THE UNIVERSITY OF MANITOBA

Effects of Sequential and Non-Sequential Conditioned Reinforcers in a Picture - Naming Task With Retarded Children

by

Carl E. Stephens

A Dissertation
Submitted to the Faculty of Graduate Studies
In Partial Fulfillment of the Requirements
For The Degree of Doctorate of Philosophy

Department of Psychology

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ABSTRACT

Picture - naming behavior of three retarded children was compared in two experimental conditions which were identical except that sequentially illuminated lights (which accumulated) were contingent upon correct responses in one experimental condition, whereas light-flashes which did not accumulate were contingent upon correct responses in the other experimental condition. Each child served in both experimental conditions. In Phase 1, primary reinforcers were delivered immediately after the fifth correct verbal response. During this phase, the performance of one subject was consistently superior in the light-flash condition. There was no difference in the performance of the other two subjects in either experimental condition. During Phase 2, subsequent to emitting five correct verbal responses a lever-press response in the presence of five illuminated lights was required to produce primary reinforcers in both experimental conditions, to increase the likelihood that the children attended to the lights. The performance of all subjects was consistently superior in the light-flash condition during this phase. In addition, the performance of the two subjects who did not show any difference between the two conditions in Phase 1 improved considerably in both experimental conditions as a result of requiring a lever-press response. Phase 3 was a reversal to the conditions of Phase 1, in that a lever-press response was no longer required to produce primary reinforcers. The performance of all subjects deteriorated in both experimental conditions. The subject who showed superior picture-naming performance in the light-flash condition of Phase 1 continued to do so in Phase 3 while the two conditions produced no differential effects for the other two subjects. The lever-press requirement was reintroduced in Phase 4 and the results of Phase 2 were

replicated in that the performance of all subjects was superior in the light-flash condition and the performance of the two subjects who showed no differences between the two conditions in Phase 1 and 3, improved considerably in both experimental conditions. During Phase 5 the schedule of primary reinforcement was increased from FR 5 to FR 10. The picture-naming behavior of two children remained superior across a number of dependent measures in the light-flash condition while the third subject's behavior deteriorated in both experimental conditions. In Phase 6 the schedule of primary reinforcement was reversed to FR 5 and the performance of all subjects was superior in the light-flash condition. The subject's behavior which deteriorated during Phase 5, recovered during Phase 6. During Phase 7 the light-flashes which followed fifth correct responses and were associated with primary reinforcers were different from the light-flashes which followed all but fifth correct responses. The two subjects exposed to this condition continued to emit superior picture-naming behavior in the light-flash condition. Performance in the sequential light condition seemed to be inferior to performance in the light-flash condition as a result of sequential lights discriminatively controlling low response rates when the probability of delivery primary reinforcers was low. Also, for two subjects the lights in either condition seemed to function as conditioned reinforcers only when a specific attending response was required to produce primary reinforcement, indicating that the simple pairing of stimuli and reinforcers is not always a sufficient procedure for establishing stimuli as conditioned reinforcers.

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CHAPTER I

INTRODUCTION

Basic Research on Conditioned Reinforcers

Events or stimuli which increase the future likelihood of behavior which they follow are called reinforcers (Ferster and Skinner, 1957). Some reinforcers, such as food and water, are able to strengthen (i.e., increase the probability of) behavior without having to be associated with other reinforcers. These are called primary reinforcers. Other reinforcers, such as money or praise, are formerly neutral events which acquire their reinforcing status by being appropriately associated with other reinforcers. These are called conditioned reinforcers. It is with conditioned reinforcers that this research is primarily concerned.

Despite the extensive basic research on conditioned reinforcement (discussed extensively by Hendry, 1969; Kelleher, 1966; and Kelleher and Gollub, 1962), disagreement remains with respect to the precise conditions necessary for creating conditioned reinforcers. One view maintains that when a stimulus is temporally paired with a reinforcer, the stimulus acquires reinforcing value. According to this theory, a stimulus such as the sound produced by the operation of a food dispenser in an experimental chamber, acquires reinforcing value simply as a result of being paired with food. An alternative view maintains that a stimulus acquires reinforcing value as a result of becoming a discriminative stimulus (a stimulus in the presence of

which a response is reinforced and in the absence of which the same response is not reinforced) for a subsequent response. According to this second theory, a stimulus such as the sound produced by the operation of a food dispenser, acquires reinforcing value as a result of functioning as a discriminative stimulus in the presence of which approaching the food tray is reinforced.

