce the use of the smaller disparate shapes, thus reinforcing practice of balancing behaviour.

Play

Beyond the serious activities necessary to everyday existence, most of a child's interactions in a natural setting are referred to as play (Dearden, 1967). Play is commonly considered to be voluntary (Garvey, 1977; Goldberg, Godfrey and

Lewis, 1967; Kleiber and Barnett, 1979; Sutton-Smith, 1971). Except for cases of games which are rule-governed or socially ritualized, specific actions within the play are not prescribed for the child by others. Play may be instigated by suggestion, modeling, or provision of a specific plaything or environment. However, adult intervention in a child's play activity is usually limited to negative control for factors such as safety, noise or convenience. Goldberg, Godfrey and Lewis (1967) describe play as "free emission of responses such that choice or response and rate of emission are determined solely by the organism" (p. 188). What Goldberg et al do not address is the role of the behaviour of the playthings in determining the player's response. In a play setting, the reinforcement or contingency network most often resides in the relationship between the child and the objects in the environment. The natural learning which occurs in play may be defined as the change in behaviour resulting from that interaction. In order to examine this learning more fully, it will be helpful to examine the existing literature regarding the structure and function of play behaviour.

The structure of play. "Play is a recognizable phenomenon, yet it has proven difficult to develop a comprehensive definition that is applicable to even the relatively few mammalian species in which some form of play has been described" (Bekoff and Byers, in press). There are certain behaviour complexes which obviously "further the serious business of life" (Dearden, 1967).

Such behaviours, which have "immediate functional consequences" such as eating, sleeping, acts of aggression, grooming or mating, are referred to as non-play (Fagen, 1974). Many other behaviours appear, at least, to be non-serious, or without function. The term often applied to these behaviours is "play". This apparent lack of function is one of the few characteristics of play that is generally accepted (Beckoff and Byers, in press; Dearden, 1967; Ellis, 1970; Fagen, 1974; Garvey, 1977; Herron and Sutton-Smith, 1971; Vandenberg, 1978).

Hutt (1970) characterizes object play as being different from investigation, drawing on Berlyne's (1966) distinction between "specific" and "diversive" exploration. According to Hutt, in play there are: 1) desynchrony, or only transient synchrony of receptors; 2) a relaxed facial expression; and 3) a variable and idiosyncratic sequence of essentially brief elements. Hutt claims that play is never manifest in the presence of novel stimuli. The implicit play query is, "What can I do with this object?" When the stimulus is novel, however, the activity is exploration, and the investigative query is, "What can this object do?" Weisler and McCall (1976) argue that exploration and play cannot be easily distinguished in an ongoing stream of behaviour. They cite examples of play which seem to involve moderate amounts of excitement and tension, and play which represents novel situations. Both types of examples run counter to Hutt's definition of play. The practicality of trying to distinguish exploration from play seems limited in its application to a study of a child's activity which is commonly referred to, and generally appears to be, play. It is a little like arguing whether an object is purple-blue, or green-blue, when the necessary distinction is between blue and orange.

Like Hutt (1970) and Berlyne (1966), Piaget (1970) also makes a distinction between exploration and play. In exploratory behaviour, according to Piaget, the child "accommodates", or adapts existing cognitive schema to fit the existing features of the external environment. In play, on the other hand, the child "assimilates", or incorporates information about the external stimulus into the existing schema (Campbell, 1976; Piaget, 1970). Piaget (1970) says, "Play...in its two essential forms of sensori-motor exercise and symbolism, is an assimilation of reality into activity proper...and transforming reality in accordance with the self's complex of needs" (p. 157).

Piaget also suggests a temporal relationship with exploration preceding play, but with no clearly distinguishable boundaries. For example, a child newly exposed to sand explores the properties and behaviour of the sand. Once this information becomes a part of the existing schema, subsequent interaction with sand is called play. According to Piaget's theory, in play the interaction reiterates, or supports the child's existing schema in regard to the sand, but does not substantially alter that schema. However, if behaviour with the sand has an unexpected result which does not fit the existing schema, accommodation may again occur. That is, the child may incorporate the new information, thereby changing or modifying the schema.

According to Piaget, if this occurs, the action is no longer play.

One problem with Piaget's differentiation of exploration and play is that it does not distinguish assimilation or accommodation in play from assimilation or accommodation in non-play, or activities in a "serious" context, such as practicing an already-acquired skill, or learning a new skill, either of which is necessary for survival. An even more important problem, from the standpoint of research, is that assimilation and accommodation (i.e., play and exploration) are differentiated by the occurrence or non-occurrence of change in the existing schema. That change, however, can only be inferred from a change in physical behaviour, or from a verbal expression of new knowledge such as a statement of fact, or cause and effect. Given this problem, the distinction will not be utilized in the present study.

It is not possible to devise operational definitions for play and non-play behaviours on the basis of behavioural criteria. Frequently, the topography of two behaviours is identical, yet one is considered to be play, and the other is not. For example, Andres Segovia may be playing the guitar purely for pleasure ("play") or for remuneration ("work") or specific practice which will eventually result in that remuneration. In order to distinguish between the behaviours, one would either have to know that payment did or did not occur, or be told by Segovia whether the guitar-playing was "play" or not.

A relatively broad definition would designate play as any activity which is called play by the player, or anyone else (Bijou, 1976). For purposes of research, Bijou's definition is useful, so long as it is constrained by the characteristics discussed earlier: 1) it must be voluntary (Garvey, 1977; Sutton-Smith, 1972) and 2) it must be "non-serious" (Dearden, 1967). Two other typical characteristics of play are noted by Gehlbach (1975). Play appears to be self-centered, with the pace and style established and maintained by the player. Play also appears to be purposive from the standpoint of the player, and referenced to either product objectives or process objectives which are determined by the player. Gehlbach (in press) suggests that in behavioural terms, all four of the constraining characteristics may be negatively specified. A behaviour may be voluntary (e.g., eating) or non-serious (e.g., going for a walk) and still be non-play. However, to be classified as play, there must be an observable absence of essentialness, and directives, and an absence of control of the behaviour by another person. These negatively-specified characteristics, with Bijou's more general description, will be used as the definition of play in the remainder of this study, with one further constraint. Since the purpose of the study is to examine the role of the contingency network inherent in the physical structure of playthings, all further discussion of play will be confined to object play, as separate from rule-governed games or role-taking.

The proliferation of studies on play is exemplified in a book by Herron and Sutton-Smith (1971) which includes more than

700 citations. In spite of this proliferation, most of what has been written is simply narrative, quasi-theoretical and non-empirical. Only a few tests concerning play have been either rigorous or quantitative, and many of these have been conducted with non-human subjects.

An important feature of the study of infrahuman play is that, for the most part, it is confined to observable and measurable behaviour (e.g., Hill and Bekoff, 1977). Like the behaviourist who studies humans, the animal ethologist avoids mentalistic terms and assumptions. Use of words such as "needs," "desires" or "feels" (in the non-tactile sense) are convenient in general conversation or discussion, but have little value for an empirical study of human behaviour. Existence of such conditions must either be inferred from observed behaviour, or self-reported. Self-report may be inaccurate or, in the case of animals and very young children, impossible to obtain.

Structural definitions of play behaviour are useful as descriptors in comparative studies of play among species. However, they do not address the causes of play or the results of play. Furthermore, structural descriptions provide no information as to how one might approach the problem of changing a child's play behaviour if that change is desired. A more useful approach is to examine the existing literature which is concerned with the function of play.

The function of play. A study of the ultimate function of play, as opposed to the immediate cause, addresses the evolutionary selection of behaviour. Although play appears to be functionless-- that is, it has no apparent "serious" consequences, numerous theories have evolved as to the reason for its survival as a behaviour complex common to many species. Bijou (1976) cites four of them: 1) the surplus energy theory postulates that children play because they are so full of pent-up muscle energy that they must be active; 2) according to recapitulation theory, through play we reinact the history of the race; 3) the catharsis theory describes play as a safety valve for pent-up emotions; and 4) the hedonist view is that play is engaged in purely for the enjoyment it gives.

Another theory which has received considerable attention, particularly in recent years, is the "practice" theory. As early as 1896, Groos proposed that play activities were a preparation for adult performance. Fagen (1974, 1976) describes play as a facilitation of a learning mechanism. However, he admits that empirical evidence is hard to find. Ethologists suggest that play and more specifically, social play, is an environmentally stable strategy which has increased in frequency because of its survival value for some species (Bekoff, 1978; Dawkins, 1976; Wilson, 1975). While this may be a viable theory for the ultimate function of social play, it has the same practical limitation as similar theory related to play in general.

