

THE ROLE OF CLASSICALLY CONDITIONED KEY PECKS  
IN BEHAVIORAL CONTRAST

by

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## INTRODUCTION

The research to be reported below is concerned with the implications of the phenomenon of "auto-shaping", or classically conditioned key pecking, for behavioral contrast. The literature on classically conditioned key pecking and on behavioral contrast will be reviewed separately and then the hypothesized relationship will be described.

As the phrase will be used here classical conditioning refers to a procedure in which two stimuli are presented in sequence (i.e., a conditioned stimulus is followed by an unconditioned stimulus) or to the effects of this procedure. Conditioning is said to have occurred if the response to the conditioned stimulus (CS) differs from the response which would have occurred if the CS had not been followed by the unconditioned stimulus (US). In instrumental conditioning procedures the presentation of the reinforcing stimulus is made contingent upon the to-be-conditioned response (i.e., the reinforcing stimulus is never presented except following a response).

In a free operant procedure an organism is able to respond freely during the entire experimental session; in a discrete trial procedure each response is terminated by a change in the stimulus situation which prevents the organism from making the response again until the next trial. The sequencing of stimuli in many operant procedures is similar to the conditions necessary for the acquisition of classically conditioned responses. For example, in the discriminated operant paradigm there are regular sequences of a discriminative stimulus followed by reinforcement. Thus if the stimulus event maintaining the operant response is also a US for classical conditioning, one would expect classically conditioned responses as well as operant responses to be acquired (Rescorla and Solomon, 1967).

Rescorla (1967) made a distinction between two conceptions of classical conditioning. The first notion emphasizes the temporal pairing of CS and US as the sufficient condition for Pavlovian conditioning. The number of such CS-US pairings determines the degree to which conditioning is excitatory. The second notion suggests that it is the stimulus contingency between CS and US which is important. The idea of contingency differs from pairings in that contingency refers to the probability of a US presentation given the presence of the CS and the probability of a US presentation given the absence of the CS. This notion includes not only what is paired with the CS but also what is not paired with the CS. The contingency notion suggests that conditioning occurs when the probability of the US in the presence of the CS is greater than the probability of the US in the absence of the CS (Rescorla, 1968).

Key pecking and certain other responses typical of those used in studies of instrumental learning have been acquired when a classical conditioning procedure was employed using pigeons (Brown and Jenkins, 1968; Williams and Williams, 1969; Rachlin, 1969), quail (Gardner, 1969), monkeys (Sidman and Fletcher, 1968), and fish (Squier, 1969). Classically conditioned key pecking has been referred to as auto-shaping (Brown and Jenkins, 1968).

The typical paradigm which produces auto-shaping in pigeons consist of forward "pairings" of key-light stimulus and response independent food (Brown and Jenkins, 1968). Gamzu and Williams (1971), however, conducted an experiment using a contingency procedure which avoided the "pairing" of key-stimulus and food. These authors demonstrated that the stimulus control over pecking in auto-shaping is not specific to the Pavlovian procedure but represents a more general manifestation of associative

learning through classical conditioning. The procedure employed was a variation of one introduced by Rescorla (1967). Grain presentation was provided in the presence of the illuminated key at randomly determined times. In the differential group, the probability of reinforcement in the absence of the illuminated key was zero. In the nondifferential group the probability of reinforcement was the same in each period (i.e., in the presence of the illuminated key and in the absence of the illuminated key). While subjects in the differential group acquired and maintained key pecking, no subjects developed sustained pecking in the nondifferential group. Gamzu and Williams concluded that the key light had to accompany a change in the frequency of grain presentation for key pecking to be acquired. Acquisition and maintenance of pecking is dependent on a greater probability of food presentation during the CS than in its absence.

Williams and Williams (1969) have shown that classically conditioned key pecks can also be acquired and maintained when an omission procedure is employed. On each trial a response key was illuminated for six seconds. Key pecking during the CS turned off the key light and blocked presentation of food. If no pecks occurred during the six second interval, the CS was terminated and grain was presented. Pecking was maintained despite the negative correlation between pecking and reinforcement (auto-maintenance). Williams and Williams hypothesized that the persistent pecking might be attributed to reinforcement from stimulus changes on the response key. A second experiment was, therefore, conducted to explore this possibility. When the key was illuminated by a positive discriminative stimulus, a peck turned off the key and the feeder was presented. On trials where a second stimulus was presented, a peck turned off the key but the feeder was never

presented. Thus pecking to the second stimulus would indicate that pecking can be maintained by a change in stimulus conditions on the response key alone. The persistent responding that characterized auto-maintenance was obtained only with the stimulus correlated with positive reinforcement. Thus the variable which seems to be responsible for the sustained pecking observed under the negative contingency is the pairing of the negative stimulus with grain on trials where pecks do not occur. Pecking seems to be maintained by a stimulus if it is followed by reinforcement more frequently than its absence is followed by reinforcement.

Since the key peck has usually been shaped and maintained by response-contingent reinforcement its emergence under response independent reinforcement was unexpected and intriguing. These findings seem to indicate that much of the key pecking obtained with some "operant" procedures might occur even if food delivery were not response contingent.

Behavioral contrast designates a phenomenon typically obtained when subjects are run on several different multiple schedules in succession. A multiple schedule is one in which two or more schedules of reinforcement each of which is associated with a different exteroceptive stimulus are alternated (Ferster and Skinner, 1957). The rate of responding during the presentation of one of the stimuli of the multiple schedule may be altered by changing the schedule of reinforcement in the other component (e.g., Brethower and Reynolds, 1962; Reynolds, 1961b). Interactions between components of a multiple schedule can be described by the direction of the rate of change in the constant component (Reynolds, 1961b). In the typical contrast experiment, a baseline rate is established by presenting a single variable-interval (VI) schedule in both components. Then the frequency of

reinforcement is either increased or decreased in the variable component and the change in the rate of responding to the constant component is determined. If the rate of responding in the changed component decreases while the rate of responding in the constant component increases, a positive contrast effect is said to occur (Reynolds, 1961b). For example, following a change in the variable component of a multiple schedule from VI 2-min. to extinction there may be a reduction in the rate of responding to zero in the variable component and an increase in rate in the constant component (Reynolds, 1961a, 1961b).

Many investigators have attempted to isolate the variables which are responsible for producing behavioral contrast (e.g., Bloomfield, 1966; Reynolds, 1961a, 1961c). A review of recent studies reveals that there are two major interpretations of the phenomenon. One is that response-rate reduction is the important variable (Terrace, 1963), the other emphasizes relative rate of reinforcement (Reynolds, 1961a). It is difficult to choose between these two interpretations since the methods employed usually confound rate of responding and rate of reinforcement in the variable component (Freeman, 1971). Typically, when the reinforcement rate in the variable component is reduced, there is a decrease in rate of responding in the variable component accompanied by an increase in rate of responding in the constant component.

Reynolds (1961a) hypothesized that contrast is dependent on "the frequency of reinforcement in the presence of a given stimulus, relative to the frequency during all of the stimuli that successively control an organism's behavior (p. 70)." Later studies (e.g., Reynolds, 1961c, 1963) have shown that the magnitude of the contrast effect is inversely related

to the rate of reinforcement in the other component. No correlation was indicated when responding in the extinction component of a Mult VI Ext schedule and the magnitude of behavioral contrast were examined during the formation of a discrimination. If the prevailing rate of responding during the extinction component determines the magnitude of the contrast effect, rate of responding in the constant component would be negatively correlated to the rate in the variable (Ext) component (Reynolds, 1968).

Terrace (1966) has maintained that if a discrimination is trained without errors (i.e., with no responses to the negative stimulus) contrast is not obtained. Following errorless discrimination learning, behavior during the negative stimulus is a settling down under the response key. However in a discrimination similar to those studied by Reynolds, in which responses to the negative stimulus (errors) do occur the negative stimulus evokes various emotional responses e.g., flapping of the wings. Terrace, therefore, stated that contrast might be a manifestation of "emotional" responses produced by the aversiveness of receiving no reinforcements for responding to the negative stimulus (i.e., in a multiple schedule for responding in the variable, extinction, component). The contrast effect occurs in the following manner: the subject during the formation of a discrimination makes non-reinforced responses in the variable component; the exteroceptive stimulus associated with the variable component acquires aversive properties; these aversive properties produce emotional responses during the variable component which result in a suppression of responding in this component and an increase in responding in the constant (reinforced) component.

If Terrace's rate of responding hypothesis is true, then prolonged discrimination maintenance should lead to the disappearance of the contrast

effect owing to the habituation of the emotion produced by non-reinforced responding. Reynolds and Limpo (1968), however, have shown that negative contrast occurs if the schedule of reinforcement in the variable component is changed from Ext to a VI schedule after the positive contrast effect has disappeared. Terrace's interpretation can not account for these data. In order to do so, Terrace would have to predict that the emotion habituates after a prolonged period of time, causing positive contrast to disappear, and then, somehow, reverses in sign by the recurrence of reinforcement producing the negative contrast effect.