Early research on conditioned reinforcers revolved around this issue and evidence was produced for both positions. For example, in a study with rats, Schoenfeld, Antonitis and Bersh (1950) paired a stimulus light with the ingestion of food rather than with food delivery. They were unable to demonstrate that the light had acquired conditioned reinforcing value and concluded that simple pairing of a stimulus and reinforcer was not sufficient for creating a conditioned reinforcer. In contrast, Stein (1958) found that pairing a tone with the non-contingent delivery of reinforcing intra-cranial stimulation was sufficient to establish the tone as a conditioned reinforcer. This indicates that it is not necessary to establish a stimulus as a discriminative stimulus in order to establish it as a conditioned reinforcer. However, in studies such as Stein's it is possible that the stimulus which preceded reinforcer delivery discriminatively controlled an operant response which was unidentified by the experimenter. In short, the repeated pairing of a stimulus and a primary reinforcer, with the stimulus briefly preceding the primary reinforcer, is a sufficient procedure for establishing the stimulus as a conditioned reinforcer. Whether a stimulus must be a discriminative stimulus in order to function as a conditioned reinforcer is not known. Since this issue apparently cannot be resolved with current experimental techniques, it seems to have been temporarily set aside.

One of the problems with earlier research was that the effects of conditioned reinforcers were demonstrated during experimental extinction in

which primary reinforcement was withheld. Since conditioned reinforcers quickly lose their effectiveness as reinforcers when delivered in the absence of primary reinforcers, this approach prevented a thorough analysis of the effects of conditioned reinforcers. It now seems more promising to study conditioned reinforcers while the behavior of interest is being maintained by some schedule of primary reinforcement.

A schedule of reinforcement is a prescription for initiating and terminating reinforcing stimuli in relation to some behavior (Morse, 1966). In other words, a schedule of reinforcement specifies which instance of a behavior will be reinforced. Two general types of schedules are those that reinforce a response on the basis of time since the previously reinforced response (interval schedules) and those that reinforce a response on the basis of number of responses since the previously reinforced response (ratio schedules). Both interval and ratio schedules fall into two basic classes: fixed and variable. In a fixed-interval (FI) schedule of reinforcement, reinforcement is delivered to the first response that occurs after a fixed period of time following the previous reinforced response. In a variable interval (VI) schedule of reinforcement, reinforcement is delivered to the first response after a varying period of time following the previous reinforced response. In a fixed-ratio (FR) schedule of reinforcement, reinforcement occurs after a fixed number of responses since the previous reinforced response. Each of these four schedules generates a characteristic type of performance. Ferster and Skinner (1957) have described in detail the typical performance of rats and pigeons under different values of these schedules, and under a number of other complex schedules which are essentially variations and combinations of these simple schedules.

Two complex schedules whose effects have been extensively described

in the basic literature are chained and tandem schedules. These two types of schedules are similar in that primary reinforcers are delivered contingent upon the completion of a number of simple schedule components. For example, one type of chained or tandem schedule might specify that the first response after each successive one-minute interval completes a FI component, and that a primary reinforcer is delivered after every third fixed-interval component completion. Chained and tandem schedules differ only in that chained schedules have a different exteroceptive stimulus associated with each component, whereas no exteroceptive stimulus changes occur in a tandem schedule. Some of the most interesting recent research on conditioned reinforcement involves comparisons of chained and tandem schedules in which tandem schedules are used as control procedures for evaluating the effects of the exteroceptive stimuli in chained schedules. Research has demonstrated that the exteroceptive stimulus associated with each component of a chained schedule is a conditioned reinforcer (reviewed by Hendry, 1969; Kelleher, 1966).

A number of studies have compared the effects of chained and tandem FI schedules on the key-pecking of pigeons. For example, Gollub (1958) showed that in chained schedules, long pauses in responding occur in the FI component farthest from primary reinforcement, while typical FI scallops (a positively accelerating rate of response with the lowest rate occurring following reinforcer deivery and the highest rate occurring just prior to reinforcer delivery) occur in the other FI components. Neither pauses or scallops occur in the FI components of comparable tandem schedules. As a result tandem schedules typically maintain much more responding than comparable chained schedules. Gollub's study suggests that the component stimuli closest to primary reinforcement in two or three component chained schedules are discriminative stimuli controlling moderate response rates in their respective

components, but are not powerful conditioned reinforcers for responding in a preceding component.

The exteroceptive component stimuli farthest from the primary reinforcer are never associated with reinforcers in chained schedules. This probably accounts for some of the differences in performance generated by chained and tandem schedules. This conclusion seems to be supported in a study by Kelleher and Fry (1962). They examined three-component FI schedules in which the stimuli associated with each FI component were manipulated. They found that if the same stimulus was present in each component (i.e., a tandem schedule), response rate was positvely accelerated throughout the entire schedule. If a different stimulus was correlated with each component (i.e., a chained schedule), pauses and low response rates were apparent in the two components farthest from primary reinforcement. If a different stimulus was correlated with each component but the order of the stimuli was varied so that primary reinforcers were delivered equally often in the presence of each, the pattern of responding was positively accelerated within each component. This study emphasizes the fact that component stimuli have discriminative as well as reinforcing properties. In a chained schedule the component stimuli farthest from the primary reinforcer are never associated with the reinforcer and may discriminatively come to control low response rates. As a result, a stimulus may be a conditioned reinforcer for responding in the preceding component but response rate in that component may be low as a result of the discriminative properties of the stimulus correlated with that component.