There is a major difficulty in proving any theory regarding the ultimate function of play. For example, in order to establish that play is essential to some ultimate behaviour, or physical or emotional well-being, it is necessary to compare organisms of the same species that have, and have not played. This method is possible, to a degree, with laboratory animals. With children, however, there are ethical and practical problems for any study which proposes to withhold opportunities for play in a controlled experiment. On the other hand, studies which attempt to evaluate children who have had no play opportunity in their natural environment are confounded by other variables such as health, nutrition and adult attention.

Sylva, Bruner and Genova (1974) suggest that play provides a non-threatening setting for the practice of skills. Play minimizes the risk of adverse consequences which would result from failure in non-play activities which it simulates. The end product of play is not crucial, so that learning can occur in a less risky situation. This theory addresses a possible value for play, but does not suffice to explain why children play, since much learning does occur in non-play settings. The task in Sylva, Bruner and Genova's study was to fish a prize from a latched box which was out of reach. To do so, the children had to extend a pair of sticks by means of a clamp. Children age three to five who were simply allowed to play with the sticks and clamps did as well as children who had been given a demonstration of the principle of clamping sticks together. They did as well as groups that practiced fastening a clamp to a single stick, or who watched the experimenter carry out the task. This study is often cited as evidence that play furthers cognitive development in that it provides knowledge of the properties and possible functions of physical objects (e.g., Bekoff and Byers, 1978; Fagen, 1976; Vanderberg, 1978). However, this is not exactly the conclusion drawn by the authors of the study. The value of play, according to them, appears to be more motivational than informational. They propose that play is a behaviour which increases goal direction in subsequent problem-solving tasks. Players in the Sylva, Bruner and Genova study had an opportunity to explore alternative serial orders of activity, but more importantly, according to the authors, the players' exploration was less stressed by anticipation of success and failure. Sylva et al also suggest that with practice in self-initiated activity, the players were able to approach the problem situation gradually, without quitting due to frustration. The emphasis in the tasks was on means, rather than on ends.

Berlyne (1960) considers specific and diversive exploration (i.e., the behaviour commonly called play) to be natural "drives". Specific exploration reduces uncertainty or arousal produced by novel or complex stimulation, whereas diversive exploration increases sensory input so as to avoid a state of boredom or a state of overly high arousal. Ellis and Sholtz (1978) emphasize epistemic behaviour as the function of play. According to them, play generates an information flow. They define information as a reduction of uncertainty. The practical limitation of these and most other theories regarding the function of play, is that they link play behaviours to variables such as pleasure (e.g., Leuba, 1953) arousal and drives (e.g., Berlyne, 1960) acquisition of knowledge (Ellis and Sholtz, 1978) creativity (e.g., Lieberman, 1978) and verbal development (e.g., Bruner et al, 1976). The problem with such theories is that play is not the only childhood activity related to those variables. Consequently, the argument that play exists because it has an ultimate function is neither logically nor scientifically compelling (Gehlbach, in press). Behavioural theory, by contrast, views play behaviour as no different from any other behaviour. It may be treated functionally as "a sequence of operant interactions with physical objects, or physical dimensions of social and biological stimuli" (Bijou, 1976). The variables are observable, and can be measured, and therefore theories regarding relationships of these variables can be empirically tested. All that remains is to identify reinforcers and/or operant contingencies, which Bijou does not really do.

Play variables. To date, most play research has centered on the delineation of stimulus variables in the play environment which affect play preference, as measured by either approach appeal (initiation of behaviour) or sustained appeal (maintenance of behaviour). The emphasis has been on stimulus properties with either physical dimensions such as colour, height or complexity, or with dimensions such as novelty, or frequency of previous encounters.

Gramza and Witt (1969) found that colour has only a negligible secondary effect on patterns of preference for preschool children. Spatial position does appear to have significant effects. Witt and Gramza (1970) report that there is preference for objects in a central position. Knowledge of this preference is of little use to someone who must make decisions regarding the choice of playthings to be provided in a home or school. However, it may have implication for studies related to preference for other attributes. For example, indication of preference between blocks which are coloured and blocks with a natural wood finish may be confounded by the spatial position of those blocks which may lead to an erroneous decision as to the significance of colour itself. A study by Karlssen and Ellis (1972), reported in Ellis and Sholtz (1978), indicates that there is no significant preference for height. However, Ellis and Sholtz suggest that the results may have been due to the short time element in the study. Gramza (1970) examined preference for encapsulation, and concluded that preschool children prefer visual cut-off and darkness for play. These components also appear to be more important than the tactile components that such enclosures provide.

Farnham-Diggory and Ramsey (1971) examined the effects of defective toys on appeal, and came to the not-too-surprising conclusion that defects decreased play persistence. Many studies concerned with sustained appeal have examined preferences for general types of toys and play environments in relation to such variables as age, sex and cognitive level (e.g., Harper and Sanders, 1975; Lewis, 1972; Rubin and Krasnor, 1979; Rubin and Seibel, 1979). These studies, however, have not attended to specific physical properties, and therefore are of little value in the development of new designs for play stimuli, except in a very general sense.

There has been considerable research which has attended to novelty as a stimulus property (e.g., Berlyne, 1960; Butrand, 1969; Ellis and Sholtz, 1978; Fantz, 1964; Louzos, 1967; Menzel, 1965). The problem with research on the property of novelty is that designating a stimulus as "novel" presupposes information about the total stimulus history of the individual. It is often possible to estimate the likelihood that the individual has previously encountered the stimulus, but it is seldom empirically determined. Furthermore, in the design of new play stimuli, it may be assumed that the designer's goal is sustained interaction, which, by definition, precludes novelty beyond the early encounters. A possible exception is a totally random environment in which successive unpredictable states of a stimulus effectively provide a "new", or novel stimulus.

Another stimulus variable which has been examined is complexity. Gramza and Sholtz (1974) found that complexity, as measured by diversity and variety in the stimulus pattern, or by the number of distinguishable parts, did not produce significantly higher initial physical interaction with the stimuli. However, Gramza (1972) suggests that functional complexity does seem to be a critical attribute. In behavioural terms, appeal is affected both by the number of possible actions of the child on the environment, and by the variations in discriminative feedback from the environment in response to those actions. According to Gramza, information comes from the interactive possibilities rather than the physical complexity itself. A play environment, whether physical, or social, or both, must provide information regarding the child's actions which is sufficient to sustain those actions. If functional complexity and variety are substantial and multimodal, each unimodal stimulus within the play complex is less critical.

A study by Sholtz and Ellis (1975) which examined the effects of repeated exposure, indirectly addressed the effect of other children on the functional complexity of the environment. They observed repeated exposure to objects and peers in a play setting for fifteen sessions of fifteen minutes each, during three consecutive weeks. To manipulate complexity, the number and variety of trestles, balance beams, boxes, etc. was varied in two conditions. Thus, the complexity was a property of the total physical and social environment, rather than a property of a single object. The subjects were boys and girls of nursery school age. Overt preference for play objects declined with repeated exposure, but rate of decline was inversely related to complexity of the total stimuli. On the other hand, preference for peers increased as a function of repeated exposure, again with the amount being an inverse function of complexity of the physical setting. Sholtz and Ellis conclude:

> As the information in one source, the apparatus, was exhausted, the children turned to the other available source, their peers. The rapid reduction of uncertainties in the simple setting triggered an earlier switch of preference from objects toward engagement with peers (p. 455).

It stands to reason that the addition of a peer can provide a greater variety of responses to the child's actions than any physical environment alone, regardless of structural complexity. Therefore, it is not surprising that the results of the study indicate that the interaction with other children increases the total interaction time, since the presence of peers increases the functional complexity of the total play environment.

The effect of functional complexity on sustained appeal is an often overlooked but important result of a frequently cited study by Hutt (1966). Hutt observed children's interactions with a novel play apparatus. The apparatus was a box with a moveable lever. Four directional movements of the lever were registered by post-office counters which could be made visible to the child. Auditory feedback was also possible. Horizontal movement activated a bell, and vertical movement activated a buzzer. Four conditions of relatively increasing complexity were available: 1) no sound or vision; 2) vision only; 3) both buzzer and bell; and 4) vision, buzzer and bell. Five familiar toys were also available. Initial interaction was high in each case, and there was a progressive decrease in what Hutt terms "exploratory behaviour". Hutt concludes that specific exploration is a function of novelty, and decreases with familiarity. Hutt notes that in the more complex conditions there was a slower decrement of exploration. However, she concludes that because the apparatus was more complex, it was more novel.

A more important consideration may be the role of feedback in the interaction. The results reported by Hutt clearly indicate that the total time of exploration plus play was greater when the apparatus was more complex. In the complex conditions, the apparatus provided a greater variety of differential feedback to the child as a result of his actions. Therefore, it may be the case that total interaction time was a function of that feedback, rather than a function of complexity per se. In the most functionally complex condition, the child could still move the lever in only four directions, but the apparatus provided a greater variety of feedback to these movements.

