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Conditioned Reinforcement: An Attempt to Replicate the Thomas Procedure with Children

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CONDITIONED REINFORCEMENT: AN ATTEMPT TO REPLICATE THE THOMAS PROCEDURE WITH CHILDREN

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Michael B. Oberlin

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INTRODUCTION

Many applications of behavioral psychology are derived from basic laboratory research in the experimental analysis of behavior. One experimental area of special importance to the applied behavior analyst is that of conditioned reinforcement. References to conditioned reinforcement are ubiquitous in the applied behavior analysis literature. The idea that previously neutral stimuli can acquire reinforcing properties is utilized extensively in applied studies. Experimenters are advised to "establish themselves as conditioned reinforcers" before working with clients. Designing effective token systems also demands that experimenters understand the procedures for making tokens serve as reinforcers.

One notion that often recurs in the applied field is that stimuli established as reinforcers in one situation will exhibit this reinforcing function in situations in which the pairing of neutral and primary reinforcers never occurred. The purpose of the present experiment was to examine this notion using a procedure already utilized by Thomas (1969) in the experimental area. The present experiment was not designed to contribute to the experimental literature on conditioned reinforcement, but simply to test a paradigm derived from experimental studies concerning stimulus properties frequently employed in applied studies.

In order to provide an overview of the concept of conditioned reinforcement it is necessary to review the most frequently cited experimental reports. Comparing studies utilizing human and non-human

subjects is difficult because of the experimenters inability to impose rigorous controls upon human beings similar to those imposed on non-human subjects. In spite of this difficulty such comparisons will be made in an attempt to establish the relationship between the results of experimental and applied stuides.

Most applied behavioral studies have relied on a simple pairing interpretation to explain how neutral stimuli become conditioned reinforcers. In this view, an arbitrary stimulus acquires a behavior-strengthening function due solely to temporal contiguity with an unconditioned reinforcer.

The present experiment is designed with children as subjects to replicate the experiment by Thomas (1969) concerning conditioned reinforcement. Thomas' experiment is important because its results favored a pairing interpretation of conditioned reinforcement.

In one phase of the Thomas experiment, pigeons were exposed to a four component multiple schedule: FR120, blackout, and FR10, blackout. Responding in the FR10 component produced a brief presentation of the stimuli associated with grain reinforcement, a .3 second operation of the feeder, which was not long enough to permit feeding. The blackout period served to isolate the FR components and to guard against any chaining which might occur between components.

Thomas (1969) demonstrated that substantial behavior could be maintained in the multiple schedule component which provided only brief "conditioned reinforcers." Calculating response rates from the cumulative curves for multiple FR80, FR10 (Fig. 4.6, p.85), where FR80 is the schedule of primary reinforcement and FR10 the schedule of conditioned reinforcement, indicates a mean response rate of 109

responses per minute for the conditioned reinforcer only, and a mean rate of 180 responses per minute for the conditioned reinforcer plus primary reinforcer.

The question asked in the present experiment is whether the Thomas procedure employed with humans as subjects would result in sustained responding in the schedule component yielding only the stimulus paired with primary reinforcement in the other component.

Recent experimental literature has questioned the pairing interpretation, either favoring an interpretation based on reinforcement density, calculated as the number of reinforcements per unit time in the presence of a given stimulus (Fantino, 1977), a delay-reduction hypothesis which states that a stimulus acts as a conditioned reinforcer because it is associated with a reduction in time to primary reinforcement (Fantino, 1977). A related point of view suggests a functional interpretation: "When an arbitrary stimulus is programmed to follow a response the effects of that stimulus on responding are a function of the conditions of primary reinforcement being cued by the stimulus" (Schuster, 1969, p.231).

Schuster (1969) questioned the validity of a majority of early experiments which supported the pairing hypothesis. These experiments involved chained schedules, and Schuster argues that they did not isolate conditioned reinforcement effects due to pairing from effects due to the potential cue function of the conditioned reinforcer. In the studies that involved chained schedules, responding was maintained in initial links of the chain by presenting a stimulus (the conditioned reinforcer) which was paired with and which also

predicted the primary reinforcer in the terminal link. In this way responding in initial links could be maintained indefinitely. Schuster suggested that research with chained schedules was confounded, since stimuli associated with components of the chain served to predict or cue primary reinforcement in the final component, and this function, rather than pairing might have maintained responding.