A change in relative frequency of reinforcement is a sufficient condition to produce contrast. Therefore the hypothesis that contrast is produced by a change in the number of classically conditioned responses during the constant component is compatible with the data. Specifically since the key peck has been typically employed as the operant response, classically conditioned key pecks may play an important role in behavioral contrast. It was pointed out that contrast occurs when a Mult VI VI schedule is changed to Mult VI Ext.. Classically conditioned key pecks occur only if there is a differential association of key stimuli and food. In a Mult VI VI schedule the probability of reinforcement may be equal in both components; in this case the probability of reinforcement in the presence of the constant component is equal to the probability of reinforcement in the absence of the constant component. In this case classically conditioned key pecks will not occur (Gamzu and Williams, 1971). However, if the schedule in the variable component is changed to extinction the probability of reinforcement in the presence of the constant component will be greater than zero, i.e., the probability of reinforcement in the variable component. Both classically

conditioned key pecks and positive behavioral contrast are to be expected under these conditions.

Contrast has been obtained in some studies in which the schedule of programmed reinforcement in the variable component remained the same (Brethower and Reynolds, 1962; Terrace, 1963, 1968). Brethower and Reynolds (1962) conditioned pigeons to peck a key on a Mult VI 3-min. VI 3-min. schedule. The constant component (green) and the variable component (red) were both maintained on VI 3-min. but each response to the red stimulus was punished. By varying the shock intensity, Brethower and Reynolds showed that the rate of unpunished responding increased markedly during the presentation of green when each response in red was punished and that the frequency of punished responding decreased as the intensity of the shock increased. Since a reduction in response rate caused a reduction in reinforcement frequency one can not specify which condition led to contrast.

Terrace (1968) also conducted a study in which one component of multiple schedule was correlated with punishment. Each response in the punished component produced a brief mild electric shock. After shock was introduced the rate of responding decreased in the shock component and increased in the other component. The density of reinforcement, however, in both components was equal. Even though Terrace concluded that a reduction in response rate is the necessary condition for contrast, the contrast effect may have been an artifact of the method employed (e.g., the addition of shock to a constant rate of positive reinforcement is similar to a reduction in rate of positive reinforcement, Brethower and Reynolds, 1962).

It is the present author's opinion that the similarities between the stimulus conditions producing and maintaining classically conditioned key

pecks and the conditions in which contrast is obtained are not purely coincidental. Classically conditioned key pecks and/or inhibition of key pecking seem to play a role in producing behavioral contrast in multiple schedules of reinforcement.

Contrast effects have also been obtained under schedules other than multiple schedules. Wilton and Gay (1969) conducted several experiments to explore the possibility of obtaining contrast-like effects in chain schedules. In the first experiment pigeons were initially trained to respond on a VI 1-min. schedule in the presence of a vertical line. A horizontal line (initial component) was then introduced for a period of at least 1-min. (i.e., FI 1-min.). The first response in the initial component after 1-min. led to the presentation of the terminal component (vertical line). Responding in the terminal component was reinforced on a VI 1-min. schedule. Each reinforcement was followed by presentation of the initial component of the next chain. Responding in the terminal (VI) component of the chain FI 1-min. VI 1-min. schedule showed some elevation over responding to the VI component when it was in isolation. Recent studies in the Kansas State University laboratory have demonstrated that classically conditioned key pecks can be obtained using sequences of stimuli similar to those in chaining procedures (Ricci, 1971). This implies that classically conditioned key pecking may also be producing contrast effects in experiments employing chained schedules.

Discriminative control of previously conditioned stimuli (CSs) has been shown in various studies (e.g., Rescorla and Lolordo, 1965; Lolordo, 1971; Henton and Brady, 1970). Rescorla and Lolordo (1965) trained dogs under a Sidman contingency to avoid shock in a shuttle box. After avoidance conditioning the dogs were confined to one side of the shuttle box and given

Pavlovian conditioning sessions. When the dogs were later performing the instrumental response, test trials of the positive stimulus (the stimulus followed by shock, CS+) and the negative stimulus (the stimulus followed by no shock, CS-) were inserted. Avoidance responses increased in the presence of CS+ and were inhibited during CS-. Thus the conditioning procedure resulted in immediate discriminative control of previously established instrumental responses by classical CSs that had not been present during avoidance learning.

It is quite possible that the introduction of shock in one component of a Mult VI VI schedule (Terrace, 1968) may also lead to the formation of classical CRs. The component stimulus to which responses are punished becomes a CS+ and the other component a CS-. An aspect of this response might be that it tends to inhibit key pecking. If so the CS+ would suppress and CS- facilitate key pecking. These CRs may cause a contrast effect.

Another procedure which demonstrates the effects of Pavlovian conditioning on an operant response is the superimposition of a classical procedure onto a schedule of response-dependent positive reinforcement. An organism is first trained to make an operant response. The to-be-conditioned stimulus is then presented at random intervals to determine if it has any initial effect on the operant response. Finally response-independent pairings of the CS and US are presented while the operant response is being performed. Lolordo (1971) using pigeons as subjects obtained an increase in the rate of food-reinforced pecking when a stimulus paired with response-independent food (CS+) was superimposed onto the operant schedule. A negative conditioned stimulus, which was never paired with response-independent food, had no reliable effect upon response rate. Henton and

Brady (1970) obtained similar results with monkeys. These studies are an indication of the discriminative control that classically conditioned stimuli have over operant responding. It seems quite likely that the facilitative effect observed in these studies as well as in studies on behavioral contrast was due to the formation of classical CRs.

Most of the aforementioned studies dealing with contrast have employed pigeons as subjects. However, several investigators (e.g., Smith and Hoy, 1954; Pear and Wilkie, 1971; Wilkie, 1972; Freeman, 1971) have reported that behavioral contrast can be obtained in rats. The magnitude of the contrast effect, however, is usually much smaller than the magnitude of the effect when pigeons are employed as subjects. Freeman (1971) examined the role of response rate in producing behavioral contrast in rats. The schedule of reinforcement associated with the constant component was always VI 2-min.. The variable component was correlated with three schedules of response-independent reinforcement (VI 30-sec., VI 2-min., and Ext). The constant component was on for a duration of 5 min. and alternated with either 4 minute or 6 minute presentations of the variable component. The rate of responding during the variable component was equated for all response-independent schedules of reinforcement by retracting the response lever. The results indicated that a negative contrast effect was obtained in the Mult VI 2-min. VI 30-sec. group. In the Mult VI 2-min. VI 2-min. and the Mult VI 2-min. Ext groups transient positive contrast effects were obtained (i.e., the rate of responding increased in the constant component during the first and second minutes but declined to baseline during the third, fourth, and fifth minutes).

Halliday and Boakes (1971) using pigeons as subjects ran a study to determine if a reduction in response rate produced by the presentation of response-independent reinforcers would be accompanied by a contrast effect in the constant component. It had been previously shown (Rescorla and Skucy, 1969) that a fairly rapid decline in response rate can be obtained following a change from response contingent to response independent reinforcement. Thus Halliday and Boakes were able to equate rate of reinforcement in both components of the multiple schedule while producing a reduction in rate of responding in only the variable component. The results were that when rate of reinforcement was equal in both components there was no contrast effect. However, if the rate of response-independent reinforcement was lower than the rate of response-dependent reinforcement, e.g., a VI 1-min. Ext schedule, contrast effects were obtained.

The Halliday and Boakes study differed from the Freeman study in which only transient effects were obtained in two major ways: pigeons were used as subjects and the subjects had the opportunity to make responses in the variable component. Since a reduction in response rate is not a sufficient condition to produce contrast the likely difference is a species difference. Hence even though contrast can be obtained in rats the magnitude of the effect is smaller than when pigeons are used.

The literature reviewed in the previous sections has dealt with classically conditioned key-pecking and its implications for behavioral contrast. The hypothesis presented states that classically conditioned responses play a role in behavioral contrast (i.e., the classical conditioning contingencies produce a response tendency which plays a role in behavioral contrast). This hypothesis seems to be a reasonable deduction from the

comparisons presented on the preceding pages. For example, the stimulus sequences in instrumental conditioning procedures supply the same stimulus-reinforcer sequence needed for acquisition of classically conditioned responses. In addition when the frequency of reinforcement associated with one stimulus differs from that associated with its absence or with a second stimulus, behavioral contrast or classically conditioned responses may occur.

The present study was an attempt to determine the role of classically conditioned key pecks in behavioral contrast. Since classically conditioned key pecks have been obtained only to localized CS(s) (i.e., stimuli on the response key) it was expected that classically conditioned key pecks would be obtained to a greater extent in a key light group than in a group in which the CS was not localized (e.g., the houselight group). If behavioral contrast effects are dependent on classically conditioned key pecks then behavioral contrast effects should appear in the key light group. Contrast effects in a houselight group would indicate that the contrast effect is not due entirely to contamination by classically conditioned key pecks.

Half of the subjects were divided into experimental groups and the other half of the subjects were placed into yoked control groups. Half of the experimental subjects were placed in a houselight group and the other half were placed in a key light group. When designating groups houselight and key light refer to the location of the stimuli distinguishing the components of the multiple schedule. One control subject was yoked to each experimental subject and received the same number and temporal distribution of environmental stimuli and reinforcements as the experimental subject with which it was paired. All experimental subjects were placed on a Mult VI Ext schedule for approximately 20 sessions. Then the rate of

reinforcement in the variable component was changed to a VI schedule and the change in rate of responding in the constant component was determined. In the final phases of the experiment the Mult VI Ext schedule was alternated with the Mult VI VI schedule. By making daily shifts from one schedule to the other it was possible to show immediate changes in the rate of responding in the constant component.

