CONTROL OF PREFERENCE IN CHILDREN BY CONDITIONED POSITIVE REINFORCEMENT¹

JUDITH ELBERT FAVELL AND JAMES E. FAVELL

UNIVERSITY OF KANSAS

A preference measure was employed with children to evaluate the conditioned positive reinforcing function of a stimulus that preceded reinforcement. A match-to-sample procedure was arranged in which subjects could respond to either the form or color dimension of a compound sample stimulus. Intermittent token reinforcement was provided equally for color and form matches. Two stimuli were employed (Stimulus A and Stimulus B), each consisting of a distinctive tone and colored light. One of these stimuli (the paired stimulus) preceded each token delivery, and the other did not (nonpaired stimulus). The paired stimulus was dependent upon each response to one match dimension, and the nonpaired stimulus followed each response to the other dimension. Three of the five subjects responded primarily to the dimension that was followed by the paired stimulus. This effect was obtained regardless of which stimulus (A or B) was paired and on which match dimension (color or form) the paired stimulus was dependent. These results were unaltered by discontinuing the nonpaired stimulus. The other two subjects demonstrated consistent preferences for the form dimension and Stimulus A, respectively.

In a recent study by Clark and Sherman (1970), pigeons were trained to peck at whichever of two keys was the same color as a sample key. A fixed-interval 8-min (FI-8-min) schedule provided reinforcement of the first matching response after 8 min following the previous reinforcement; each food delivery was preceded by 0.5 sec of orange key illumination (referred to as the paired stimulus). It was shown that the paired stimulus acquired a reinforcing function through its pairing with food, so that when mismatches (responses to a key of a different color than the sample) produced brief presentations of the paired stimulus alone (without food), the rate of mismatching increased. By demonstrating control of a conditional discrimination by conditioned reinforcement, the Clark and Sherman study extended previous studies that controlled simple responses by conditioned reinforcement in concurrent schedules (*e.g.*, Zimmerman, 1963; Randolph and Sewell, 1965; Zimmerman and Hanford, 1966), and second-order schedules (*e.g.*, Findley and Brady, 1965; Kelleher, 1966; Thomas and Stubbs, 1966). Stubbs and Galloway (1970) reported similar findings: under some schedules of reinforcement of correct responses, the rate and accuracy of pigeons' match-to-sample responding were increased when every correct response produced a stimulus that was intermittently paired with food delivery.

The purpose of the present experiment was to examine the effects on children of a procedure similar to that of Clark and Sherman and of Stubbs and Galloway. Specifically, the procedure was designed to evaluate if a stimulus paired with reinforcement could control children's preference for one of two matches when unconditioned reinforcement was available equally for the two.

METHOD

Subjects

Two females and three males, ranging from 10 to 12 yr of age, all from low income families in the community, served.

¹This paper represents a portion of a dissertation submitted by the first author to the Department of Human Development and Family Life, University of Kansas, in partial fulfillment of the requirements for the Ph.D. degree. The authors gratefully acknowledge the advice and support of Dr. James A. Sherman throughout the conduct of this investigation. This investigation was supported by Public Health Service training grant HD 00183 from the National Institute of Child Health and Human Development to the Kansas Center for Research in Mental Retardation and Human Development, and by grant number OEO 4125 to the University of Kansas Head Start Evaluation and Research Center from the Office of Economic Opportunity. Reprints may be obtained from either author, Department of Psychology, Western Carolina Center, Morganton, North Carolina 28655.

Apparatus

The experimental enclosure was a 2.3 by 2.7 m sound-attenuated room. Scheduling and recording were accomplished by standard electromechanical equipment and a human observer, respectively, both located in an adjacent room. Differential lighting of a one-way mirror allowed observation of the subject, but prevented the subject from seeing the observer.

The match-to-sample apparatus was similar to that described by Hively (1964): the subject faced a panel that displayed a single 11 by 3.75 in. (28 by 9.5 cm) frosted plastic (Plexiglas) window (sample window) above four 2.75 by 3.75 in. (7 by 9.5 cm) windows (choice windows). A green lamp was mounted to the left and a red lamp to the right of the choice windows. A slide projector positioned behind the panel projected stimuli onto each of the windows. Depression of each window activated a different switch and was recorded as a response. A Gerbrands Universal Feeder (Model 70), located behind the wall supporting the panel, delivered marbles into a plastic tray immediately above the match-to-sample panel.