More recent experiments, including that of Schuster, have emphasized response maintenance as opposed to acquisition. In these procedures, a neutral stimulus is continually paired with a primary reinforcer on one response key, or in one component of a multiple schedule, but only the potential conditioned reinforcing stimulus appears on, or in, the other. In this way, the pairing of the neutral stimulus with the primary reinforcer presumed necessary for response maintenance is continued. Schuster argued that the brief stimuli would not develop a discriminative or cue function in the component in which they were presented alone, because they would not be associated with primary reinforcement in that component. He believed that any behavior maintained in this component could then be attributed to the reinforcing value of the brief stimuli due solely to their pairing with the primary reinforcer in the other component.

In two experiments designed to test the pairing interpretation of conditioned reinforcement with human subjects, Lovaas and his associates obtained conflicting results. The first experiment with

two 5-year old autistic children developed adults as valued social stimuli by associating them with the removal of pain (Lovaas, Schaeffer, Simmons, 1965). After pairing the experimenter with shock reduction, Lovaas found that the sight of the experimenter became a conditioned reinforcer, and could be used to maintain a lever-pressing response. In a second study with two schizophrenic boys, however, Lovaas was unable to establish a word, "good," as a conditioned reinforcer despite several hundred pairings of the word with food delivery (Lovaas, Freitag, Kinder, Reubenstein, Schaeffer and Simmons, 1966). Lovaas suggested that these discrepant findings resulted because the children attended to the relevant social stimuli in the first experiment, but not to the verbal stimuli paired with food in the second.

In an animal experiment with pigeons as subjects, Zimmerman (1963) was able to sustain responding of about twelve pecks per minute indefinitly on a key which delivered only stimuli associated with food reinforcement: the sound of the solenoid operated magazine, the illumination of a magazine light, the absence of the key lights and the absence of the house lights. Responses on another concurrently operative key produced all of these stimuli and four seconds access to the food magazine. Response rates on this key stabilized at 120 per minute. Responses on both keys were reinforced on a three minute variable interval schedule.

In a replication of the experiment by Zimmerman (1963), Derdyk (1977) attempted to maintain responding in one component of

a concurrent (VI30, VI30) schedule by following responses by a buzzer. The buzzer was paired with tokens and occasionally edibles in the other component. Although Derdyk's results showed that two of her human subjects continued to respond at mean rates of 2 and 5 responses per minute in the buzzer-only component, this responding continued even when pairings of the buzzer and tokens were discontinued. The failure to obtain a decrease in rate suggested that responding was not being maintained by any conditioned reinforcing value of the buzzer. The third subject failed to respond during the buzzer component.

Walton (1977) utilizing a pairing procedure similar to that of Zimmerman (1963) and Derdyk (1977) attempted to establish a light flash as a conditioned reinforcer using rats as subjects. Mean response rates of 16 and 6.6 were recorded in the conditioned reinforcer plus primary reinforcer component, for subjects 1 and 2, respectively, but this rate fell to 3.4 and 2.6 during the light-only component. In a second study which utilized a multiple schedule in a procedure similar to Thomas' (1969) Walton obtained results similar to his first experiment. In one component of this experiment, a tone was paired with food presentation on an FR12 schedule. In a second component, a light flash always followed responding on an FR3 schedule. In this procedure although rates of 127, 59, 66, and 45 responses per minute were obtained in the conditioned reinforcer plus primary reinforcer component, rates of .07, .3, and 1.44 were obtained in the conditioned reinforcer

only component. Rats did not continue to respond in the component in which they received only a tone which was paired with the primary reinforcer in the other component. In the last five days of the experiment, response rates in this component averaged .68 for subject one and .87 for subject two. Rates during the tone plus food component during these final sessions averaged 76.4 for S_1 and 45.3 for S_2.

This review of studies concerning the pairing interpretation of conditioned reinforcement has been included to acquaint the reader with this area, before presenting the present experiment. It is hoped that this material has also indicated the close relationship between applied and experimental studies.