Gehlbach (in press) proposes a paradigm for the representation of play which emphasizes the feedback system in the interaction of a player and a play stimulus. His paradigm, shown in Figure 2, includes player parameters, environmental parameters and plaything parameters. For example, player parameters include factors such as age, cognitive level, physical coordination and history of reinforcement. Presented with a

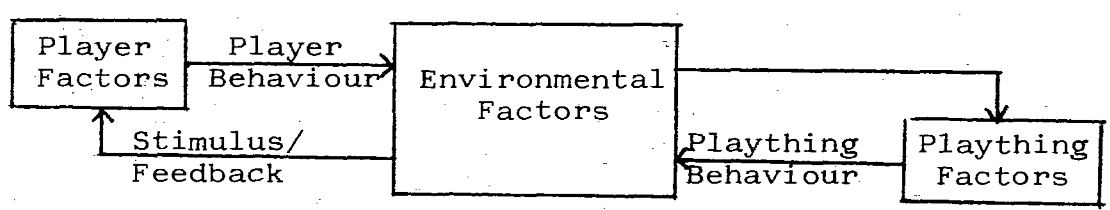


Figure 2. A cybernetic diagram representing a simple play event, with a single player, a set of playthings, and a player/plaything environment. Boxes represent sets of relatively stable control variables, and arrows represent change. (Courtesy of Roger D. Gehlbach)

pile of blocks, a child will initially behave in a particular way, depending in part on those parameters, and in part on the environmental parameters which include both physical and social stimuli. Similarly, the behaviour of the plaything (i.e., the "response" of the blocks) depends on the action of the child, and on the environmental parameters. In the block-play example, these parameters might include the condition of the surface on which they rest, and the presence or absence of other children. The behaviour of the blocks also depends on the properties of the blocks themselves. The response of the blocks, in turn, affects the subsequent behaviour of the child. If the block response is reinforcing to the child, the child's actions are likely to recur. Gehlbach's paradigm has implications for the present study. If, in the physical structure of the play environment, a contingency network is provided such that the feedback from the play object predictably reinforces a specific target behaviour, play might become a vehicle for instruction, rather than simply an interesting phenomenon.

Play and instruction. Gehlbach (note 3) defines instruction as the "installation and maintenance of a disturbance of the social and physical environment of a person such that adaptation to that disturbance results in learning of a specified kind to a specified level" (note 2). Gehlbach suggests that the system is similar to any general control system in formal cybernetics (e.g., Ashby, 1963). In common educational practice, instruction is most often teacher-directed. The teacher controls, or regulates the environment. The "disturbance" is the structuring of three major aspects of the learner's experience; 1) exposure to new skills or information, 2) practice requiring use of the skill or information, and 3) feedback in response to the learner's behaviour, and contingent on the proximity of that behaviour to the specified learning goal. For example, if the specified learning is the names and recognition of the primary colours, the teacher provides exposure by presenting examples of the colours, and by verbally specifying the colour name in each case. Practice is provided by asking the learner subsequently to name the colour of those or other objects, or perhaps to point to, or to choose an object of the specified colour. Indication of the correctness of the response provides feedback to the child. In behavioural terms, indication of correctness, perhaps coupled with social approval or a material reward, provides the reinforcement which results in the likelihood of repeated behaviours. The learner, when presented with subsequent examples of that colour, is more likely to repeat the reinforced response (naming the colour correctly) than some other response.

Instruction can also occur as a result of the physical structure of the environment. One example is computer-assisted instruction in which the computer serves as a surrogate human. The machine provides the exposure to the information and the feedback to the learner. Opportunity for practice is also provided by the machine, but the decision to engage the machine is most commonly made by someone other than the learner. The goals of the learner and of the one who provides the machine must usually be identical-- the acquisition of the knowledge or skill.

Another example is the play environment, with one major constraint. As has been discussed earlier, play may effect learning. However, play is only instructional to the degree that the learning is predictable, and behaviour reaches specified goals. There are two major differences between computer-assisted instruction and instructional playthings. First, since play is voluntary, the decision to engage in an interaction with the plaything is always made by the learner, at least ostensibly. Second, the learner's goal may be, and usually is, entirely different from the goal specified by the provider of the plaything. It would be most unusual for a child to indicate that he or she was playing with a puzzle in order to improve visual-motor development. If play is to be truly instructional, there are three requirements: 1) since play is voluntary, a play environment, or stimulus, must be provided which is salient enough to initiate target behaviour as operants; 2) the operative contingency must be determined by the character, or structure of the plaything or play environment which governs the overall environmental response to successive player behaviours; and 3) the interaction must result in predictable occurrence of a specified target behaviour.

Environmental design. The problem with existing playthings and play environments is that there has been virtually no empirical evidence indicating that the results of interaction with them is more than incidentally educational, let alone specifically instructional (Derman, 1974; Gehlbach, 1975). Existing designs of playthings and play environments have differed both in purpose and in quality of research. The purpose of some designs is to instigate and sustain play for the sake of play itself. For example, a wind-up toy has no obvious purpose other than to engage the player in activity with it. Success or failure of design is measured by usage alone. Other designs such as climbing apparatus or painting easels, are intended to effect specific behaviours. Relatively few playthings or environments are designed with attention to the results of usage, and of those, even fewer have been empirically tested.

A notable pioneer in the design of playthings for specific goals was Maria Montessori (1962). While Montessori uses the term "activity" rather than play, the materials she designed fulfill the requirements of instructional play materials in that the usage is voluntary, but the player's behaviour is deliberately manipulated, through the physical structure of the materials, to sustain activity and produce specific outcomes. An example is a set of cylinders, graded by size, which fit into holes in a box. If any one is placed incorrectly, there will be at least one peg which will not fit in the remaining holes. Thus, the feedback to the child is the information that a mistake has been made. All cylinders fitting is an indication of "correctness" of behaviour, and will very likely reinforce similar correct placement on subsequent trials.

In terms of the quality of studies, design proposals based on observation or theory alone have taken precedence over rigorous empirical research. For example, Kamii and DeVries (1978), drawing on Piaget's theory, emphasize the need for design of play environments which provide the necessary information for physical knowledge. They include detailed suggestions for design of the environment and for teacher strategies, with many observations regarding the child-environment interactions. They provide, however, no empirical evidence of resultant learning as compared to evidence of that knowledge prior to the interactions. Furthermore, the report of their study indicated that there was considerable adult intervention in the form of questions, suggestions and modeling. Therefore, the role of the physical environment in effecting interactions is not clear.

Derman (1974) reports two other examples of play environment design proposals which are well known, but unsupported empirically. One is a proposal by Dattner (1969) that design of play environments should "provide for interaction with replicas of the real world, so that abundant experimental potential may be actualized through physical forms" (p. 347). The obvious limitation in Dattner's design is exemplified in the words "provide for" and "may be". The implication is that mere provision of opportunity and chance of occurrence of the target behaviour is sufficient reason to implement design. The other design has been proposed by Burnette (1952). Burnette's "infant learning landscape" for day care settings is a complex environment which symbolizes countryside, council chamber, work, highways and social settings, and includes various other sensory inputs. Burnette hypothesizes, but specifies no method of verifying, that the values of this environment are: 1) acquisition of increased amounts of explorative behaviour; 2) acquisition of a "coherent cognitive world model"; and 3) formation of strong social relationships between infants and peers, and infants and adults.

The paucity of rigorous empirical research on instructional play indicates a need for research in two areas: 1) empirical validation of the results of play in already existing play environments; and 2) design of new play materials and play environments which produce specified behaviours. Studer (1973) advocates the application of the methods of the behavioural sciences to problems in environmental design and evaluation. He suggests that:

> "The task is...to arrange environmental contingencies such that particular stimuli and behaviour become functionally linked through discriminative learning. The environmental-behaviour relationship is thus designed and implemented..." (p. 142)

Studer's (1971) design paradigm calls for 1) the specification of a physical form or design which might result in a specified behaviour, 2) execution of the design, and 3) an empirical test. Studer also advocates an iterative approach. Upon failure to achieve the target behaviour, the elements of the design should be systematically changed and tested. While Studer's paradigm was formulated to apply to complex systems, it is also applicable to design research which is concerned with individuals, single playthings and specific elements of the play environment.

One of the few attempts to design a play object to achieve a specific goal, and then to test the results empirically, was made by David Olson (1970). Olson designed a puzzle-like toy which produced measurable effects on the acquisition of the concept of diagonality, and demonstrated empirically that the acquisition was achieved through the modification of the toy.