Stimulus Materials

The stimuli were chromatic geometric forms including all combinations of the colors: red, green, blue, and yellow; and the forms: circle, rectangle, square, and triangle. This combination of forms and colors resulted in 16 possible stimuli. Slides were constructed by sticking 0.125 by 0.125 in. (0.5 by 0.5 cm) geometric forms, cut from colored translucent paper,² onto 1.5 by 1.5 in. (3.8 by 3.8 cm) squares of frosted acetate. Each slide contained five colored forms such that when projected, one stimulus appeared approximately centered in each window.

Procedure

After being seated facing the match-to-sample panel, each subject was introduced to the experiment with the following instructions:

"Select the one of these (the experimenter pointed to each of the four choice stimuli) that matches this (the experimenter then pointed to the sample stimulus). You select one by pressing its window, like this (the experimenter pressed each window sequentially). When you are right, a marble will drop into this tray. After you are finished, you can trade each marble for a penny."

The experimenter then left the room, and signalled through an intercom for the subject to begin. Each of two daily sessions was terminated after 65 trials; the experimenter then returned and counted the marbles with the subject, then redeemed each for a penny.

On each trial, the choice stimuli were related to the sample stimulus and to each other in the following ways: (1) one stimulus was different in color but of the same form as the sample; (2) another stimulus was different in form but of the same color as the sample; (3) the two other stimuli were different from the sample stimulus in both form and color; (4) all choice stimuli were different from each other in both form and color. During each session, 15 of the sample stimuli were presented four times, and one was presented five times. Slides featuring each of the 16 samples were arranged in random order, and the same 65-slide sequence was used throughout the experiment.

Each mismatch, *i.e.*, each response to a stimulus that differed from the sample in both color and form, was followed by 1.5 sec, during which all windows were dark; then, the next slide was presented. Each matching response produced the following sequence: (1) for 0.5-sec conditions did not change; during this interval a response to any other window immediately produced the conditions appropriate to a mismatch; (2) if no other response occurred during the 0.5-sec interval, a particular tone and colored light combination (described below) was presented for 0.5 sec; (3) a 1.5-sec period followed the offset of the tone and light, during which all windows were dark as the projector advanced to the next slide. Responses occurring while the projector advanced had no scheduled consequences and were not recorded. Marble delivery, if scheduled, occurred as the projector advanced.

²Zip-a-Tone, manufactured by Para Tone, Inc., and available at the Max Morris Co., 3415 Main, Kansas City, Missouri.

For Subject 1, a variable-interval 15 sec (VI 15-sec) schedule of marble delivery was in effect for both color and form matches: after aperiodic intervals averaging 15 sec, the next matching response, either color or form, produced a marble. For Subjects 2, 3, 4, and 5, a variable-ratio 4 (VR 4) schedule provided that matching responses, either color or form, produced a marble on an average of every fourth matching response. Thus, under both VI and VR schedules, marbles were equally available for responding exclusively to either the color dimension, or the form dimension, or distributing responses between the two.

During most experimental conditions, every matching response produced 0.5 sec of tone and light. Two combinations of tone and light color were used: a 1500-Hz tone was coincidental with illumination of the green lamp (Stimulus A), and a 450-Hz tone accompanied illumination of the red lamp (Stimulus B). For each experimental condition, one of these compound stimulus events (the paired stimulus) preceded the delivery of each marble. The other compound stimulus (the nonpaired stimulus) was not presented before marble delivery. The paired stimulus was presented after each response to one dimension of the match-to-sample stimuli (either form or color), and the nonpaired stimulus was dependent upon responses to the other dimension. For example, while Stimulus A served as the paired stimulus and was presented after each match of one type, *e.g.*, form, Stimulus B was the nonpaired stimulus and dependent upon responses to the other dimension, *e.g.*, color, except when marble delivery was scheduled. When reinforcement was due, either type of match produced the paired stimulus alone, followed by marble delivery.