METHOD

Subjects and Setting

Three normal children served as subjects, a 3 year old girl (F-3) and two boys (M-5) and (M-8). The experiment took place in a laboratory room measuring 7 X 7 m. This area was free from visual and noise distractions.

Apparatus

The apparatus consisted of a 21 X 18 X 9 cm. box on which a red and white light were mounted on opposite sides of a button. This response box was placed before a subject who sat at a table. The experimenter sat facing the subject, but hidden behind a partition. Two tubes protruded through the partition to permit tokens and edible reinforcers to be delivered. The token tube consisted of a length of transparent one-half inch tubing which extended from one side to the other down the side of the board facing the subject. A removable bolt blocked the end of the tube. The transparent token tube permitted subjects to view the tokens as they accumulated during a session. The edibles tube was a short piece of hard plastic tubing secured at a sharp angle so that food would slide through it onto the table in front of the subject. All responses were recorded automatically by electro-mechanical counters.

Procedure

Sessions took place Monday through Friday for F-3, and Monday through Sunday for M-5 and M-8. Subjects were told they could accumulate marbles during the experiment which could be exchanged for toys of their choice at the end of each session. The token delivery system itself was designed to be potentially reinforcing to the subjects. The marbles which served as tokens were placed in the tube at the top of the board separating subjects from the experimenter, and traveled down through the transparent tubing in front of the subjects before coming to a stop against the end bolt or another marble whith a click sound. Subjects were told that they had to fill the tube with marbles up to a certain mark. They were told that when they reached this mark and when the red light went out, the session would end and marbles could then be exchanged for toys. Twenty marbles or 200 responses were required to complete a session. Sessions generally lasted four minutes and forty-five seconds.

In the first session, the token system was explained to each subject, and they were shown the line the marbles must reach before the marbles could be exchanged for toys. The experimenter then pointed to the response box and modeled the response as he said "you can push the button like this." The subject was then asked to depress the button twice. No reinforcers were delivered. The experimenter instructed the subject to sit and then moved behind the partition and said "Alright, we can start now." No

additional training was provided, subjects were immediately exposed to the contingencies.

A multiple schedule was in effect throughout the experiment: irrespective of responding, the red light remained on one minute, followed by a 15 second period in which both lights were inoperative, after which the white light was illuminated for 1 minute, at which time another 15 second blackout of both lights occurred, with this cycle repeating until the session terminated. The number of times subjects were exposed to both red and white components depended upon how quickly they accumulated the required number of tokens. Sessions always began with the white light, and ended with the red light component.

Phase I: Acquisition

During the first phase of the experiment, an FR10 response requirement was in effect during the red light condition. Following every 10th response when the red light was illuminated, a one-second tone sounded, immediately after which a marble and edible reinforcer were delivered. The experimenter counted the clicks of the response button and could anticipate the delivery of the tone for the tenth response. This permitted him to ready himself to drop the token with his left hand and edible with his right nearly at the instant the tone sounded. During the white light condition, an FR5 response requirement was in effect; every fifth response produced only the one second tone. Responses during the period in which both lights were out had no effect. Subjects were told

they could eat the edible reinforcers they obtained and talk to the experimenter only during this period.

After several sessions each subject was exposed to separate experimental manipulations.

Phase II: Reversal

For M-5 and M-8, the second manipulation reversed the condition in effect in the previous phase, as token and food delivery were paired with the tone after every 10th response in the white light component. The tone alone followed every 5th respone in the red light component. These conditions were in effect for 10 sessions, after which the experiment was terminated.

Phase II: No pairing

For F-3, the second manipulation consisted of removing the tone from the FR10 component. Responding during this component continued to produce tokens and food, but the tone preceding each delivery of token and food was discontinued. Except for the absence of the tone in the red light component, stimulus conditions were identical to those in the first phase. This phase lasted for 10 sessions.

Phase III: No tone

A third and final manipulation was instituted for F-3 and M-8 because of their response rates during Phase II. The tone was removed completely, and occurred neither in red nor white. Four sessions of this condition ended the experiment.