An interesting study by Byrd (1971) examined performance on chained FI schedules when the stimulus appearing in the terminal component (the component associated with the primary reinforcer) also appeared in other components. He found that when as many as eight components comprised a

chained schedule and the stimulus appearing in the terminal component also appeared in alternate components, moderate response rates were maintained in all components in which the stimulus was present, except in the initial component in which response rate was low. He felt that this was largely due to the discriminative effects of the terminal stimulus. His results indicate that low response rates in the initial components cannot be accounted for solely in terms of the reinforcing effect of component stimuli. Response rates during the third component increased more than eight times when the schedule was increased from three to five components; and fifth component performance increased when the schedule was changed from five to seven components. Byrd concluded that response rates in a chained schedule are low in the first component regardless of the number of components, whether or not the stimulus present in the subsequent component is a conditioned reinforcer, and whether or not the stimulus present during the initial component discriminatively controls high rates in other components. This is the case provided that the number of components and order of component stimuli remain constant during successive sequences.

In general, then, it seems that response rates in chained schedules are low in the components farthest from the reinforcer as a result of stimuli not associated with the delivery of reinforcers controlling low response rates, rather than a result of component stimuli functioning as weak reinforcers. While in some chained schedules it seems to be the stimulus associated with the initial component which controls low response rates, this does not always seem to be the only stimulus involved.

Other research has examined the effects of conditioned reinforcers such as tokens and brief light illuminations in chained schedules and other complex schedules of reinforcement in which conditioned reinforcers are

contingent upon completion of schedule components and are only intermittently accompanied by primary reinforcers. The performance characteristically generated by chained schedules is similar to the performance generated by schedules in which tokens are contingent upon completion of schedule components. For example, Kelleher (1957) described performance of chimpanzees under a chained FI 5-min. schedule in which the number of FI 5-min. components required was increased from one to eight. A token was delivered contingent upon the first response after the passage of a five-minute time interval, measured from the preceding token delivery. Primary reinforcers accompanied the exchange of a fixed number of tokens (i.e., primary reinforcers were contingent upon completing a fixed number of FI 5-min. components). Kelleher found that as the number of FI 5-min. components was increased, response rate in the initial component decreased. When the schedule consisted of eight FI 5-min. components, responding in the initial component ceased entirely.

In a similar study with chimpanzees Kelleher (1958) examined the effects of a chained schedule which consisted of fifty FR 125 components. A token was delivered contingent upon each subsequent one hundred and twenty-fifth response and primary reinforcement occurred after the exchange of fifty tokens. Kelleher found that responding was sporadic with frequent pausing until a number of tokens had been obtained. This initial pausing could be eliminated by giving the chimpanzee fifty free tokens (which were later exchanged for primary reinforcers) at the start of the schedule. In general, the performance generated by these token schedules is similar to the performance generated by other chained schedules. In token schedules, however, it is the accumulation of tokens which provide the stimulus change defining a chained schedule, and for token trained organisms the number of tokens in possession is a powerful controlling stimulus. The conditions which exist

prior to the delivery of the first few tokens are conditions which immediately follow the consumption of reinforcers and are quite dissimilar from the conditions associated with the delivery of primary reinforcers. As a result, these conditions seem to control low response rates discriminatively.

The typical performance generated by token schedules is not apparent in similar schedules when conditioned reinforcers which do not accumulate, as do tokens, are used. Several studies have utilized a brief change in some exteroceptive stimulus as a conditioned reinforcer. Stimuli such as these (e.g., the brief illumination of a light), because of their transient nature, are less likely than tokens to acquire discriminative functions. There is considerable evidence that when brief conditioned reinforcers are made contingent upon the completion of FI and FR schedule components, rate of responding is increased. Such conditioned reinforcers maintain what otherwise is often weak behavior without the pausing and low rates that typify token-schedule performances. For example, Findley and Brady (1965) examined the effects of brief conditioned reinforcers in an FR 4000 schedule with chimpanzees. In one condition the hopper-light which illuminated the food tray was illuminated only when reinforcers were delivered (i.e., after 4000 responses) while in a second condition a brief hopper-light illumination was contingent upon every four-hundredth response as well as when primary reinforcers were delivered. They found that post-reinforcement pauses were shorter and less time was taken to complete the ratio in the condition in which the hopper-light occurred after every four-hundredth response. In short, performance was enhanced in the condition in which brief conditioned reinforcers were periodically contingent upon correct responses.