Two types of procedural reversals were employed. The first involved changing which stimulus preceded marble delivery. The second type involved interchanging the stimuli produced by the form and color matches, *e.g.*, replacing Stimulus A with B as the consequence for form matches, while simultaneously replacing B with A as the stimulus following responses to color. The initial experimental conditions, *i.e.*, which stimulus served initially as the paired stimulus, and on which type of match that stimulus was first made dependent, were arbitrarily assigned

and varied across subjects. The order of subsequent conditions was consequently varied across subjects.

For Subjects 1, 2, and 3, a condition was imposed in which the nonpaired stimulus was omitted as a consequence. Under this condition, when a nonpaired stimulus presentation was due, the scheduling and recording equipment was affected as usual, but the nonpaired stimulus was not presented to the subject. As before, responses to either the form or color dimension produced marbles (preceded by the paired stimulus) intermittently. This condition was designed to evaluate if the presentation of the nonpaired stimulus was necessary to the formation or maintenance of a discrimination. The question was: Could an apparent preference for the paired stimulus be accounted for by some property of the nonpaired stimulus, *e.g.*, its punishing function, rather than, or in addition to, the conditioned reinforcing properties of the paired stimulus?

In summary, this procedure included the following components: (1) intermittent marble reinforcement, equally available for color and form matches, (2) preceding each marble delivery (whether for a color or form match) by a paired stimulus, and (3) presentation of the paired stimulus dependent on each response to one match dimension, and the nonpaired stimulus after each response (except those producing marbles) to the other match dimension. A condition was changed after a minimum of two sessions, when a stable preference was observed (stability was judged by visual survey) or when the behavior was changing in a direction opposite to that expected under the next manipulation (in each condition it was expected that preference would be for the dimension producing the paired stimulus).

Conditions were continued for more than two sessions for one of two reasons: (1) to gain added assurance of the durability of a reversal, or (2) to observe the trend of an unexpected preference, *i.e.*, for the nonpaired stimulus.

RESULTS

Results for Subjects 1, 2, 3, and 4 are shown in Figure 1. The proportion of color matches was calculated for each session by dividing the number of color matches by the total number of matches. The median and the range of all

Fig. 1. Results for Subjects 1, 2, 3, and 4. Median proportions of color matches (bars) are plotted; each bar is bracketed by the range of values. The letter C or F at the top of each bar represents which type of match, color or form, produced the paired stimulus. The number below each bar indicates the number of sessions in that condition. "B paired" or "A paired" indicates which stimulus was paired with reinforcement. The phase number designates the order in which that condition occurred in the experiment.

proportions for each condition were then plotted. Mismatches are not plotted, since these responses decreased during the first session for each subject and remained at a near-zero level throughout the experiment.

Similar results were obtained for Subjects 1, 2, and 3: when the paired stimulus was presented dependent upon color matches, subjects responded primarily to the color dimension; when form matches produced the paired stimulus, subjects responded mostly to the form dimension. These results were the same regardless of which stimulus was paired with

marble delivery, and were not affected by discontinuing presentation of the nonpaired stimulus. Thus, a reversal of dimension preference was readily accomplished by interchanging the stimuli (A and B) that were dependent upon form and color matches, or by alternating which stimulus was paired with marble delivery.

A sequence of manipulations was employed with Subject 3 that differed from that for Subjects 1 and 2. During Phases 2, 3, and 4, form and color matches always produced Stimuli A and B, respectively. Which of these stimuli

was paired with marble delivery was alternated across phases.

For Subject 4, a relatively small shift in preference to the paired stimulus is evident. However, the subject maintained a slight but consistent preference for the form dimension. No further manipulations were performed with Subject 4, due to his request to withdraw from the experiment.

Initially, Subject 5 (whose data are not shown) demonstrated a clear preference for the form dimension, which produced the paired stimulus (A), and thereafter shifted to whichever dimension produced A. This preference was not affected by discontinuing the pairing of A and making B the paired stimulus. For 16 sessions, responding remained almost exclusively to the dimension that produced A.