RESULTS

The mean rate of responding per minute during each component is presented as a semi-log plot. Results are indicated for F-3 in Figure 3, and for M-5 and M-8 in Figure 1 and Figure 2, respectively. A log scale was used on the ordinate to equalize rate increases occurring at low rates with those at higher rates.

All three subjects in the present experiment exhibited high response rates in the component in which they received tokens and edibles for every 10th response. The mean response rate during this component for M-5, M-8, and F-3, respectively, was 116, 104, and 110 responses per minute.

The data in Figure 1 indicated that responding followed by the tone, alone, declined to near zero levels by the seventh session for M-5. The mean response rate in this component during sessions 1-5 was 36 and in 6-15 was 3.35. After making 21.6 responses per minute in the tone-only component during the first session after reversal, the mean response rate for M-5 in the next ten sessions declined to 4.25.

As shown in Figure 2, M-8 also exhibited little responding in the tone-only component. The mean response rate in sessions 1-8 declined from 39.4 to a mean rate of 6.6 in sessions 9-18. Following the removal of the tone in the white light component during Phase III the mean response rate decreased to 7 responses per minute during 25-28.

These low rates for M-5 and M-8 are in contrast to the rate

of approximately 109 responses per minute obtained by Thomas on a multiple FR80-FR10 schedule of conditioned reinforcement plus primary reinforcement, and conditioned reinforcement only. When conditions were reversed in Phase II so that the tone-only component was now associated with the red light, both subjects immediately began responding more during the white light, and avoided the button when the red light was on.

The data from F-3 is presented in Figure 3. F-3 continued to respond in the component in which she received only a tone for every fifth response. This subject responded at a rate of 62.4 responses per minute in this component during Phase I. During Phase II, in which the pairing of tone, food and tokens was discontinued in one component, the F-3 continued to respond at a mean of 71.5 responses per minute for the tone only. During Phase III, subject F-3 responded at a mean rate of 60 responses per minute in the component in which her responses had no effect.