In a similar study, Kelleher (1963) described the effects of a chained FI 4-min. schedule which consisted of fifteen FI 4-min. components.

A light-flash was contingent upon the completion of each FI 4-min. component and primary reinforcement accompanied every fifteenth component completion. He found that when the light-flash also accompanied primary reinforcement, the scalloped pattern of responding in each FI 4-min. component resembled food-reinforced FI responding. If the light flash did not accompany primary reinforcement, response rates were lower in all components and the typical FI patterning was no longer apparent. Thus it seems that brief conditioned reinforcers can often result in enhanced performance in chained FR and FI schedules. Similar effects are not evident in comparable schedules when conditioned reinforcers seem discriminatively to control low response rates when the likelihood of primary reinforcement is low. Brief conditioned reinforcers on the other hand, produce patterns of responding like those maintained by similarly scheduled primary reinforcers. This often results in chained schedule performance which is superior to that produced by chained schedules in which no conditioned reinforcers are utilized or in which conditioned reinforcers which accumulate are utilized.

Another type of enhancing effect of brief conditioned reinforcers is demonstrated in a study involving a more complex discrimination task with pigeons. Stubbs and Galloway (1970) trained pigeons to peck a centre key and then to peck a right or left side key depending on the stimulus produced on the centre key. In one condition each correct response to a side key produced a brief illumination of the hopper-light and the illumination of the hopper-light was periodically accompanied by the delivery of primary reinforcers. In a second condition, correct responses did not produce light illuminations. Primary reinforcers were delivered according to a variety of simple schedules in both experimental conditions. Regardless of the schedule of primary reinforcement, the addition of the light-flash resulted in higher response

rates and greater accuracy than occurred when light-flashes were not contingent upon correct responses. As well as producing increased response rates then, it seems that brief conditioned reinforcers can improve accuracy of responding on complex discrimination tasks.

Research on Conditioned Reinforcers in Applied Settings

While the basic literature suggests a number of rules for the effective use of conditioned reinforcers, even the most fundamental questions cannot be confidently answered with respect to the effective use of conditioned reinforcers in applied training procedures.

The present research is primarily concerned with the application of conditioned reinforcers to the training of the mentally retarded. In recent years, behavior principles derived from the basic experimental analysis of behavior have been used to develop a variety of procedures for training the mentally retarded. Conditioned reinforcers have proven important in these procedures because of their advantages over primary reinforcers. For example, many conditioned reinforcers can be presented immediately and in small amounts, unlike most primary reinforcers. In addition, conditioned reinforcers are less likely than primary reinforcers to lose their effectiveness over long training sessions because of satiation. These and other advantages have resulted in the wide-spread use of conditioned reinforcers in applied settings, and in the development of elaborate token economies in which tokens are delivered contingent upon specified behavior and are ultimately exchanged for a variety of reinforcers (see Ayllon and Azrin, 1968).

Despite the wide-spread use of conditioned reinforcers in applied settings, very little is known about their effects. In mental retardation, as in many other areas, little fundamental research has been conducted to

determine the conditions sufficient for establishing conditioned reinforcers, the most effective schedules of pairing conditioned and primary reinforcers, and the most effective types of conditioned reinforcers in applied settings.

One study which did examine the conditions sufficient for establishing conditioned reinforcers was conducted by Lovaas, Frietag, Kinder, Rubenstein, Schaffer, and Simmons (1968). They initially established "good" as a stimulus in the presence of which a psychotic child received a bite of food independent of his behavior. They were then able to strengthen and maintain lever pressing with "good" as the only reinforcer. They found that "good" retained its control of lever pressing so long as "good" continued to be paired with food delivery in the lever-press situation. In a similar study, Reynolds and Risley (1968) described the conditions under which adult attention would function as a reinforcer. They found that they could increase a four-year-old child's rate of talking if they attended to the child verbally when she talked, and paired this attention with other reinforcers. Adult attention lost its reinforcing properties when it was presented in the absence of primary reinforcers for some time. Studies such as these, in which some aspect of conditioned reinforcers is the specific variable of interest, are quite rare in the applied literature. In recent research with retarded children at the St. Amant Centre in Winnipeg, Manitoba, two research topics related to conditioned reinforcers - the effects of different schedules of pairing primary and conditioned reinforcers and the effects of different types of conditioned reinforcers - have been examined.

The schedule of pairing of primary and conditioned reinforcers is one aspect of conditioned reinforcers that has received relatively little attention to date. If conditioned reinforcers are to be used for extended periods of time (e.g., verbal training procedures), they must periodically be