DISCUSSION

The results for Subjects 1, 2, and 3 indicate that the paired stimulus was a conditioned positive reinforcer: it increased the frequency of responses that produced it, and its reinforcing effectiveness depended on a particular experimental operation, *viz.* pairing with an already established reinforcer. Specifically, the paired stimulus presentations increased the proportion of matches that produced them, regardless of which stimulus was paired. These results were reliable within, and general across three subjects. Further, it was shown that the nonpaired stimulus consequence was not necessary to control preference: when the nonpaired stimulus was discontinued, subjects continued to prefer the dimension that produced the paired stimulus.

The results show that conditioned reinforcement can produce effects on some children's match-to-sample performance that are both large and rapid. Furthermore, the overall conditioned reinforcement effects can be quite durable (*e.g.*, for Subject 1, conditioned reinforcement potency was undiminished after 168 sessions). Thus, despite numerous procedural differences, the present results are generally consistent with those of Clark and Sherman (1970) and of Stubbs and Galloway (1970). The present experiment showed substantially larger conditioned reinforcement control of matching than did the Clark and Sherman experiment, probably because unconditioned

reinforcement was equally available for both matches, rather than dependent upon only one particular match.

In an experiment with pigeons, Schuster (1969) altered pigeons' preferences for two keys with conditioned reinforcement, but was unable to maintain such preference for more than about 20 sessions. Because the present study did not attempt to maintain preference for a particular dimension (form or color) for more than approximately 10 sessions, and because of numerous other procedural differences, it is difficult to compare the present results to Schuster's.

These results demonstrate the efficacy of teaching discriminations to children by using stimuli that have been chosen for convenience and economy and then made into positive reinforcers by pairing with already established reinforcers. In this way, teachers can provide non-intermittent reinforcement of correct responses without the expense and inconvenience of unconditioned reinforcers such as food.

The inability of the paired stimulus to control the preference of two subjects limits the generality of these findings. Subjects 4 and 5 demonstrated a consistent preference for form matches and Stimulus A, respectively. This experiment did not determine whether the pairing procedure was ineffective in establishing conditioned reinforcers for these subjects, or whether other more powerful variables were overriding the conditioned reinforcement effects.

REFERENCES

- Clark, H. B. and Sherman, J. A. Effects of a conditioned reinforcer upon accuracy of match-to-sample behavior in pigeons. *Journal of the Experimental Analysis of Behavior*, 1970, 13, 375-384.
- Findley, J. D. and Brady, J. V. Facilitation of large ratio performance by the use of conditioned reinforcement. *Journal of the Experimental Analysis of Behavior*, 1965, 8, 125-129.
- Hively, W. A multiple-choice visual discrimination apparatus. *Journal of the Experimental Analysis of Behavior*, 1964, 7, 27-36.
- Kelleher, R. T. Conditioned reinforcement in second-order schedules. *Journal of the Experimental Analysis of Behavior*, 1966, 9, 475-485.
- Randolph, J. and Sewell, W. Competitive conditioned reinforcement during differential reinforcement of low rates. *Psychonomic Science*, 1965, 3, 411-412.
- Schuster, R. H. A functional analysis of conditioned reinforcement. In D. P. Hendry (Ed.), *Conditioned reinforcement*. Homewood, Illinois: The Dorsey Press, 1969. Pp. 192-234.

- Stubbs, A. and Galloway, W. D. Conditioned reinforcement and discrimination performance. *Journal of the Experimental Analysis of Behavior*, 1970, 14, 23-31.
- Thomas, J. R. and Stubbs, A. Enhancement of fixed-ratio performance by briefly presented conditioned reinforcing stimuli. *Psychonomic Science*, 1966, 5, 329-330.
- Zimmerman, J. Technique for sustaining behavior with conditioned reinforcement. *Science*, 1963, 142, 682-684.
- Zimmerman, J. and Hanford, P. V. Sustaining behavior with conditioned reinforcement as the only response-produced consequence. *Psychological Reports*, 1966, 19, 391-401.

Received 28 September 1970.

(Final acceptance 25 February 1972.)