Environmental variables do not, by definition, change during interactions either between players and playthings or between playthings themselves (Gehlbach, in press). To the degree, however, that the physical constraints of the play environment (e.g., the partitions on a play table or the surface onto which a ball is bounced) affect the interactions, those constraints must be specified and controlled in any empirical research on play design.

A recent study by Gehlbach and Partridge (1978) is different from most studies of play in that it examined the effects of a small change in only one specific element of a play environment. A play table was designed with a partition which had two-inch holes permitting only partial visual access between players. The partition could be removed for the control condition, thereby permitting total visual access. Lego bricks were provided for play. An A-B-A-B time series design was employed to compare verbal communication between the open and partial vision conditions. The hypothesis for the design was that limited visual access would change the character of children's verbal communication. Results of the study indicated that for four-year olds, speech contained significantly higher levels of specific adjectival and nominal verbal references to their playthings when the partition was in place. In a similar study (Partridge and Gehlbach, note 3) the subjects were eight-year old boys, and the play activity was construction of model airplanes. Again, verbal communication was compared in the open and partial vision conditions, and verbal specificity increased when the partition was in place.

Conclusions and hypotheses

From the literature on social development, learning and play, several conclusions may be drawn: 1) prosocial behaviour is valued in our society; 2) prosocial behaviour is learned in the same way that any other behaviour is learned-- through a network of reinforcement contingencies; 3) some learning in natural settings appears to run counter to traditional behavioural analysis in that its predictability occurs in spite of a contingency network which reinforces both target and non-target behaviours; and 4) while learning may occur during play, play is instructional only to the degree that it reliably produces a specified target behaviour.

The main hypothesis which this study tested was that changes in the physical features of the play environment, which altered the structure of social contingencies between two players, would produce measurable effects on social behaviour. A related secondary hypothesis was that a "soft-contingency" network, in which both target and non-target behaviours were reinforced, but reinforced differently, would produce a target behaviour at a level above the baseline condition, in which reinforcement was not related to, or dependent on, the target behaviour (i.e., a "no-contingency" condition). Accordingly, a plaything was designed to deliver reinforcement on three different contingency levels, by means of small changes in one detail of the physical structure. At the baseline level, both prosocial and non-social behaviours were reinforced in a manner comparable to free play in an open sandbox. Prosocial behaviour was operationally defined to include the following behaviours: 1) filling sand into the partner's side of the apparatus; 2) verbal requests for sand; and 3) contracts in regard to giving and receiving sand. Non-social behaviours included: 1) filling sand into the player's own side; and 2) cranking the machine. When the plaything was adjusted for a hard-contingency network, only prosocial behaviour (the target) was reinforced. In the soft-contingency condition, both non-social and prosocial behaviours were reinforced, but they were reinforced differently. Social behaviour was recorded and analyzed for each of the three conditions. The experimental method and results are reported in the following chapters.

CHAPTER 2

Method

Subjects

Six five-year old boys from a kindergarten in Burnaby, B.C., participated in the study. The kindergarten teacher provided an alphabetical list of the boys in her class from English-speaking homes. From that list, the first six whose parents consented were used in the study. There were three reasons for the choice of five-year old boys as subjects: 1) prosocial development is a common target behaviour in kindergartens; 2) the use of only boys eliminated a possible sex variable; and 3) there is some indication that five-year old boys, when playing with a same-age peer, are less prosocial than children in other preschool age-sex combinations (Lewis, 1972). Thus, the possibility of a ceiling effect was reduced. A treatment which is designed to increase a target behaviour is less likely to have a demonstrable effect if that target behaviour already occurs with high frequency at baseline.

Since research indicates a possible relationship between altruism and perspective taking (e.g., Buckley, Siegel and Ness, 1979) two tests on perspective taking were administered during the first week of the experiment for descriptive purposes. The first test was for perceptual perspective taking and the second for cognitive perspective taking. The two tests were adapted from Burns and Brainerd (1979). In the first test, the assistant and the subject each had identical circular trays to which three plastic animals were affixed. The assistant rotated his tray four times, to four different orientations. Each time the subject was asked to align his own tray, "so that you see the animals just the way,I'm seeing them now." In the second test, four objects were arranged haphazardly on a table. The objects were a set of jewelry, a tie, a train engine and a doll. The subject was asked to point to an appropriate birthday present for: 1) father, 2) mother, 3) teacher and 4) a boy in kindergarten. The choice was made from all four objects in each task. No indication of correctness was indicated in either test. There were four tasks in each test, scored either 0 or 1. The tests were treated as two parts of a single perspective-taking test. Therefore, subject's scores could range from 0 to 8, and a dyad composite score from 0 to 16. Table 1 shows the results of the two perspective-taking tests.

Table 1

Scores on Two Perspective-taking Tests

Subject	Test 1	Test 2	Subject Total	Dyad Total
1	3	2	4	9 (A)
2	4	1	5	
3	1	2	3	11 (B)
4	4	4	8	
5	0	1	1	4 (C)
6	3	0	3	

Dyad totals are the combined scores for subjects who had been randomly paired for the experiment. The total score for dyad C was noticeably lower than the scores for A and B.

Materials

The sand machine that was designed for the study is illustrated in Appendix A. The machine was placed in a 48" x 60" sand box. It was comprised of two identical sides. The sides were separated by an upright divider 36" high and 48" wide. Each side contained a vertical chute which directed sand to an enclosed horizontal conveyer belt. The conveyer was a metal chain normally used to convey chicken feed. It was activated by a hand crank connected to the right end of the chain loop. The crank could be turned in either direction. At each end of the conveyer, sand dropped through holes in the bottom or the horizontal enclosure, creating sand "mountains", or filling a container or truck appropriately placed by a player. A 4" x 5" opening in the vertical divider gave direct and constant access to the partner's vertical chute. A similar opening in the player's chute was adjustable by the experimenter, but not by the player.

Constant accessibility to the partner's chute, together with adjustment of the access to the player's own chute, provided three contingency conditions with respect to prosocial behaviour. In the no-contingency, or baseline, condition (NC), the plexiglass was removed from the player's own chute. Since the player could fill either to his partner's side <u>or</u> to his own side, reinforcement from the creation of "mountains" was not contingent upon prosocial behaviour. In the hard-contingency condition (HC), the chute was totally closed on the player's side. A plexiglass cover exactly the size of the opening was fixed in place by a screw. Each player could put sand into his partner's system, but not into his own. Conversely, sand could enter each player's chute only from the partner's side. Therefore, use of either conveyer required prosocial behaviour from the partner. In the soft-contingency condition (SC), the player's chute was only partially closed. A 3" x 5" plexiglass plate was screwed to the opening, leaving a player access of only 1" x 5" at the bottom of the opening. Full access to the partner's chute was still available. Consequently, it was possible, <u>but not easy</u>, to fill one's own chute. Sand could enter in larger quantities, and with less effort, from the partner's side, thus providing the possibility of creating a larger sand mountain sooner, via the crank and conveyer system if prosocial behaviour occurred (i.e., each filling the other's chute).

Colour has been shown to have only secondary effects on approach and sustained appeal of playthings (Gramza et al, 1969). The apparatus was stained with a natural wood colour, with two exceptions: 1) the crank shaft was painted black and a white bicycle handle was attached; and 2) there was a white 1/2" painted border, surrounded by a black 1/8" painted border, around the two openings on each side. The rationale for colour choice was an effort to reduce the salience of the overall apparatus, while possibly making the openings and cranks more salient by contrast. Half-way through the experiment, interest in the sand machine appeared to be lagging. Consequently, a minor change was made in an effort to increase appeal, and therefore to increase general interaction with the machine, without changing the structure of that interaction. A plexiglass panel was inserted in the front surface of the horizontal enclosures which contained the chain conveyers, making the movement of sand and conveyer visible. Play activity did increase to earlier levels, and the experiment was continued for the remainder of the scheduled sessions.

A small square container and a small truck were provided for each player. Each could be used to fill chutes, or simply for other purposes in the sandbox itself.

A video-tape camera was used to record both verbal and physical activity, and a watch with a sweep second hand was used to determine the five-minute intervals for each session.

Procedures

Two pilot studies preceded the experiment. The purpose of the first pilot study was to assess (1) the mechanical integrity of the machine, and (2) its appeal, in terms of its ability to prompt sustained play behaviour. The pilot study was conducted at the Simon Fraser University Day Care Centre, with the children using the machine different from the subjects in the experiment. The pilot study was conducted on four consecutive days. A second pilot study was conducted in the laboratory. Two four-year old girls from the Day Care Centre were video-taped while playing with the sand machine in each of the three treatment conditions. Video tapes were generated to check the validity of the coding instrument, and to train the coder.