## METHODS

### Subjects

Sixteen White King pigeons, obtained from a local supplier, were maintained at 75% ( $\pm 10$  grams) of their free feeding weight and served as subjects. Subjects were housed in individual cages in a colony room kept under constant illumination.

### Apparatus

Two identical experimental chambers, 57 x 43 x 39 cm., were equipped with a translucent response key (Gerbrands) located 21.3 cm. from the floor and one 10-w lamp mounted above the grain feeder (Lehigh Valley) for illumination of the aperture on feeder presentations. The key was transilluminated by either a white, green, blue or red light. Transillumination was accomplished by stimulus lamps mounted behind the response key (Type E 2412, 6v miniature lamps). Four 6-w, stimulus lights (e.g., white, green, blue and red General Electric Christmas tree lights) located in the ceiling of the experimental chamber above an opening 5.9cm. in diameter also provided illumination. Each key peck produced auditory feedback by operating a relay mounted inside the experimental chamber.

A masking noise, between 89 and 90 dB's inside the experimental chamber (on the A scale of a General Radio Co., sound level meter) was provided by a ventilating fan and white noise. Experimental events were recorded and controlled by relay operating switching circuits, steppers and clocks, counters and print-out counters, cumulative recorders and programming tapes. An event recorder was used to record responses on each trial. Inspection of

records and observations of subjects provided no evidence at all that sounds from the equipment when reinforcement was set up affected the bird's behavior.

### Procedure

During magazine training (Phase I) the experimental chamber was illuminated by a white houselight, except during feeder presentation, and the response key was covered with grey tape. When the feeder was presented the feeder light was always on and the houselight and key light off. The experimenter initiated magazine training by holding the bird over the raised feeder until the bird began to eat at which time he was gradually released and the door to the chamber closed. If a bird failed to eat in 3 to 4 minutes he was returned to his home cage without being fed. The same procedure was then initiated at the same time the next day.

After the subject had eaten for 30 sec. the feeder was lowered and then quickly raised. This procedure was repeated 5 to 15 times, successively increasing the duration of the interpresentation interval and decreasing the duration of feeder presentation until the subject approached the feeder from any part of the chamber within 4 sec. each time the feeder was raised. After one or two days of manual magazine training reinforcements were delivered automatically. The next day approximately 30 reinforcements of  $2\frac{1}{2}$  sec. duration each were delivered on a VI 15-sec. schedule. If the subject did not eat during at least 3 of the last 5 presentations the same training was given the next day. No bird required more than two days to reach this criterion.

After magazine training subjects were randomly assigned to experimental and yoked control groups. Each control subject was yoked to an experimental subject, i.e., it received the same number and temporal distribution of stimuli (including reinforcements) as the experimental subject to which it was yoked.

During nondifferential training (Phase II) all experimental subjects were shaped to peck a white illuminated response key by the method of successive approximations. Yoked controls received response-independent reinforcements at the same time that their respective experimental subject's collected a reinforcement. As in Phase I the houselight was white. The first key peck of the experimental subject and each successive peck was reinforced until 30 continuous reinforcements (CRF) had been recieved. Day two of nondifferential training began with 10 additional reinforced responses. Following CRF a fixed interval (FI) 10-sec. schedule was presented until 20 reinforcements had been collected. On day three, 10 reinforcements were received on the FI 10-sec. schedule and then this was replaced by a variable interval (VI) 15 sec. schedule for 20 additional reinforcements. Thirty reinforcements were provided on the VI 15-sec. schedule on day four. The same VI 15-sec. schedule was always associated with the constant component.

Experimental subjects with their yoked controls were then randomly assigned to houselight or key light groups before the initiation of Phase III. Groups are designated houselight or key light in accordance with the location of the stimulus distinguishing the components of the multiple schedule.

After the first day, the duration of a daily experimental session was approximately 95 minutes and consisted of 22 cycles of a two-component

multiple schedule. On Day 1, the constant component was 20 sec. of VI 15-sec. during key (houcelight) illumination of red and the variable component was 20 sec. of key (houcelight) illumination of blue or green. The key light group always had a white houcelight and the houcelight group always had a white key light. On each subsequent day the constant component was 20 sec. and the variable component was 4 minutes. Throughout Phase III the variable component was on an extinction schedule. Thirty reinforcements were received during each session. Phase III lasted 20, 21, or 22 days.

In the test for contrast (Phase IV) the stimulus associated with the variable component was green or blue (whichever was not used during Phase III) and the schedule of reinforcement was VI 15-sec. schedule. Thus the schedule was Mult VI 15-sec. red VI 15 sec. blue (green). Forty reinforcements were collected each day. Phase IV lasted 10 days.

All subjects were then returned to the Mult VI 15-sec. Ext schedule which they received in Phase III, for 1 day (Table 1). This was followed by a day on the Mult VI 15-sec. VI 15-sec. schedule received in Phase IV. For the remaining sessions in Phase V, the variable component in the Mult VI Ext schedule was changed from a duration of 4 min. to a duration equal to the constant component (i.e., 20 sec.). Throughout Phase V subjects were given daily alternations of Mult VI Ext and Mult VI VI for a total of 5 days on each of Mult VI Ext and Mult VI VI. The progression used for generating the variable interval schedules is one in which the probability of reinforcement as a function of time since reinforcement is constant (Fleshler and Hoffman, 1962). Appendix A lists minor variations in procedure for some subjects. These were usually due to weight gain or apparatus failure and did not appear to affect overall results. A summary of the schedules employed is given in Table 1.

TABLE 1

## Summary of Procedure

Phase	Houselight	Key Light	Schedule	Days
I	Manual magazine	White	Covered	CRF
	Automatic magazine	White	Covered	VI 15-sec.
Assignment of subjects into experimental and yoked control groups.				
II	Nondifferential	White	CRF	1½
			FI 10-sec.	1
			VI 15-sec.	1½
Assignment to key light and houselight groups.				
III	Differential	HE	VI Red Ext Blue(green)	White
		KE	White	VI Red Ext Blue (green)
IV	Contrast test	HE	VI Red VI Green (blue)	White
		KE	White	VI Red VI Green (blue)

TABLE 1 (cont.)

## Summary of Procedure

Phase	Houselight	Key Light	Schedule	Days
V	Alternation of Mult VI 15-sec. Ext and Mult VI 15-sec. VI 15-sec.			
Day 1	HE	VI Red	Mult VI 20-sec.	1
	KE	Ext Blue (green)	Ext 4 min.	
		White	VI Red	
		Ext Blue (green)	Mult VI 20-sec.	1
		White	Ext 4 min.	
Day 2	HE	VI Red	Mult VI 20-sec.	1
	KE	VI Green (blue)	VI 20-sec.	
		White	Mult VI 20-sec.	1
			Mult VI 20-sec.	
Days 3-10	Schedule and stimuli are the same but the variable component on VI-Ext days is now 20 sec. instead of 4 min.			

## RESULTS

An index of differential responding was computed for each subject on each day of Phase III, IV, and V from the rate in responses per minute during each component of the multiple schedule. The index was a ratio of the rate in the constant component (C) divided by the rate in the variable component (V) plus the rate in the constant component,  $\frac{C}{C + V}$ . Figure 1 shows the mean index for the key light and houselight experimental groups. At asymptote both experimental groups had few errors (i.e., an index of 1). The fact that they appear to be the same may be entirely a ceiling effect. Once both groups reached the upper limit there is no way to detect any possible differences.