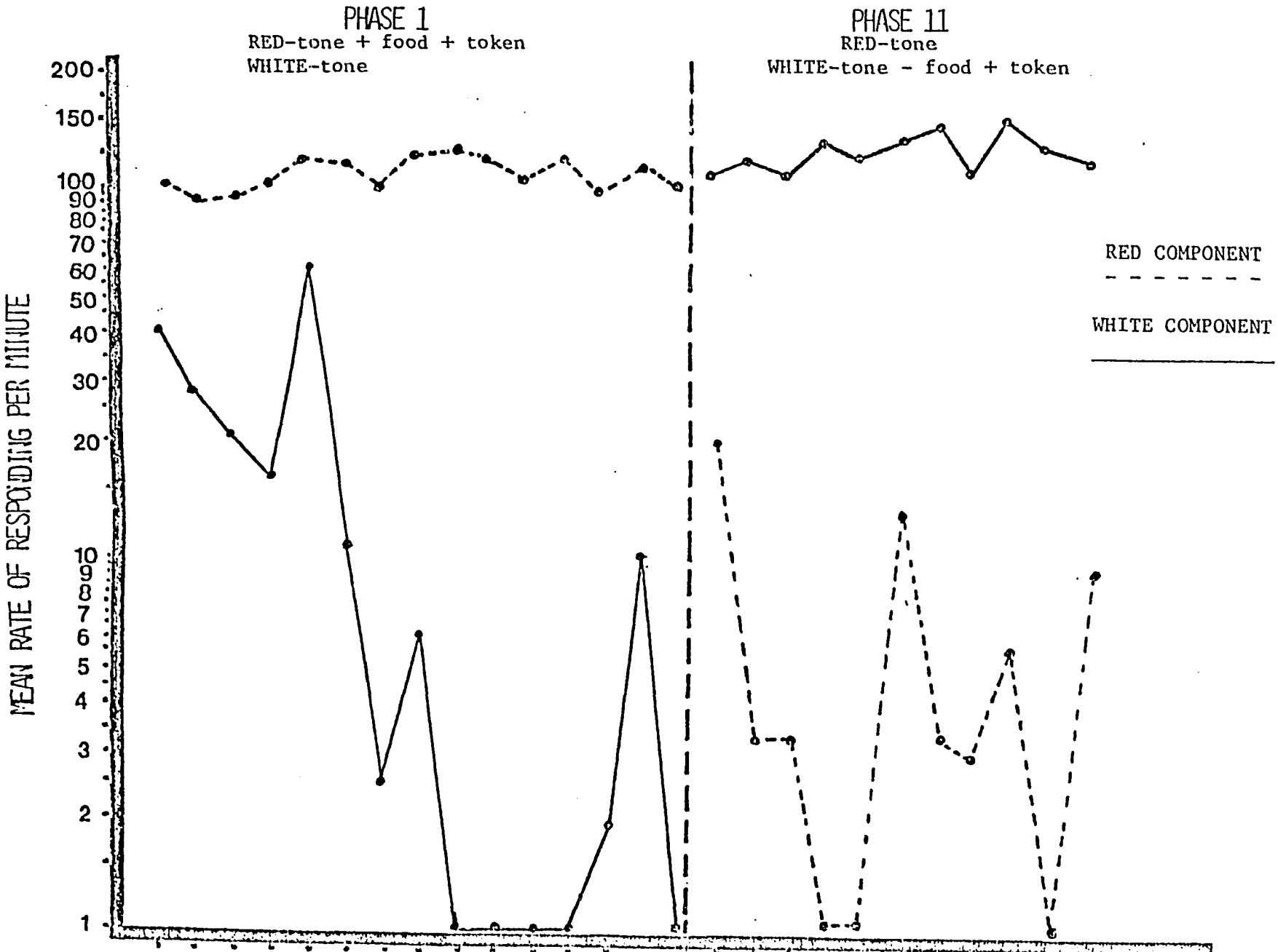

Fig. 1 Rate of presses per minute during the red light and white light component per session for the five year old boy.