The experiment was conducted over 27 sessions for each of the three dyads. The sessions were limited to five minutes to prevent satiation, and were conducted over three consecutive days for nine weeks. Each dyad served as its own control, thus reducing interactive effects due to individual differences. The subjects were not available until after the start of the school year, and the study was limited to nine weeks to avoid a hiatus over the Christmas holidays. Specific scheduling within those nine weeks was dependent on availability of the laboratory.

The period of the experiment was divided into three segments, with the random assignment of conditions conducted within each segment. This arrangement was selected to guarantee usable data in the event that a major and unexpected decay of interest in the play apparatus occurred prior to the end of the targeted nine-week period. The purpose of randomly assigning treatments was to ameliorate the possible effects of serial dependency (Hersen and Barlow, 1976). The order of treatments is shown in Appendix B. The assignment of treatment conditions was identical for all three dyads. Each subject had the same partner throughout the experiment.

The experiment was conducted in a laboratory, one dyad at a time, and subjects were instructed simply to "play in the sand." No other instructions were given, and no comments made, except to request that each player remain on his side of the sandbox. The experimenter started the camera and then sat in a position where she could observe both players and make anecdotal notes. The four replication subjects played with toys in a separate room under the supervision of an assistant. The order of video-taping the three dyads was rotated each day, in order to avoid any confounding of results from social perceptions of which dyad had the "first turn".

It was necessary to cancel the twenty-second (HC) and twenty-third (SC) sessions due to scheduling conflicts. Therefore, the final session (NC) was also cancelled in order to maintain an equal number of sessions in each condition.

Scoring

Behaviours were individually coded for each subject. From the video tapes, a trained observer blind-coded occurrences of three non-verbal and two verbal behaviours related to use of the machine. The three non-verbal categories of behaviour were: 1) putting sand in one's own chute, or "filling to self" (FLS); 2) putting sand into partner's chute, or "filling to partner (FLP); and 3) turning the crank (CR). The two verbal behaviours were: 1) requests or mands (REQ) for sand from a partner and 2) contracts (CON) related to the giving and receiving of sand. Appendix C contains a list of the specific criteria used in coding each of the five behaviours. The recorded score was the number of coded occurrences of a given behaviour in a given session.

CHAPTER 3

Results

This chapter begins with a report of coder reliability and a description of the units of analysis. Next, cell means and standard deviations are presented by dyad and treatment for each independent variable. Results indicating serial independence of individual sessions are followed by analyses of variance for each of the dependent variables. Finally, Newman-Keul post-hoc test results are reported to indicate which treatments are responsible for the variability among the means.

Coder reliability

Three sessions, randomly chosen, were independently coded for each subject by the experimenter, and scores were compared with those coded by the principal coder, with a reliability coefficient of .91. The coefficient was determined by dividing actual agreements by the number of opportunities for agreement. The total score for one dependent variable, for one subject in one session, constituted one opportunity for agreement. With three sessions, coded for six subjects, on each of the five variables, the total number of opportunities for agreement was 90 (3 x 5 x 6). The totals which the coders recorded were identical in 81 of the 90 possible opportunities.

Unit of analysis

For purposes of analysis, the scores for the two subjects in each dyad were combined, and the unit of analysis was the dyad score. The reason for combining the scores was that when two subjects are interacting, it is impossible to determine the degree to which the behaviour of one is affected by the behaviour of the other. One member of the dyad may function as a model, or may request or reinforce specific behaviours of the other. Furthermore, general attitude toward the other might affect response to modeling or response to requests. For example, a pair of subjects who were friendly might be more likely to copy one another's behaviour (Bandura, 1969). On the other hand, either a unilateral or mutual antipathy could have a negative effect on a player's response to a partner's request.

Descriptive data

Individual dyad scores and total scores were computed for each of the five dependent variables, in each of the three treatment conditions. Means and standard deviations by cell are reported in Table 2. Totals for the two major non-verbal social behaviours (fill to self and fill to partner) are displayed in bar graphs in Figure 3.

In the hard-contingency treatment, the design of the sand machine was such that the aperture to a player's own system was fully closed, therefore there should have been no occurrences of filling to self. However, on five occasions, a subject left his own play area, and walked around the partition to fill his own system from the partner's side. Strictly speaking, he was "filling to self", and the behaviour was recorded as such. Since, except in those five cases, filling to self was precluded by design, variability was assymetrically distributed about the median. If those occasions had not occurred, all means and standard deviations for FLS would have been zero in the hard-contingency treatment. In the other two treatments, filling to one's self and mutual filling to partner both resulted in sand entering the player's machines (i.e., both behaviours were reinforced for each player). According to classical operant behavioural analysis, one behaviour was no more predictable than the other, and therefore, large standard deviations were to be expected. Further analysis was required to determine whether the apparently different mean scores were statistically different among the three treatments.

Serial dependency

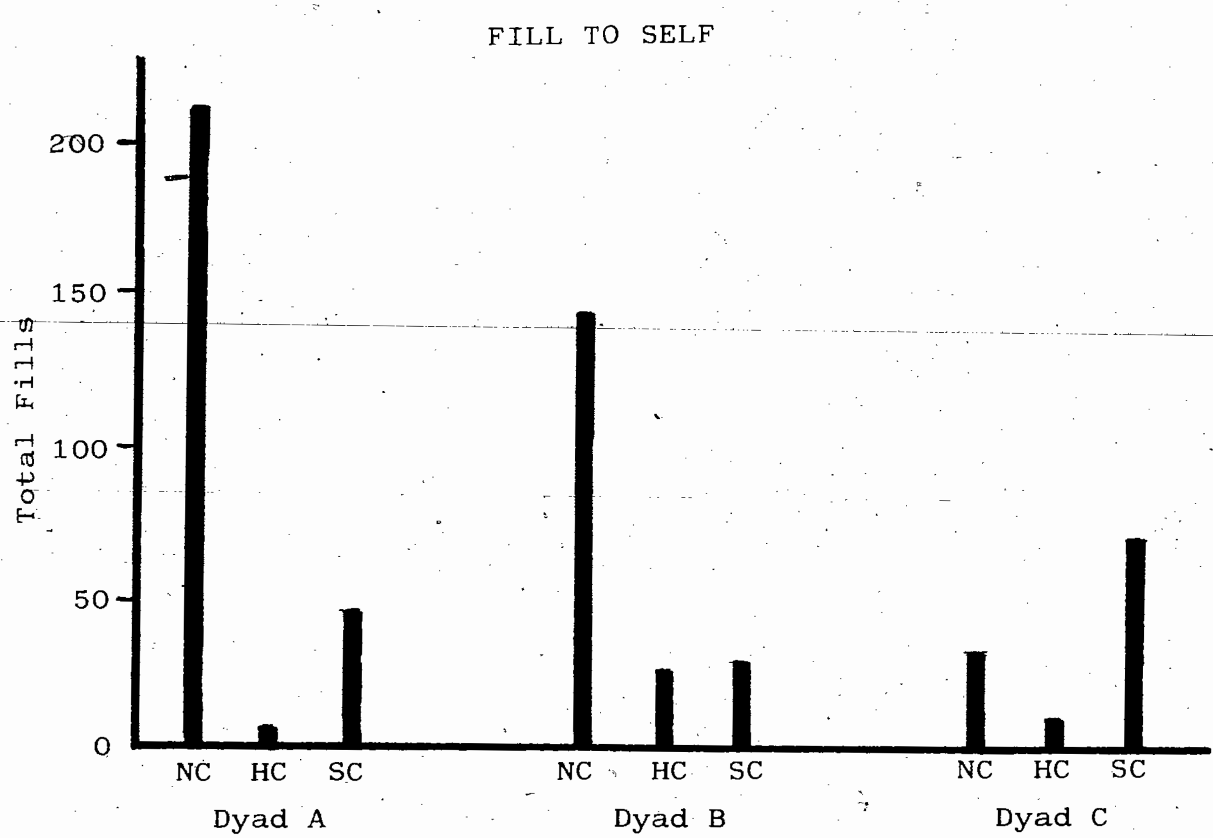
When an experiment is conducted on a single subject or dyad over a series of sessions, there is the possibility that each event is dependent, to a degree, on the previous event. The relationship between those events is referred to as "serial dependency". One method of ameliorating that dependency is to randomize the order of treatments. Hersen and Barlow (1976) argue that, if the order is truly randomized before the onset of the experiment, the probability is no greater than chance that the order of treatments will result in treatment effects which are different from what they would be if treatments were presented in any other order. Although the treatment order had been randomized prior to this experiment, it was still deemed prudent to test for serial dependency. A lagged correlation is a measure of that dependency. By pairing each event with the following event (e.g., first with second, second with third), a correlation coefficient is calculated. If the correlation is