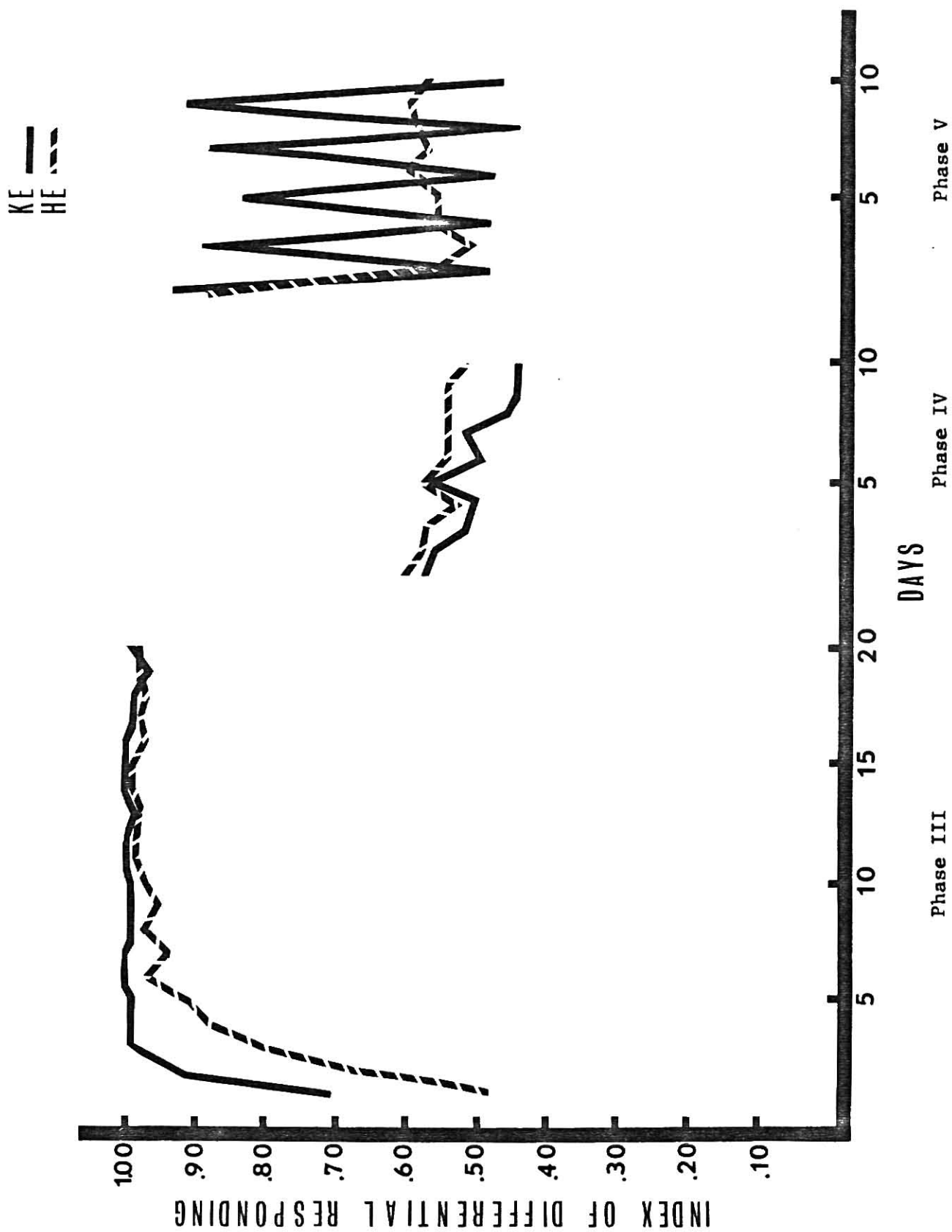
It can be seen that the index during Phase III, Mult VI 15-sec. Ext, was initially higher for the key light experimental subjects. The houselight experimental subjects seem to be slower in forming the discrimination. A U Test was run on the number of days it took each experimental subject to reach the criterion of a differential index of .95. All key light experimental subjects reached criterion before any houselight experimental subject ( $U=0$ ,  $p=.028$ ). U Tests were also computed using the mean and median indices of each experimental subject across Days 1-6. Again there was no overlap between the key light experimental subjects and the houselight experimental subjects. Thus it was concluded that the houselight experimental group acquired differential responding to the constant and variable components more slowly than the key light birds. It is possible, however, that the key light subjects did not actually acquire the discrimination faster but that their rate of responding in the constant component was augmented by the addition of classically conditioned key pecks. This would give the key light group larger ratios.

Figure Caption

Figure 1. An index of differential responding for the key light experimental group and the houselight experimental group during Phases III through V.

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CONTAINS  
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THAT ARE CROOKED  
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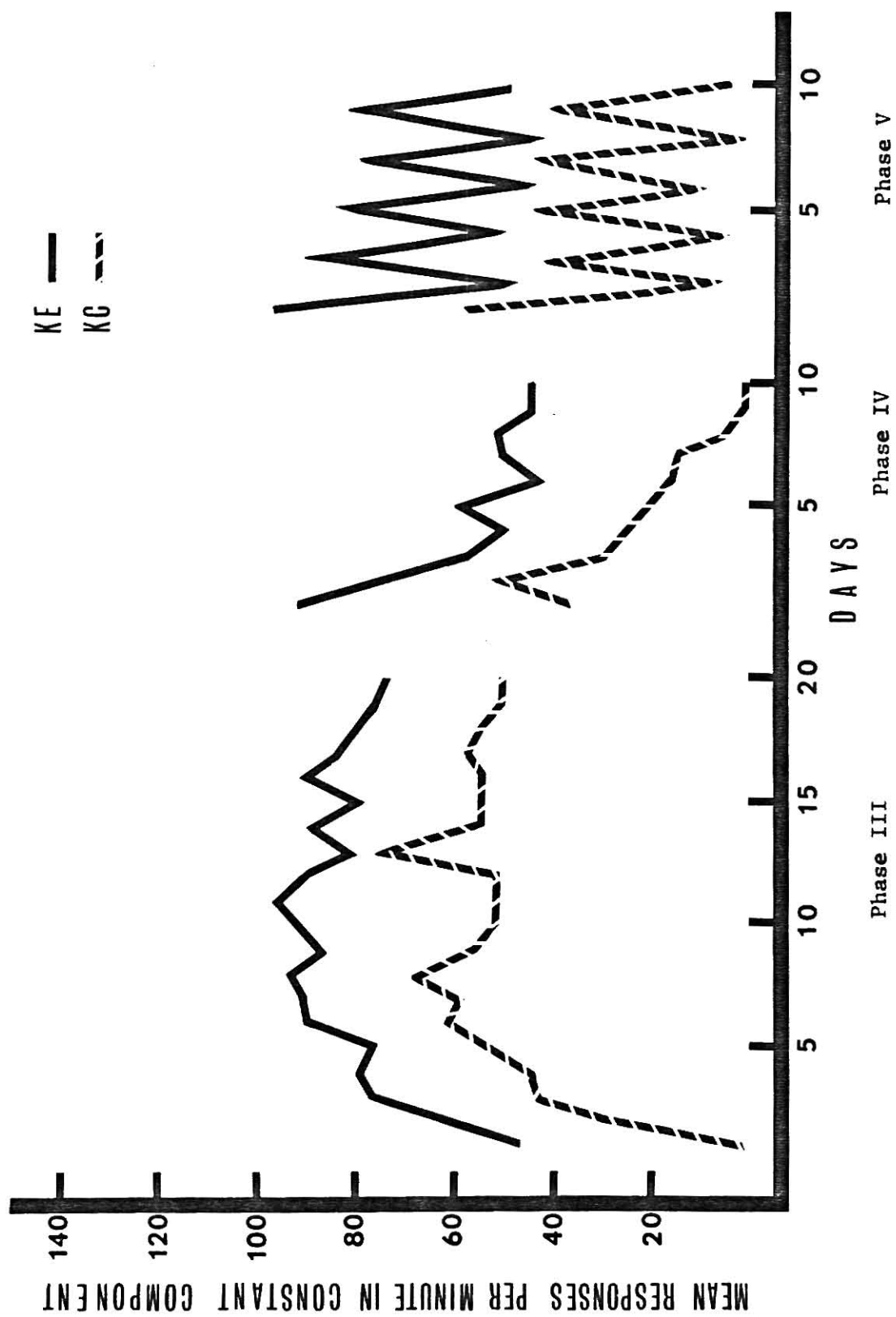
During Phase IV, Mult VI 15-sec. VI 15-sec., both experimental groups were responding about equally to each stimulus (i.e., the index was .5). However, there was a trend in the key light experimental group for the ratio to decrease below .5. This was probably due to subject KE 578 who seemed to develop a slight preference for the variable component. No suggestion of such a trend was found for two of the other subjects which suggests that the trend was not a systematic group effect.

Phase V consisted of daily alternations of Mult VI Ext and Mult VI VI. It can be seen in Figure 1 that the key light experimental subjects were making a discrimination between the VI-Ext days and VI-VI days. The house-light experimental subjects seem to be discriminating in Phase III but not in Phase V where the index remains close to .5 even on VI-Ext days. It seems that the houselight subjects were not making the discrimination between days in the variable component. This was unexpected since pilot subjects showed discrimination between the blue and green houselights. In the present experiment, however, the blue and green houselights used in the variable component were never temporally close together as they were in the test for discrimination with the pilot birds. Perhaps the blue-green discrimination was too difficult when the components were separated by a 24 hour period.

Figure 2 shows the mean rates of the key light experimental and yoked control groups during the constant component for Phases III-V. By comparing Phases III and IV it can be seen that a contrast effect was obtained in the key light experimental group (i.e., the rate in responses per minute in the constant component decreased when the rate of reinforcement in the variable component was changed from Ext to VI 15-sec.) There seemed to be an initial increase, however, when the key light experimental birds were

### Figure Caption

Figure 2. Mean responses per minute in the constant component for the key light groups, experimental and yoked controls, during Phases III through V. Each point represents four subjects.