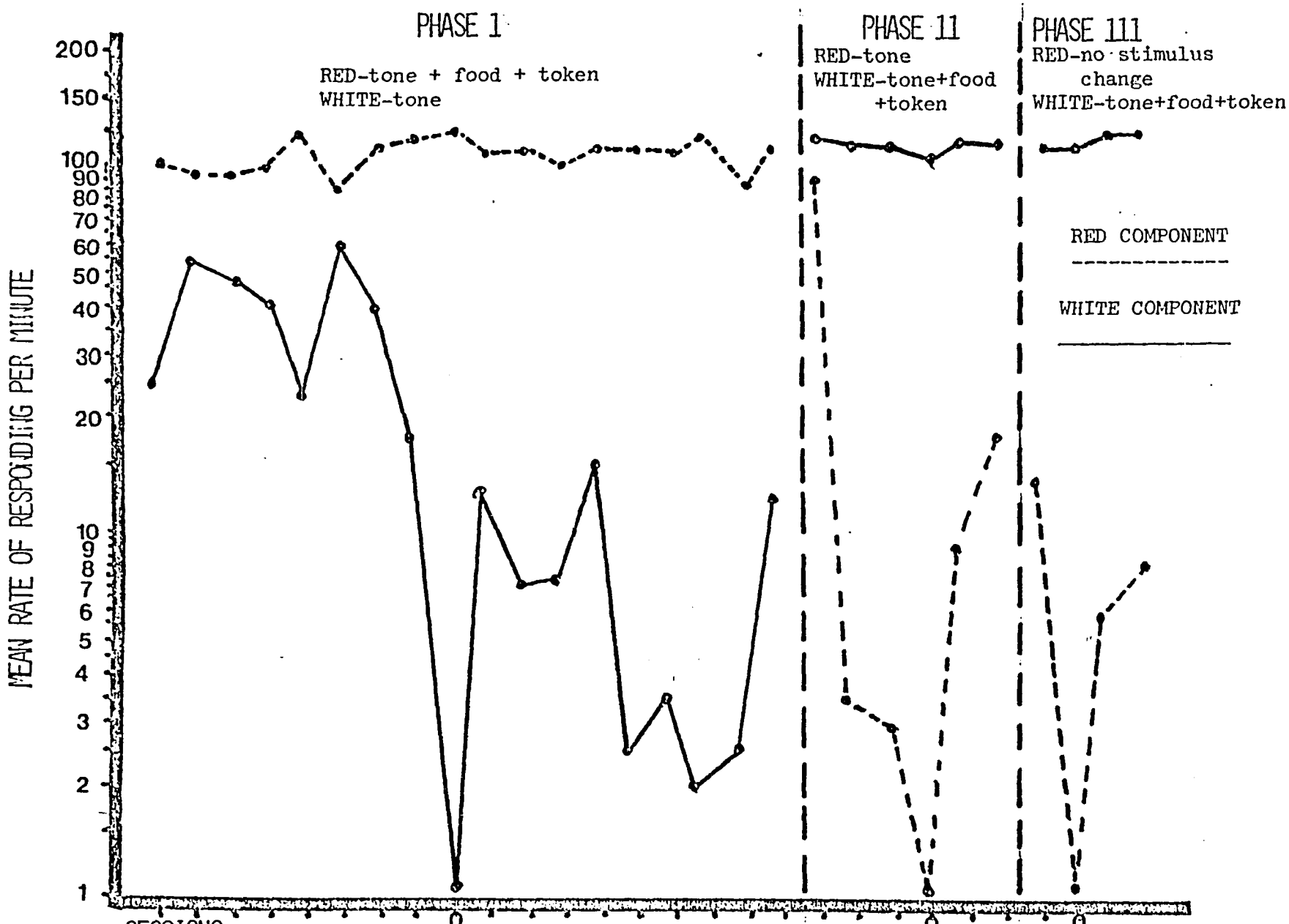

Fig. 2 Rate of presses per minute during the red light and white light component per session for the eight year old boy.