Table 2

Means and Standard Deviations By Cell

Variable	Dyad	Treatment			
		NC	HC	SC	Total
FLS	A	26.38 (18.15)	0.75 (2.12)	5.63 (9.52)	10.92 (16.06)
	B	17.87 (17.07)	3.13 (6.27)	3.15 (3.69)	8.08 (12.44)
	C	4.13 (4.39)	1.25 (2.43)	8.50 (11.74)	4.63 (7.67)
	Total	16.13 (16.80)	1.70 (4.03)	5.79 (8.86)	7.88 (12.63)
FLP	A	1.25 (1.67)	12.50 (11.51)	11.13 (8.54)	8.29 (9.57)
	B	4.38 (6.26)	10.38 (9.09)	6.75 (5.97)	7.17 (7.36)
	C	0.13 (0.35)	3.50 (3.81)	1.00 (2.07)	1.54 (2.81)
	Total	1.92 (4.02)	8.79 (9.23)	6.29 (7.23)	5.67 (7.62)
CR	A	23.75 (30.60)	63.50 (63.60)	56.88 (43.59)	48.04 (43.09)
	B	43.38 (49.55)	6.13 (6.51)	8.50 (11.15)	19.33 (33.18)
	C	71.75 (109.88)	33.50 (46.68)	33.50 (41.08)	46.25 (70.99)
	Total	46.29 (71.50)	34.38 (46.68)	32.94 (41.08)	37.88 (54.28)
REQ	A	0.00 (0.00)	0.00 (0.00)	0.25 (0.46)	0.08 (0.28)
	B	0.00 (0.00	0.75 (1.17)	1.00 (1.60)	0.58 (1.18)
	C	0.00 (0.00)	2.50 (2.92)	0.38 (1.06)	0.95 (2.05)
	Total	0.00 (0.00)	1.08 (2.04)	0.54 (1.14)	0.54 (1.40)
CON	A	0.13 (0.35)	0.00 (0.00)	0.13 (0.35)	0.08 (0.28)
	B	0.00 (0.00)	0.25 (0.46)	0.00 (0.00)	0.83 (0.28)
	C	0.00 (0.00)	0.25 (0.46)	0.00 (0.00)	0.83 (0.28)
	Total	0.04 (0.20)	0.17 (0.38)	0.04 (0.20)	0.08 (0.28)

Note. Upper figure is mean. Lower figure is standard deviation.



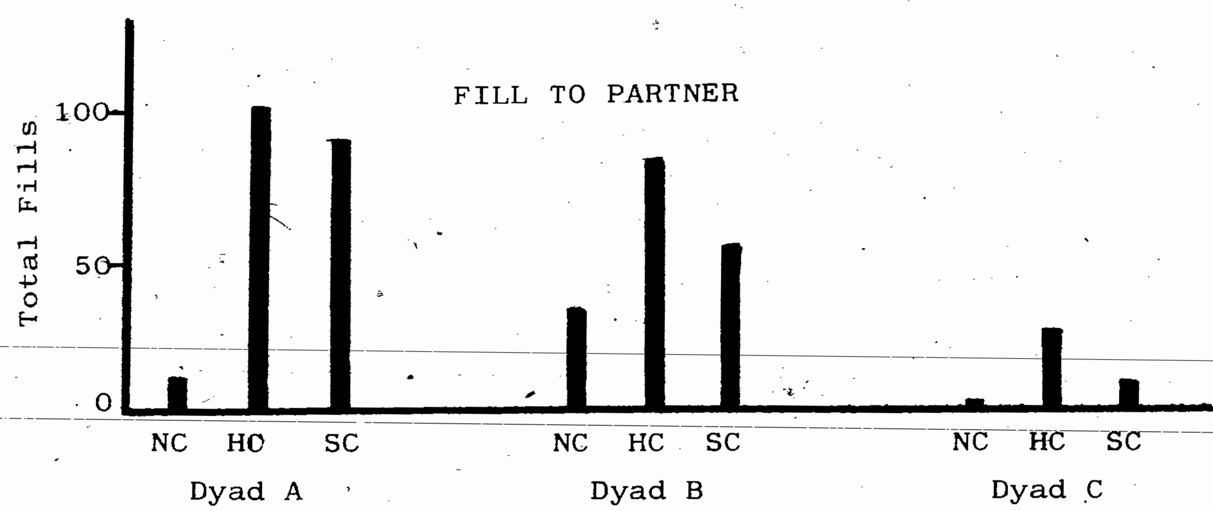


Figure 3. Totals for the two major social variables, for each dyad.

is high, it is assumed that the events are not independent (Hersen and Barlow, 1976). A lag-1 correlation, as described in the above example, was computed for each variable, over the 24 sessions, for each dyad. Lag-2 and lag-3 correlations were also computed to measure delayed effects. In a lag-2 correlation, the first event is paired with the third, and the second with the fourth. In a lag-3 correlation, the first event is paired with the fourth, etc. Only one of the forty-five correlations computed was significant at $\alpha = .05$. The lag-2 correlation for dyad B on the crank variable (CR) was .42. All other correlations ranged from 0 to $\pm$ .23 ($p > .10$). It was concluded that the sessions could be treated as independent tests (See Appendix D).

Analysis of Variance

Having satisfied the assumption of serial independence, the data for each dependent variable were subjected to a 2 x 3 x 3 factorial analysis of variance (2 parts x 3 dyads x 3 treatments). Because the machine was modified between the twelfth and thirteenth sessions, "part" was used as a variable to indicate whether a session occurred before, or after, that modification. Dyad was included as an independent variable to account for possible error variance due either to between-dyad effects, or to interactions of dyad and treatment.

Even though assumptions of homogeneity of variance and normal population distribution were violated (see Table 2), the F statistic in an analysis of variance is fairly robust if the cell sizes are equal (Donaldson, 1968). Therefore, the alpha levels of F were taken as given. Details of the analyses are shown in Tables 3 to 7. Since the three-way interaction (part x dyad x treatment) was of no theoretical interest, that source of variance was not tested in the five analyses of variance, but was included in the residual mean square.

Table 3

Analysis of Variance on FLS

by Part, Dyad and Treatment

Source	df	SS	MS	F	p
Part	1	42.01	42.01	0.41	.526
Dyad	2	476.58	238.29	2.31	.108
Treatment	2	2650.33	1325.16	12.85	.000
Part x Dyad	2	227.69	113.85	1.10	.338
Part x Treatment	2	272.11	136.06	1.32	.275
Dyad x Treatment	4	1676.09	419.02	4.06	.006
Residual	58	5980.91	103.12		
Total	71	11325.74	159.52		

Table 4

Analysis of Variance on FLP

by Part, Dyad and Treatment

Source	df	SS	MS	F	p
Part	1	20.06	20.06	0.46	.499
Dyad	2	627.75	313.88	7.24	.002
Treatment	2	581.25	290.62	6.71	.002
Part x Dyad	2	128.53	64.16	1.48	.235
Part x Treatment	2	31.86	15.93	0.37	.694
Dyad x Treatment	4	216.50	54.12	1.25	.300
Residual	58	2512.04	43.31		
Total	71	4117.99	58.00		

Table 5

Analysis of Variance on CR

by Part, Dyad and Treatment

Source	df	SS	MS	F	p
Part	1	21945.12	21945.12	9.45	.003
Dyad	2	12415.08	6207.53	2.67	.077
Treatment	2	2574.33	1287.16	0.55	.577
Part x Dyad	2	10942.74	5471.37	2.35	.104
Part x Treatment	2	7152.33	3576.16	1.54	.223
Dyad x Treatment	4	19443.89	4860.97	2.09	.093
Residual	58	134615.00	2320.94		
Total	71	209088.50	2944.90		

Table 6

Analysis of Variance on REQ

by Part, Dyad and Treatment

Source	df	SS	MS	F	p
Part	1	3.12	3.12	2.04	.158
Dyad	2	9.25	4.62	3.02	.056
Treatment	2	14.08	7.04	4.60	.014
Part x Dyad	2	3.25	1.62	1.06	.352
Part x Treatment	2	1.75	0.87	0.57	.568
Dyad x Treatment	4	19.66	4.91	3.21	.019
Residual	58	88.75	1.53		
Total	71	139.87	1.97		

Table 7

Analysis of Variance on CON

by Part, Dyad and Treatment

Source	df	SS	MS	F	p
Part	1	0.05	0.05	0.73	.395
Dyad	2	0.00	0.00	0.00	1.000
Treatment	2	0.25	0.12	1.65	.201
Part x Dyad	2	0.11	0.05	0.73	.484
Part x Treatment	2	0.19	0.09	1.28	.284
Dyad x Treatment	4	0.50	0.12	1.65	.174
Residual	58	4.38	0.07		
Total	71	5.50	0.07		

Part had a statistically significant main effect at $\alpha \pm .05$ only on cranking. An examination of the raw data revealed that 40% of the cranking behaviour occurred in the first three of the 24 sessions, indicating that the difference in cranking behaviour in the two parts was actually due to a "novelty effect" at the onset of the experiment, rather than to the modification of the machine itself. Since Part had no statistically significant effect on any other independent variable, it was not considered further.