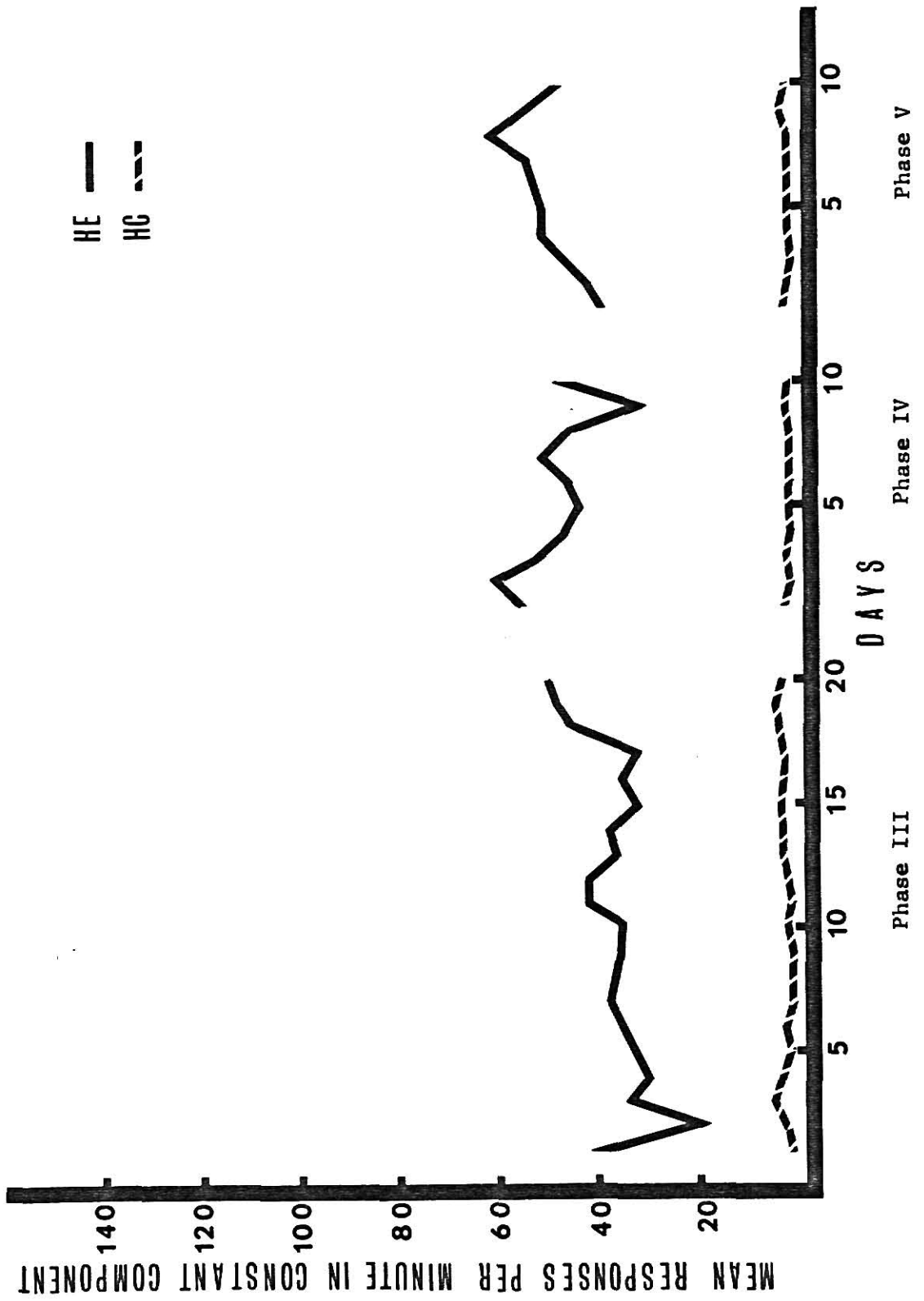
changed from Mult VI Ext to Mult VI VI. Since a clear increase was obtained from two of the four birds it is not clear whether this is a reliable effect. No explanation will be offered here. The key light yoked controls showed a similar decrease during Phase IV as the experimental group. Phase V demonstrates contrast with the key light experimental subjects more clearly than Phases III and IV. The rate in the constant component on all Mult VI Ext days is much higher than the rate on Mult VI VI days. The key light yoked controls also responded at a higher rate on VI Ext days than on VI VI days during Phase V.

Figure 3 shows the mean rates of the houselight experimental and yoked control groups. A comparison between the rate in the constant component during Phase III and Phase IV does not indicate any contrast effect for the houselight experimental group. Phase V also does not show a contrast effect, but the houselight experimental group was not discriminating between the variable component stimuli.

A Mann-Whitney U Test was employed to test the hypothesis that there was no difference in change in rate of responding for the houselight and key light experimental groups from Phase III to Phase IV. For each experimental subject, a mean rate in responses per minute was computed over the last 10 days of Phase III. A second mean was then computed for each experimental subject using the last 5 days of Phase IV. Individual indices were then found using the mean rate in the last half of Phase III and Phase IV. Each index was a ratio of the mean rate during Phase III (VI-Ext) divided by the sum of the mean rate in Phase IV (VI-VI) plus the mean rate in Phase III,  $\frac{\text{VI-Ext}}{\text{VI-Ext} + \text{VI-VI}}$ . All of the ratios of the key light experimental subjects were  $\geq .51$ , indicating a higher rate in Phase III than in Phase IV. The

### Figure Caption

Figure 3. Mean responses per minute in the constant component for the houselight groups, experimental and yoked controls, during Phases III through V. Each point represents four subjects.



houcelight experimental subjects had ratios between .38 and .56. The groups did not differ significantly in this index,  $U(4, 4) = 2$ ,  $p = .114$ .

A second U Test was run on each experimental subject's mean difference score (i.e., the mean rate in the last half of Phase III minus the mean rate in the last half of Phase IV). This difference score gives the absolute magnitude of the contrast effect. For a two-tailed test,  $U(4, 4) = 2$ ,  $p = .114$ . Thus the two measures used to test for a contrast effect indicate that the two groups did not differ significantly. It should be noted, however, that all the overlap between the groups depended on one key light experimental subject. Since some subjects do not auto-shape well, as can be seen by subject KC 572 in Figure 5, this low rate might be a result of poor auto-shaping. Significance might have been obtained if a larger N had been employed.

Individual data similar to the group data in Figure 2 are shown in Figures 4 and 5. Figure 4 shows subject KE 578 and its yoked control, KC 404. KE 578 responded most like the group mean in Figure 2, Figure 5 shows the most atypical key light experimental subject, KE 461, and its yoked control, KC 572, which happens to also be the most atypical yoked control. As can be seen in Figure 5 even KE 461 showed the same pattern of responding as the other key light subjects. Figures for individual houselight subjects are not given since the individual rates were all quite similar to the group mean given in Figure 3.

If one compares the mean rates in Figure 3 to the mean rates in Figure 2 for the key light group, he will notice that the houselight group would look very similar to the key light group if classically conditioned key pecks had been acquired. Figure 6 shows the prediction of the rate in

**Figure Caption**

**Figure 4.** Responses per minute in the constant component for an experimental key light subject, KE 578, and its yoked control, KC 404, during Phases III through V.