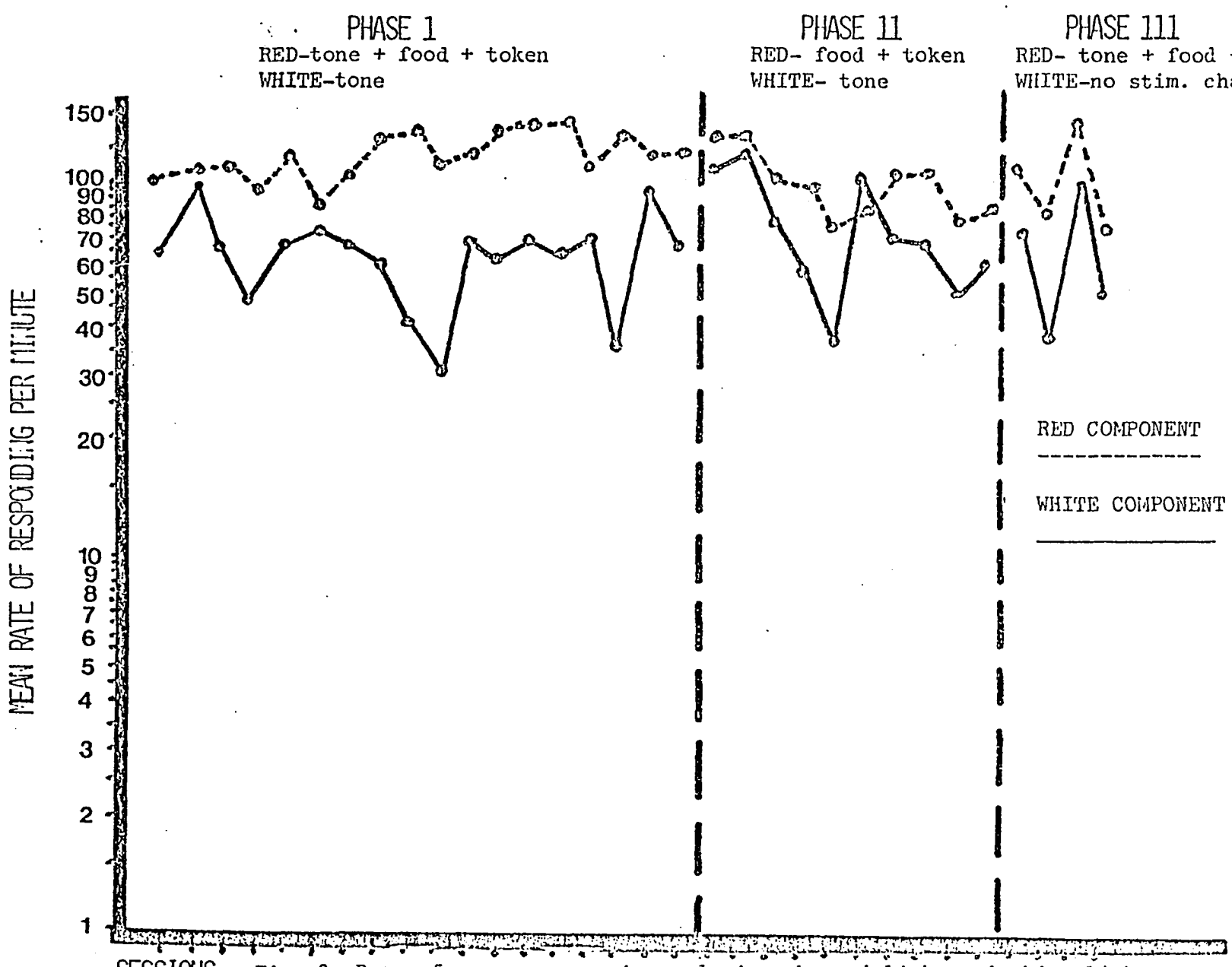

Fig. 3 Rate of presses per minute during the red light and white light component per session for the three year old girl.

DISCUSSION

A simple interpretation of conditioned reinforcement implies when a neutral stimulus is closely and frequently paired with a primary reinforcer, the neutral stimulus will function as a conditioned reinforcer. These conditions were met in the present experiment. The tokens and food were reinforcers, as they were found to maintain high levels of responding. Although by requiring that atleast 20 tokens be accumulated during each session the experimenter was guaranteed 200 responses in the token-food component, overall responding was often above the level required. The second condition, frequent pairing, was also met: since responding exceeded 200, more than 20 pairings of the neutral and reinforcing stimuli occurred during each session.

Despite the high rates in the primary reinforcement component, for two subjects responding quickly declined in the component in which the tone alone followed every fifth response. The mean values of 3.5 and 4.25 in Phases I and II for the M-5 and 6.6 and 6.4 (excluding the first session after the reversal) for M-8 represent the number of responses per minute occurring in the tone-only component. With the FR-5 response requirement in effect, this meant that the youngest boy was responding only enough to produce the tone about once per session. These results from M-5 and M-8 suggest that the tone had not become a conditioned reinforcer for these subjects.

Since responding during the last two sessions of Phase II was quite high compared to previous rates for M-8, a third manipulation was instituted to determine if any intrinsic reward value of the tone was controlling this high rate. This manipulation consisted in removing the tone as a consequence in the red component. Responding in this component now had no effect. Responding in red dropped to zero in the second session of Phase III, but climbed again in the last two sessions of this phase. These results suggest that the tone was not the variable controlling the higher responding in the final two sessions of Phase II, but that some additional factor was involved.

For F-3, data from Phase I suggest that the tone might be functioning as a conditioned reinforcer since responding was maintained at a high level throughout this phase. In order to test whether this responding was actually the result of the response-contingent tone, the pairing of the tone with tokens and food was discontinued in the red component during Phase II. Since the association of conditioned and primary reinforcers is necessary to maintain the effectiveness of the conditioned reinforcer (Skinner, 1938) responding in the white component would decline if it was actually being maintained by the previously neutral tone. Responding iid not decline, however. The number of responses in Phase II increased to a mean of 156 responses per sessions in the tone-only component.

Since F-3's responding did not decrease during Phase II as would be expected when the tone was no longer being paired with the tokens and food, it can be concluded that responding in the white component was probably not being maintained by conditioned reinforcement, but by some other variable. In order to test whether the sound of the tone itself was maintaining responding, the tone was removed from the white component in Phase III, as it was for M-8. Responding in the white component now had no effect. The results from Phase III indicate that responding actually rose to 163.5 responses per minute during this phase. The tone itself did not appear to be the factor maintaining responding during Phase II.