Although cranking was not considered as a measure of social behaviour, it was included as a dependent variable because it was necessary to crank the machine before the sand could descend to create a mountain. It became apparent during the experiment that cranking also occurred independent of filling behaviour--that is, when there was no sand in, or descending from the machine. Also, cranking did not interact significantly with either Dyad or Treatment.

Treatment, the major independent variable around which the experiment was designed, had a statistically significant effect at $\alpha \pm .05$ on the two major social behaviours, fills to self (FLS) and fills to partner (FLP), and also on requests, indicating that systematic changes in the physical structure of the machine did alter the social behaviour of the subjects.

Dyad x Treatment also had a statistically significant effect at $\alpha = .05$ on the same three dependent variables (FLS, FLP and REQ), which indicated that the three groups differed in their responses to treatment. The interactive effect might have been related to the noticeable difference between Dyad C and the other two dyads on measures of social behaviour (see Figure 3). The main effect for Treatment on Requests was statistically significant at $\alpha \pm .05$, and Dyad was marginally significant at $\alpha = .06$.

Post-hoc analyses

The statistically significant effects of Treatment indicates that at least one pair of treatments is significantly different in its effect on prosocial behaviour. Several procedures exist for determining which pair, or pairs, are responsible for the variability among the individual treatment means. The two important considerations are controlling for the Type I error rate for the family of possible tests, and controlling for loss of power (Type II error). Meyers (1979) suggests that the Newman-Keuls (1952) test is a "reasonable compromise between control of the EF and the desire for power against false null hypotheses" (p. 297). Therefore, the Newman-Keuls test was applied to test pairwise differences among treatments and among Dyad x Treatment interactions. The critical value was set at $\alpha = .05$, and for each family of tests, critical values were calculated. Table 8 contains a summary of the results. Although there was no significant difference between the hard- and soft-contingencies, there was, overall, a significant difference between both contingency treatments and the baseline treatment (NC).

Table 8

Newman-Keuls Tests for Pairwise Differences

Among Main Effects and Two-way Interactions

Main Effects

Ordered Means for Treatment

Dependent Variable			
FLS	HC 1.70	SC 5.79	NC 16.13
FLP	NC 1.92	SC 6.29	HC 8.79
REQ	NC 0.00	SC 0.54	HC 1.08

Ordered Means for Dyad

Dependent Variable			
FLP	Dyad C 1.54	Dyad B 7.17	Dyad A 0.29

Two-way Interactions

Ordered Means for Dyad x Treatment

Dependent Variable									
FLS	A/HC 0.75	C/HC 1.25	B/HC 3.13	B/SC 3.25	C/NC 4.13	A/SC 5.63	C/SC 8.50	B/NC 17.87	A/NC 23.68
FLP	C/NC 0.13	C/SC 1.00	A/NC 1.25	C/HC 3.50	B/NC 4.38	B/SC 6.75	B/HC 10.38	A/SC 11.13	A/HC 12.50
REQ	A/NC 0.00	B/NC 0.00	C/NC 0.00	A/HC 0.00	A/SC 0.25	C/SC 0.38	B/HC 0.75	B/SC 1.00	C/HC 2.50

Note: Means which do not lie above the same line exceed the critical value at $\alpha = .05$.

CHAPTER 4

Discussion

Implications for theory

Operational definition of play. The overall behaviour of the subjects in all three treatment conditions corresponded to the definition of play set forth earlier. The children referred to their own behaviour as "play" (Bijou, 1976). Also, the requisite characteristics could be negatively specified (Gehlbach, in press). Beyond the requirement that the subjects remain in the laboratory, and the suggestion that they stay in the area of the sand, no specific behaviours were imposed on them. In fact, there was one occasion when a subject did not play at all-- he simply sat on the edge of the sandbox, and stated, "I'm not going to play in the sand today."

When interaction with the environment did occur, the style, pacing and choice of responses were not determined by anyone outside the player-plaything system, nor was the end product, or "goal" determined by an outsider. For example, a player was not told to "produce a sand mountain," or to "fill a truck with sand." On the other hand, contrary to the definition proposed by Goldberg et al (1971), it can be argued that responses were not "solely" determined by the player, since the significant effect of treatment on behaviours within the sequence was demonstrated. The only change which occurred across treatments was the change in one physical aspect of the plaything, and consequent changes in both individual and social reinforcement contingencies.

Testing of hypothesis. The overall results of the study confirm the main hypothesis that changes in those physical features of the play environment that altered the structure of social contingencies between players would produce measurable effects on social behaviour. Bar-Tal (1976) suggests that differences in levels of prosocial behaviour between age groups is evidence that prosocial behaviour is learned. The fact that interaction within an environment designed to reinforce prosocial behaviour did increase that behaviour would seem to be even stronger evidence that prosocial behaviour is learned.

This study is in contrast to common behaviour modification procedures, in which reinforcement contingencies are virtually always managed by humans (e.g., Ullman and Krasner, 1965) or by surrogate humans, such as in computer-assisted instruction. In this study, the physical structure of the plaything acted as the agent, so to speak, which managed the reinforcement contingencies for operant behaviours of the players. The only physical change in the environment was an alteration in the relative access to filling apertures. That change had statistically significant effects on prosocial behaviour in both contingency conditions.

The results of the study also confirm the second hypothesis, that a soft-contingency network would produce the target behaviour at a level above the baseline (Gehlbach, note 1). The frequency of prosocial behaviours produced in the soft-contingency condition was significantly greater than baseline, and not different from the hard-contingency condition. Conventional behavioural theory would predict that frequency of prosocial behaviours would have been similar in the soft-contingency and baseline conditions, since target <u>and</u> non-target behaviours were reinforced in both conditions. The difference in results between the two conditions indicates that although reinforcement occurred for competing behaviours in both conditions, that reinforcement must have differed in some way, between treatments. Conventional behavioural theory would also predict that frequency of prosocial behaviour would be greater in the hard-contingency condition than in the soft-contingency. Results of this study indicated that there was no difference.

<u>Identification of reinforcers</u>. The interaction of two players with the machine presents a question as to the identification of reinforcers and/or aversive stimuli in each of the conditions. It is likely that two sets of contingencies were changed: 1) physical, and 2) social. On the physical dimension, comments such as, "How big is your mountain?" or, "Mine is bigger," provided verbal evidence that a sand mountain was a reinforcer. There was also verbal evidence that filling a chute with sand was a reinforcer (e.g., "Mine is full to the top.") In the soft-contingency condition, as compared with the baseline, it may well have been the case that reinforcement for filling-to-self behaviour was reduced (e.g., the behaviour yielded less sand in the chute, or a smaller mountain). In the hard-contingency condition, the only interactive behaviour possible with the sand machine, and therefore the only behaviour reinforced, was filling to partner.

The question that remains is how prosocial behaviour was reinforced at all. One possibility is that filling <u>any</u> chute was reinforcing. Another possibility is that prosocial behaviour was also socially reinforced. It may take another study, or functional analysis of these data to answer that question.

Given that filling to partner was reinforcing, it may also have been the case that for players who had not yet developed a high level of prosocial skills, individual, or personal reinforcement took precedence over social reinforcement when they were equally available (in the baseline condition). When reinforcement was reduced, or an aversive stimulus added, as in the soft-contingency condition, the combination of physical and social reinforcement may have been greater for prosocial behaviour than the physical and personal reinforcement was for non-social behaviour.

<u>Dyad and treatment interaction</u>. Dyad was a moderator variable of experimental interest. In the first chapter of this study, the question was raised regarding the cause-and-effect relationship between social play and social skills. Two possibilities were suggested: 1) social play enhances prosocial skills; and/or 2) successful social play requires at least some degree of developed social skill.

Without long-term measurements of prosocial behaviour in the baseline condition, it is not possible to determine whether mere exposure to other players in the same environment would result in increased prosocial behaviour. However, the significant effect of treatment in this study does indicate that *if* the play environment is structured to deliver reinforcement for prosocial behaviour, the frequency, and hence reinforced practice, of prosocial behaviour will increase.