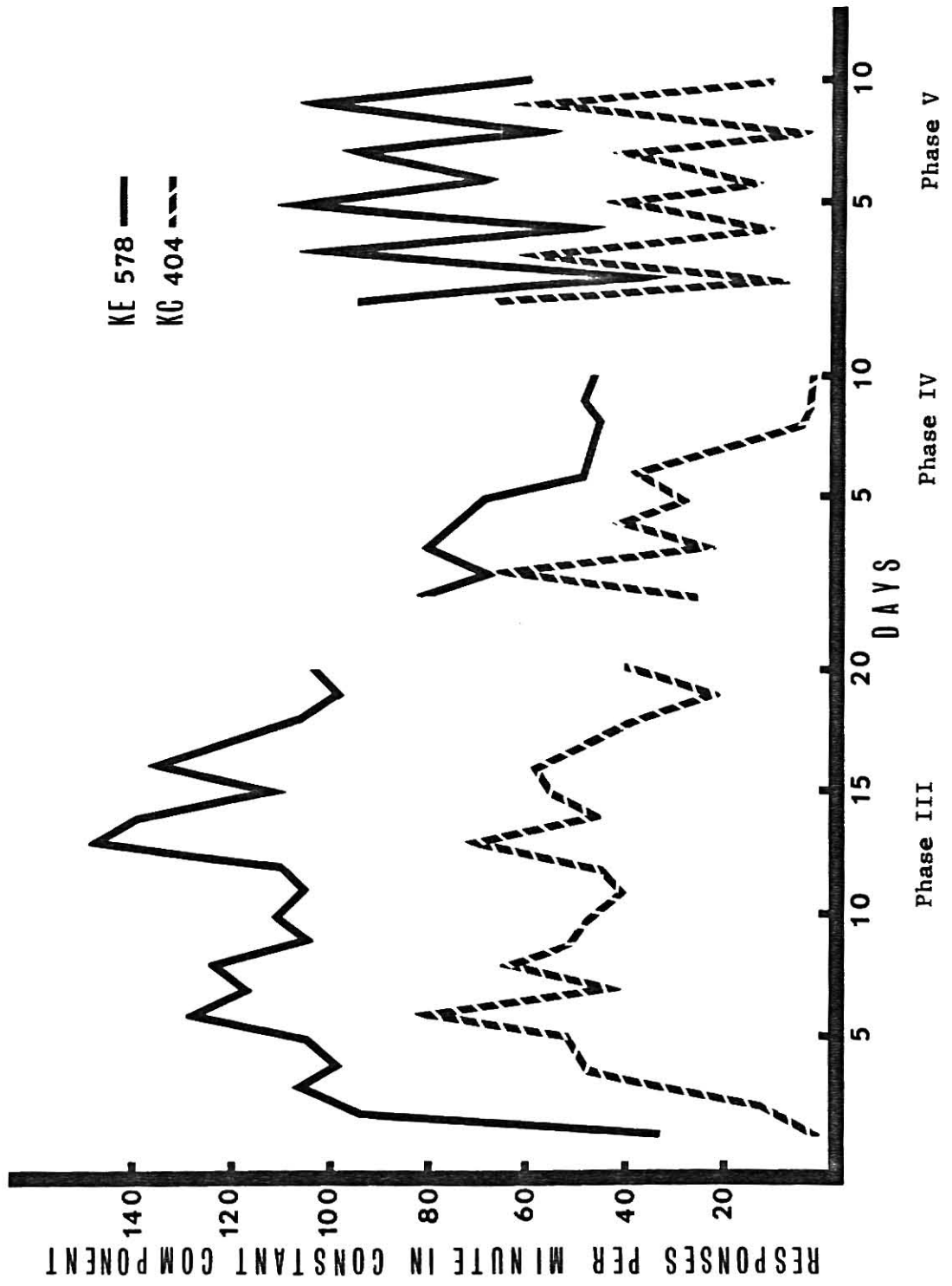
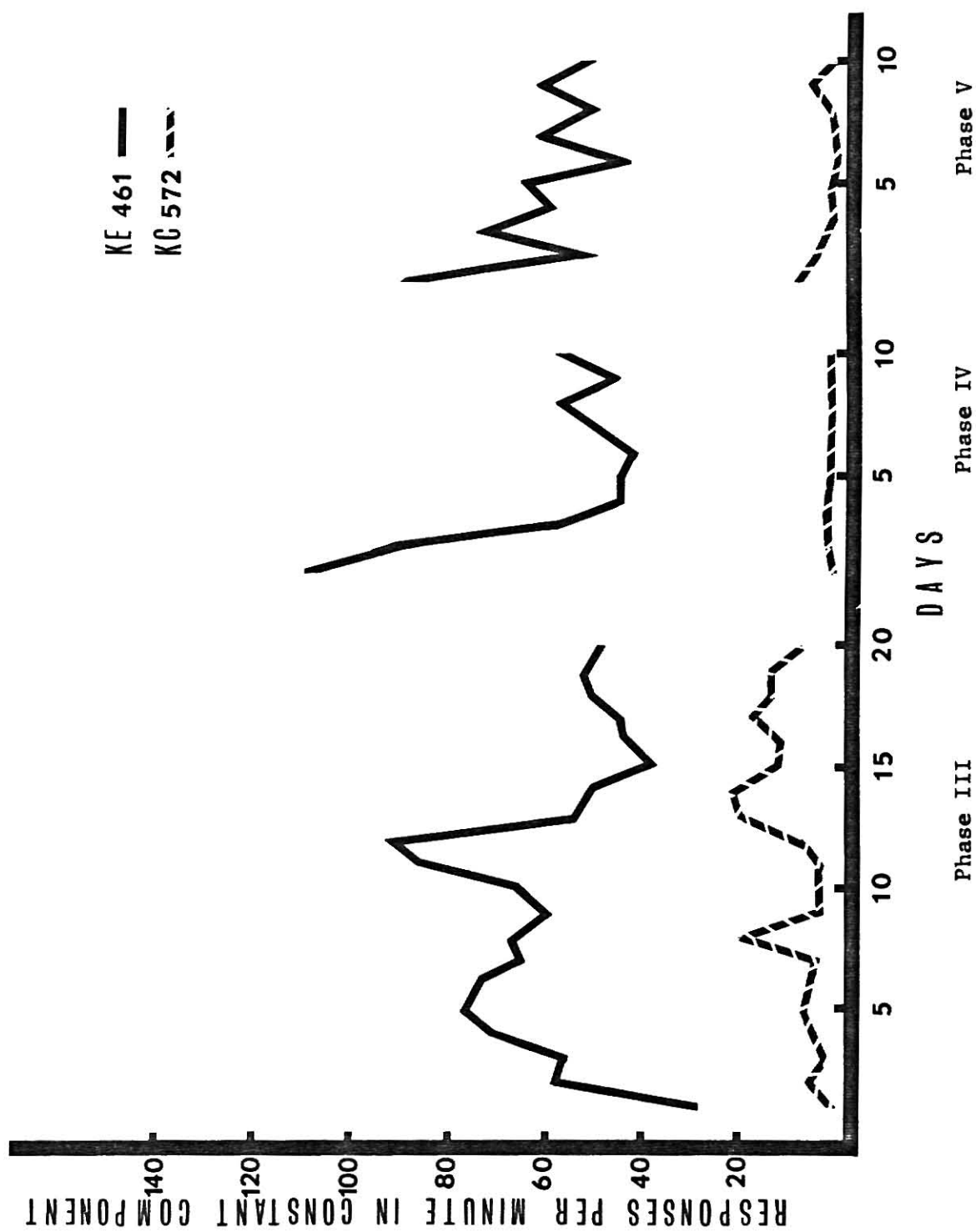


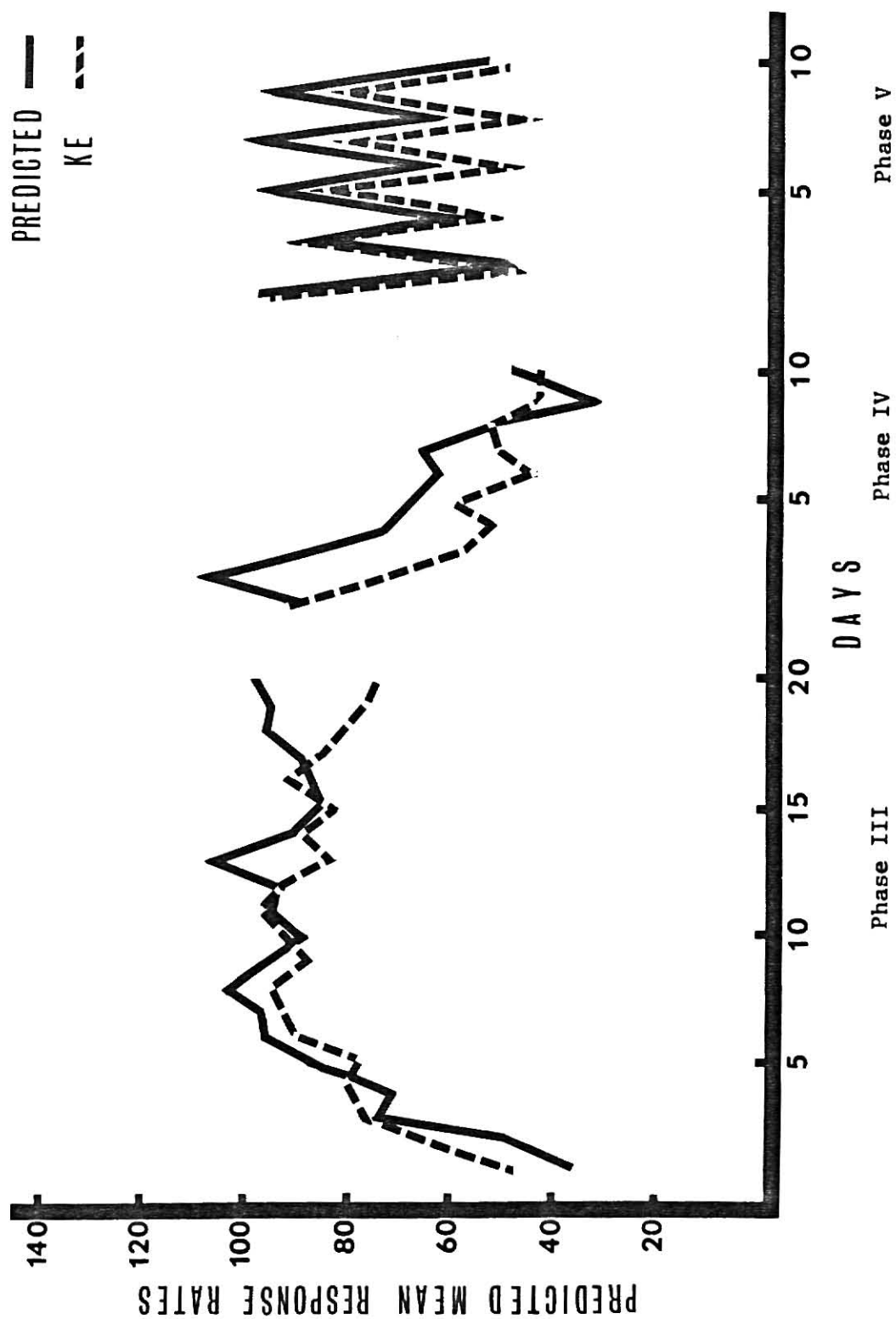
Figure Caption

Figure 5. Responses per minute in the constant component for an experimental key light subject, KE 461, and its yoked control, KC 572, during Phases III through V.