There are atleast three other explanations for the large amount of responding the F-3 exhibited during Phase II. The sustained responding may be attributed to a "frustrative effect" (Amsel, 1958). The subject was observed to respond rapidly and with much greater force than that required to operate the response button. The white light in the present experiment may have evoked frustrative responding because it was associated with the absence of the positive reinforcers, the tokens and food, in the red component. In runway experiments, Amsel found increases in running in a straight alley following non-reinforcement. Rate increases were also noted when time-outs from positive reinforcement were interposed during a schedule of positive reinforcement (Ferster and Skinner, 1957).

The second possible explanation of the large number of responses is that the child's behavior was influenced by the experimenters'

initial instructions e.g., the child may have understood that she was required to push the button frequently at all times. A constant problem facing experimenters who work with human subjects is that their instruction may influence the outcome of their experiments. Despite the terse instructions presented to subjects in this experiment, it remains possible that the subject may have interpreted them in a way which did influence responding during the white component.

A third way to account for the results is in terms of the child's history of conditioning. When the white light was on, the girl could simple sit, or she could press the button. It is plausible that during her history of conditioning she has received more reinforcers and possibly avoided mild punishment more often by "doing something" rather than just sitting. This explanation can be criticized, however, since subjects M-8 and M-5 did not exhibit behavior similar to F-3 in the same situation.

The results of this experiment failed to replicate those of Thomas. Unlike the 0.3 second operation of the grain feeder or the red light flash in Thomas' experiment, the tone did not sustain substantial rates, rates comparable to those obtained by Thomas. Lovaas may be correct in attributing the difference to subjects' tendencies not to attend to certain stimuli, in this case, the tone.

Another possibility is that species differences accounted for the results. Both Zimmerman and Thomas used pigeons as subjects and the tendency of pigeons to peck at food related stimuli (Brown and

Jenkins, 1968) may account for the high response rates in the conditioned reinforcer only components of their experiments. It may also be that a reduction of the FR requirement during the tone-only component, from FR5 and FR3 for example, would have produced substantially more responding.

These remain explanations for the discrepancy in results between the similar findings of Thomas and Zimmerman, and those of Walton, Derdyk, and the present experiment. A final explanation is recommended, however, one which is perhaps the simplest and most tenable. Michael has suggested that sustained responding in the Zimmerman and Thomas experiment be attributed to a similarity of conditioned reinforcer and primary reinforcer conditions which did not facilitate the formation of a conditional discrimination. Since the conditioned reinforcers in these two experiments consisted in stimuli associated with the delivery of reinforcement i.e. the sound of the solenoid-operated magazine, the illumination of a magazine light, the absence of key lights, and the absence of house lights, it may have been especially difficult for the animals to discriminate instances when grain was being presented, and those when it was not. In fairness to Thomas, however, it must be mentioned that he did attempt a later experiment using a red light as a conditioned reinforcer and obtain results similar to those in his first experiment. In Michael's view, then, and that of the author, the results of the present experiment and those of Derdyk and Walton could not, in any way, disprove a simple interpretation of conditioned reinforcement in

terms of temporal contiguity of a neutral stimulus and a primary reinforcer.

A second fact concerning conditional discrimination becomes important in considering the results of the present experiment and those of Derdyk, both which involved human subjects. Verbal behavior, which is unique to our species, greatly facilitates conditional discriminations. Humans have learned to tact (identify) stimulus characteristics of a situation which, as a result, become salient and can control their behavior (Skinner, 1957). The results of the human subjects in the present experiment may be attributed to their learned tendency to tact (and consequently come under the control of) stimuli potentially important in making conditional discriminations. The fact that the F-3 was not able to form the conditional discrimination may be attributed to her only rudimentary repertoire of verbal behavior, compared to the other two older subjects.

The results of the present experiment with humans failed to replicate those of Thomas. Pairing of a neutral stimulus with a primary reinforcer in one situation did not endow that neutral stimulus with a sustained behavior strengthening function in a second. These results were discussed in terms of the subjects ability to discriminate the different function of the neutral stimulus in the two situations. The role of verbal behavior in facilitating this discrimination was also mentioned.

By attempting to make comparisons between applied and experimental studies the relationship between these areas has been exposed.

In addition, this experiment has examined a paradigm utilized by both areas and has suggested some of the variables that may be important in applying this model in applied settings.

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