The possibility that individual differences have an effect on social play is supported by the results of this study. Dyad had a significant effect on the overall frequency of both fills to self and fills to partner, indicating that the dyads differed. Also, the overall differences in measures of social behaviour in the experiment corresponded to the scores in the perspective-taking tests, suggesting that there was a difference between dyads in prosocial development as measured by those tests. One might conjecture that there is a level of social skill below which this, or any other plaything, would have little demonstrable effect during a period of time as short as this one. Certainly, if one extrapolates to an infant or toddler, cooperative play under any condition would be the exception, rather than the rule.

No interactive effect was found for frequency of fills to partner. Since both contingency conditions produced higher frequencies of prosocial behaviour than the baseline, and since there was no interactive effect, it must be concluded that structuring a contingent reinforcement was equally effective in significantly increasing prosocial behaviour.

There was an interaction between dyad and treatment on fills to self. While a contingent reinforcement changed the amount of non-social behaviour for all dyads, the *amount of change* differed among dyads. Frequency of prosocial acts increased, but that increase differed in proportion to the total fills, when the dyads were compared.

Implications for design for instructional play

There is a major difference between play in general and instructional play. Learning occurs only by chance in general play. If play is instructional, learning is predictable, by definition. The results of this study indicate that playthings can be instructional, and can be designed for the purpose of producing specific target behaviours, the basis for that design being the structure of contingencies in the player-plaything relationship. The results of this study also support the efficacy of applying the theoretical and procedural aspects of Gehlbach's (in press) and Studer's (1973) paradigms to the design of instructional playthings, and to the verification that interaction with those playthings produces the specified target behaviours.

In addition to providing appropriate reinforcement, contingent upon the occurrence of target behaviours, a plaything must also provide reinforcement for simple activity with the plaything. Overall use of the machine decreased midway through the experiment, necessitating a minor modification of the machine. The addition of the plexiglass panel did not change the number of functional parts, and therefore Gramza's (1972) theory of the importance of functional complexity in sustaining play did not apply. Feedback to the player, in reference to his behaviour with the plaything did change, however, (i.e., the player could see the action of the sand and conveyer which resulted from his filling and cranking behaviour). The fact that an increase in feedback increased interaction with the plaything supports Gehlbach's (in press) argument that feedback plays an important role in player-plaything interactions.

Implications for future research

One question which is raised by this study is whether instructional playthings should be designed to incorporate a hard- or a soft-contingency network. The results of this study indicate that a soft-contingency reinforcement network is at least as effective as a hard-contingency one. With a hard-contingency network in operation, the plaything is instructional only to the degree that the child interacts with it. If the child is relatively unskilled, that interaction may not occur, since the child is effectively penalized by no reinforcement. Furthermore, with non-target behaviours reinforced at least to some degree, the unskilled child may interact with the plaything more frequently than he would otherwise. If the frequency of occurrence of target behaviour is equal for hard- and soft-contingencies, and if it were found that interaction time were increased with a soft-contingency network, one may assume that, over time, the total frequency of the target behaviour in a play setting would be greater with a soft-contingency reinforcement than with a hard-contingency reinforcement.

Another question raised by this study is whether instructional play is as good as, or better than, more conventional methods of teaching. Experimental comparison would be necessary, of course, to determine relative achievements of the target behaviours, but the results of this study indicate that a target behaviour can be achieved through instructional play.

Even if traditional methods achieved instructional outcomes faster, there are other considerations. Effective use of behaviour modification, direct instruction, discussion modeling and various combinations of those methods all require planning and specific input from the teacher for exposure, provision for practice and reinforcing feedback. Not only are those methods time-consuming, but there is considerable room for error when a teacher is attending to from 10 to 20 children. In contrast to traditional methods, instructional play is not teacher-intensive, nor is it subject to human error. Once a plaything has been shown to be instructional-- that is, once it has been shown that by virtue of its design it provides required exposure, practice and reinforcement of a target behaviour-- the provision of such a plaything would free the teacher to concentrate on other physical, social and cognitive objectives which are not met through the instructional playthings that are available.

NOTES

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2. Gehlbach, R. D. Personal communication, January 1980.

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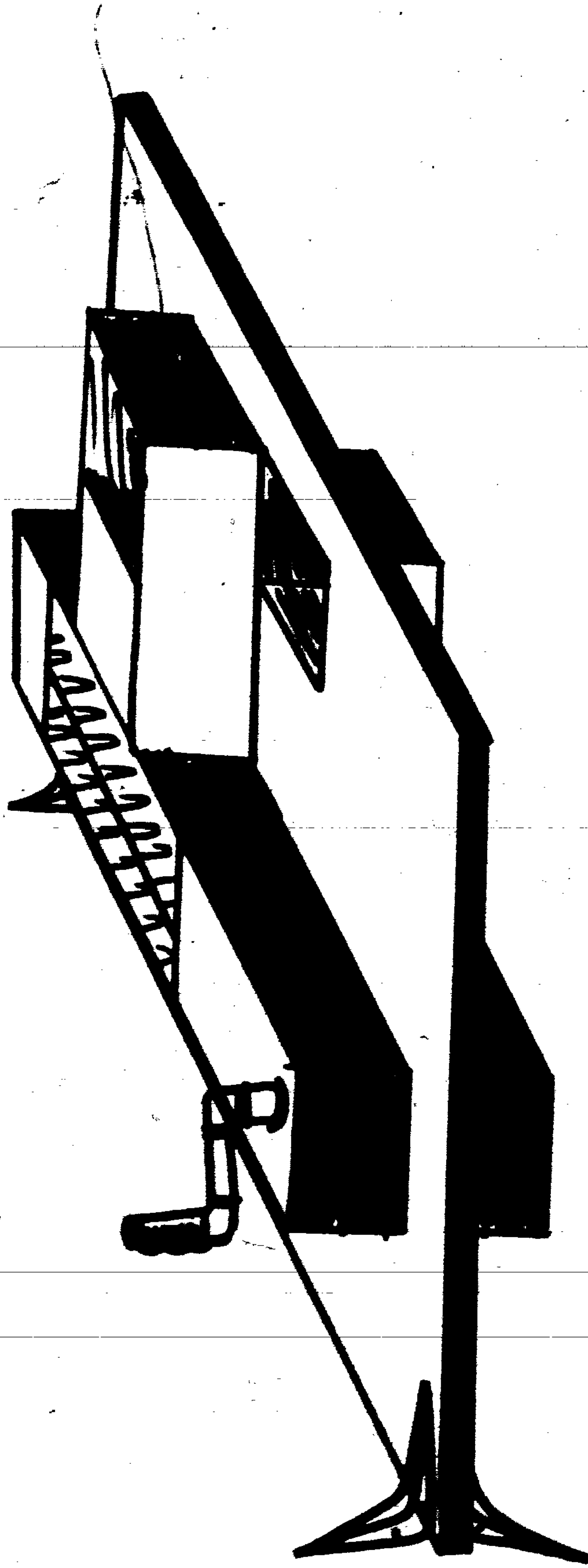
APPENDIX A



APPENDIX B

Random Order of Treatments

Session	Condition
1	NC
2	NC
3	SC
4	HC
5	SC
6	SC
7	HC
8	HC
9	NC
10	NC
11	HC
12	SC
......modification of machine.......	
13	NC
14	HC
15	NC
16	SC
17	HC
18	SC
19	SC
20	SC
21	HC
22	HC*
23	SC*
24	NC
25	HC
26	NC
27	NC*

* denotes cancelled sessions

APPENDIX C

Coding criteria for Dependent Variables

FILL: Any efforts to deliver sand into an aperture by hand, container or truck, constituted a single fill, regardless of the number of "tries" within that delivery-- that is, a second occurrence was not coded unless there was a return of hand, container or truck to the source of sand.

FLS: delivery of sand into aperture leading to player's own chute.

FLP: delivery of sand into aperture leading to partner's chute.

CRANK: one full rotation of crank by hand, or any other means (e.g., by foot)

REQ: any request or directive from a player, for a partner to fill the player's chute

Examples: "Will you put some in mine?"

"Give me some sand."

"Put more in." (meaning inferred from partner's preceding behaviour)

CON: any verbal indication of reciprocal filling agreement

Examples: "I'll put some in yours, if you'll put some in mine."

"You give me some, and I will give you some."

APPENDIX D

Three Lag Correlations for Each Dyad on Five Dependent Variables for All Sessions

Dyad	FLS	FLP	CR	REQ	CON
	Dependent Variables				
Lag-1					
A	.23	.18	.00	-.09	-.09
B	.30	.16	.23	-.14	-.09
C	-.26	-.01	.00	-.22	-.10
Lag-2					
A	-.15	.19	.00	-.10	-.09
B	-.10	-.02	.42*	.31	-.06
C	.14	-.18	.00	.12	-.10
Lag-3					
A	.06	-.05	.00	-.12	-.11
B	-.28	.03	-.05	.19	-.07
C	.09	.22	.00	.23	-.11

* Significant at α = .05