### Figure Caption

Figure 6. The predicted rate of responding for the key light experimental group. The index employed was  $HE + (KC - HC)$ . The curve labelled KE corresponds to the KE curve in Figure 2.



responses per minute of the key light experimental subjects on the basis of responding by houselight experimental birds plus classically conditioned key pecking (auto-shaping). The predicted key light experimental response rate curve was derived by: a) subtracting the mean rate of the houselight control group from the mean rate of the key light control group in order to account for stimulus-contingent affects on the key light control group. b) adding this difference which serves as an indication of classically conditioned key pecking to the houselight experimental group's rate (Figure 3). The predicted rate of responding for the key light experimental group (Figure 6) is quite similar to the rate obtained by the key light experimental group in this experiment. The curve labelled KE in Figure 6 gives values obtained for this group which also appear in Figure 2.

#### DISCUSSION

Classically conditioned key pecks occur only if there are differential reinforcement contingencies associated with different stimuli. In the Mult VI Ext schedule (Phase III) the probability of reinforcement in the presence of the constant component (VI 15-sec.) is greater than zero, i.e., the probability of reinforcement in the variable (Ext) component. Such differential association of key-stimuli and food has been shown to lead to the acquisition of classically conditioned key pecks (Gamzu and Williams, 1971). Indeed results for the key light yoked controls indicate that auto-shaping (i.e., classically conditioned key pecking) occurs under the stimulus contingencies to which the experimental subjects were exposed. The hypothesis that classically conditioned key pecks play a role in behavioral contrast is clearly supported by the fact that behavioral contrast and classically conditioned key pecks were

obtained under the same stimulus conditions. Figure 2 shows that classically conditioned key pecks (KC curve) seem to occur whenever there is an increase in operant responding by the experimental group (KE curve). Although the magnitude of the contrast effect does not differ significantly between the key light and houselight groups there does seem to be a tendency for the key light experimental subjects to show a larger contrast effect than the houselight experimental group.

Even though the results of the key light groups clearly supported the hypothesis the lack of discrimination in the houselight experimental group makes an interpretation based on classically conditioned key pecks uncertain. Evidence supporting a classically conditioned key peck interpretation would be stronger if there had been a discrimination in the houselight groups.

If a contrast effect occurred in the houselight experimental group one would have seen a decrease in responding in the constant component between Phases III and IV (Figure 3). However, instead of a decrease in responding in the constant component an increase was obtained. Perhaps in Phase III generalization from the variable component which was correlated with extinction tended to depress responding in the constant component which was correlated with a VI 15-sec. schedule. When the schedule of reinforcement in the variable component was changed from Ext to VI 15-sec. the depressive affect being exerted on the rate in the constant component through generalization would have been withdrawn. Thus the rate of responding would tend to increase in the constant component. This generalization effect on responding is exactly opposite from a contrast effect. It might well be that there was a contrast tendency in the houselight group but that it was counteracted by a stronger generalization effect.

This experiment differs from other behavioral contrast studies (e.g., Reynolds, 1961; Terrace, 1966; Freeman, 1971) in several ways. First, in this experiment two different exteroceptive stimuli were associated with the variable component. This alteration in the procedure was seen as a more convenient way of demonstrating contrast and was expected to lead to the same end result as the typical procedure. By employing two different variable component stimuli it was possible to alternate Mult VI VI with Mult VI Ext in Phase V. Bloomfield (1971) used a procedure similar to this but the external stimulus associated with the variable component was the same on Ext and VI days. By comparing the rate in the constant component on a VI-VI day to the rate on a VI-Ext day, contrast effects might be seen. The key light experimental group demonstrated such a pattern of responding (i.e., a high rate of responding in the constant component on VI-Ext days and a lower rate of responding on VI-VI days), however the houselight experimental group did not. These results for group KE are similar to those reported by Bloomfield (1971).

Another procedural difference was the presentation of Mult VI Ext prior to Mult VI VI. The differential schedule (Phase III, Mult VI Ext) was given first since it has been reported by Gamzu and Williams (1971) that nondifferential training given in advance of differential training tends to inhibit the development of classically conditioned key pecks. It was felt that if classically conditioned key pecks do play a role in behavioral contrast the stimulus conditions employed would demonstrate the relationship more clearly if they were optimal for the development of auto-shaping. If it were found that classically conditioned key pecks did not facilitate behavioral contrast under these conditions then one would certainly not expect such an effect under conditions less favorable to their acquisition.

On the basis of the Gamzu and Williams (1971) study one can make a prediction about the amount of contrast to be expected depending on the sequence in which training is given. If nondifferential training is given before differential training the magnitude of the contrast effect should be smaller than if differential training is given prior to nondifferential training. The nondifferential training will inhibit the subsequent acquisition of classically conditioned key pecks. If contrast is a result of classical conditioning affects this inhibition will also lead to a smaller contrast effect. Further research is needed to test this prediction and to answer questions that this study has generated. Some studies that have already begun deal with how the duration of the extinction component affects the magnitude of the contrast effect and with discrimination in the houselight subjects.

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## APPENDIX

## APPENDIX A

Deviations from the normal procedure produced by weight gain, apparatus failure, an excessive number of reinforcements, etc. for each experimental subject. Yoked control subjects were affected by the same changes in procedure as the experimental subject with which they were paired. An asterisk by a day means that there was a 48 or a 72 hour period after that day until that subject was run again.

<u>Subject</u>	<u>Phase</u>	<u>Day</u>	<u>Condition</u>	<u>Normal Condition</u>
KE 510	III	7*	72 hr.	24 hr.
		21*	48 hr.	24 hr.
461	III	1	40 cycles	22 cycles
		7*	72 hr.	24 hr.
		23	32 reinf.	30 reinf.
	IV	10	46 reinf.	40 reinf.
367	III	7*	72 hr.	24 hr.
		20	white key	blue key
			light	light
		23	33 reinf.	30 reinf.
578	III	7*	48 hr.	24 hr.
		9	83 reinf.	30 reinf.
	IV	5	42 reinf.	40 reinf.
WE 509	III	5	no reinf.	30 reinf.
		7*	72 hr.	24 hr.
		13	33 reinf.	30 reinf.

<u>Subject</u>	<u>Phase</u>	<u>Day</u>	<u>Condition</u>	<u>Normal Condition</u>
HE 595	III	21*	48 hr.	24 hr.
		8	48 reinf.	40 reinf.
		7*	72 hr.	24 hr.
		15	33 reinf.	30 reinf.
		21*	48 hr.	24 hr.
		8	48 reinf.	40 reinf.
425	III	3	30 cycles	22 cycles
		7*	72 hr.	24 hr.
		5	34 reinf.	30 reinf.
421	III	2	Ext 20 sec.	Ext 4 min.
			periods	periods
		3	3 reinf.	30 reinf.
		7*	72 hr.	24 hr.
		11	52 cycles	22 cycles
		13	39 reinf.	30 reinf.
		18	50 cycles	22 cycles
		20	86 cycles	22 cycles
		23	31 cycles	22 cycles
		24	31 cycles	22 cycles
	V	1	49 cycles	22 cycles
		2	40 cycles	15 cycles

Table 2

Pecks per min. in the Constant Component Phase III

Days	Key Light Exp.				Key Light Controls			
	510	367	461	578	560	536	572	404
1	90.30	33.15	29.77	38.97	2.24	2.05	0	0
2	54.78	44.28	58.14	95.39	47.01	51.69	5.71	9.00
3	73.70	71.78	57.40	107.57	45.34	91.92	2.88	36.43
4	85.14	60.64	71.95	98.57	29.14	99.22	4.42	49.29
5	69.86	55.45	77.66	105.37	66.00	94.55	6.88	52.54
6	79.25	78.77	74.18	128.77	61.25	102.33	5.67	78.49
7	89.25	96.30	64.94	116.62	78.21	109.18	4.42	45.06
8	79.48	105.14	66.70	124.66	92.47	91.14	20.40	64.66
9	89.10	96.25	60.26	104.16	91.19	81.00	4.68	50.65
10	100.00	97.12	66.56	111.10	109.85	80.27	4.33	46.85
11	104.03	92.33	85.25	105.00	105.07	63.84	3.38	40.63
12	87.67	79.09	91.56	110.24	101.23	55.32	7.14	45.54
13	84.86	44.42	54.16	147.43	100.29	101.04	20.26	69.71
14	86.12	80.65	52.21	137.00	117.76	35.84	22.08	45.14
15	77.91	96.10	38.70	117.01	97.46	56.23	13.38	55.45
16	81.49	103.51	43.77	135.29	71.94	75.97	13.51	58.86
17	95.37	73.86	44.42	123.43	80.45	85.43	18.96	49.14
18	79.86	83.77	50.00	106.86	53.43	114.42	14.93	38.43
19	62.60	92.29	52.21	98.14	56.44	111.00	14.81	23.00
20	59.43	87.38	49.57	103.14	48.86	111.00	7.43	38.57
21			75.13	106.71			6.63	28.14
22			65.97	88.08			10.15	25.21

Table 2 (cont.)

Pecks per min. in the Constant Component Phases IV and V

Days	Key Light Exp.				Key Light Controls			
	510	367	461	578	560	536	572	404
1	65.00	112.80	109.00	81.28	32.00	91.0	.60	25.11
2	51.80	86.40	89.80	68.30	68.40	61.80	1.20	66.98
3	47.17	46.04	59.57	80.00	47.17	47.74	.85	21.80
4	36.20	47.80	45.96	74.46	45.60	13.80	.85	41.91
5	46.80	77.23	45.20	68.67	14.60	46.38	.20	28.87
6	33.62	51.27	43.62	48.80	24.68	7.23	.21	37.00
7	32.08	78.00	49.00	47.66	24.91	14.00	.20	22.13
8	26.00	79.60	58.40	45.74	5.00	7.20	.40	4.26
9	25.20	55.20	46.20	48.72	0	5.40	.80	.85
10	20.53	50.21	57.37	47.00	3.51	.43	.70	0
E 1	104.58	103.14	84.48	94.86	48.92	110.71	8.81	67.14
V 2	45.00	58.30	53.60	42.77	10.00	11.91	4.60	10.00
E 3	65.00	111.10	74.03	108.83	20.14	89.59	2.09	58.70
V 4	37.66	59.36	60.20	47.23	3.19	11.06	.20	12.13
E 5	44.00	117.16	65.22	103.43	17.29	105.97	.90	43.86
V 6	30.13	55.20	44.00	69.40	10.00	18.80	0	17.80
E 7	65.75	100.15	60.96	91.04	37.95	85.07	.96	43.13
V 8	38.51	43.80	50.38	54.40	4.89	2.60	1.89	4.40
E 9	50.14	109.43	61.19	105.34	17.57	74.00	5.22	62.60
V10	41.32	45.53	52.46	59.47	3.96	4.47	.35	10.88

Table 3

Pecks per min. in the Variable Component Phase III

Days	Key Light Exp.				Key Light Controls			
	510	367	461	578	560	536	572	404
1	8.66	6.16	30.38	27.85	0	.27	0	0
2	2.26	.63	7.56	13.39	1.94	6.42	.19	.17
3	.07	.06	.15	1.82	.06	.64	1.63	.04
4	.04	.13	.14	4.12	.92	.05	.11	.08
5	.08	.10	.20	3.29	.30	.01	.04	.14
6	.08	.09	.06	1.64	.03	.03	0	.11
7	.09	.08	.20	.47	.06	.10	.01	.05
8	.09	.17	.03	6.80	.02	0	.12	.60
9	.08	.11	.10	1.30	.04	.02	.13	.02
10	.11	.49	.21	1.39	.03	.40	.13	.07
11	.13	.07	.14	.38	.01	1.48	0	.11
12	.28	.14	.09	.41	.03	.92	1.16	.06
13	.05	.92	.10	1.08	.02	.13	.50	.37
14	.06	.13	.16	.54	.01	.33	.14	.46
15	.08	.04	.09	.36	0	.15	.78	.18
16	.09	.28	.07	.63	0	.01	.13	.11
17	.09	1.10	1.05	.61	0	0	.05	.06
18	.12	.52	2.03	.30	.10	0	.10	.02
19	10.49	.65	.11	.25	.20	.25	.10	.02
20	.25	.43	.08	.89	.10	.01	.01	.02
21			.11	.49			.05	.29
22			.14	.18			.13	.16

Table 3 (cont.)

Pecks per min. in the Variable Component Phases IV and V

Days	Key Light Exp.				Key Light Controls			
	510	367	461	578	560	536	572	404
1	38.60	83.80	81.20	76.60	.80	11.60	.20	2.77
2	33.00	55.00	63.80	88.89	5.60	.20	0	34.34
3	28.87	59.43	43.40	107.80	10.00	1.13	0	12.00
4	20.40	52.60	42.34	112.34	7.00	.40	0	4.68
5	24.00	48.30	45.00	77.92	.40	1.28	0	.38
6	27.45	37.87	33.19	107.80	0	7.02	0	2.40
7	22.83	47.20	36.40	104.04	2.08	.20	.20	.85
8	40.60	62.80	49.40	99.79	.60	0	0	0
9	34.40	57.40	44.00	105.53	0	0	3.00	1.49
10	27.72	48.30	62.46	93.60	0	.43	1.05	0
E 1	9.66	2.87	3.57	15.88	.02	.17	.04	.29
V 2	34.20	48.51	56.00	95.32	.20	4.26	3.20	3.40
E 3	30.57	2.88	12.54	4.55	0	.55	.30	.26
V 4	34.26	50.21	67.60	74.04	.21	1.28	.20	1.28
E 5	26.57	34.18	.90	5.29	0	.45	0	.29
V 6	34.15	57.60	50.80	81.60	0	0	0	.40
E 7	21.37	22.84	.55	4.93	.14	.75	0	0
V 8	42.34	63.80	60.75	71.80	0	1.60	.19	.20
E 9	4.43	24.29	2.39	3.01	.29	0	0	.27
V10	56.26	49.79	60.18	71.93	0	0	0	.35

Table 4  
Pecks per min. in the Constant Component Phase III

Days	Houselight Exp.				Houselight Controls			
	509	595	425	421	537	491	395	458
1	63.29	26.86	38.49	22.43	3.28	0	0	.14
2	29.45	17.40	17.31	15.75	2.88	1.64	.11	.08
3	29.18	35.43	22.00	50.41	.43	14.79	.80	.55
4	40.29	35.57	26.58	18.90	.14	9.43	.55	2.30
5	26.10	43.56	33.57	31.64	.27	.13	1.29	1.51
6	57.12	28.22	23.29	35.19	.14	4.25	1.10	3.12
7	58.96	38.22	31.56	23.75	.41	2.34	.91	.13
8	57.66	47.12	31.57	12.09	.14	1.69	0	.27
9	50.41	54.86	26.16	15.73	.29	2.05	.82	.07
10	56.44	39.57	31.50	17.83	2.14	1.51	2.88	.58
11	65.22	37.46	31.34	38.31	.15	.45	0	2.99
12	72.74	31.23	30.86	37.81	0	3.15	1.43	.82
13	53.13	32.47	30.00	32.21	.14	6.72	.96	1.56
14	54.52	33.00	30.27	33.01	.29	8.22	2.19	.24
15	68.00	30.29	21.10	15.27	.14	13.86	.55	.12
16	44.86	31.71	27.71	36.44	.57	9.43	1.00	.56
17	56.85	29.29	40.29	7.80	.14	7.95	0	.17
18	74.78	23.38	35.89	44.11	3.38	9.55	.14	2.05
19	102.24	26.14	28.57	37.53	3.00	14.63	0	0
20	106.00	32.24	33.56	24.66	1.19	9.57	.14	1.46
21			29.87	33.40			1.43	.68
22			32.13				.50	

Table 4 (cont.)

Pecks per min. in the Constant Component Phases IV and V

Days	Houselight Exp.				Houselight Controls			
	509	595	425	421	537	491	395	458
1	73.40	37.45	53.16	57.87	1.49	4.72	0	.43
2	88.09	51.28	52.60	51.40	.43	2.98	0	.40
3	91.60	40.85	50.00	26.00	.21	4.00	.40	0
4	77.66	36.81	50.43	22.64	1.28	.21	0	.19
5	58.00	58.51	37.83	23.33	0	.20	.50	2.11
6	57.40	51.20	50.40	28.42	.40	.60	0	0
7	59.57	58.51	57.45	28.11	.85	.21	0	0
8	58.30	47.55	54.80	24.53	.19	0	0	0
9	49.60	40.38	22.83	18.49	0	.20	4.00	3.21
10	63.62	55.79	53.13	19.81	.18	.43	1.50	0
E 1	53.71	51.64	41.34	12.82	2.88	.29	2.99	1.41
V 2	58.72	49.25	53.60	10.53	0	.21	3.40	1.13
E 3	56.43	46.00	62.05	26.16	.14	.14	.14	0
V 4	59.81	54.53	62.55	29.20	0	0	1.06	.20
E 5	57.67	52.86	61.84	35.00	0	0	.11	.43
V 6	71.28	51.40	47.53	38.94	0	0	.27	0
E 7	70.14	56.57	45.34	44.48	.29	1.10	.14	0
V 8	84.47	61.94	52.60	51.70	.15	.21	3.80	.94
E 9	71.51	48.63	52.39	45.07	.14	.14	4.48	4.25
V10	53.40	50.00	51.58	40.80	.75	.20	0	.60

Table 5  
Pecks per min. in the Variable Component Phase III

Days	Houselight Exp.				Houselight Controls			
	509	595	425	421	537	491	395	458
1	59.14	35.82	29.04	32.00	.90	0	0	0
2	14.16	12.15	6.40	7.82	.02	.08	0	0
3	1.93	8.81	1.99	35.48	0	.01	.20	0
4	1.39	1.82	1.65	9.15	.01	0	.14	.06
5	4.59	1.40	1.11	6.06	0	.01	.14	.03
6	1.49	1.03	1.39	1.35	0	.02	0	.15
7	.95	.41	.84	5.03	0	.02	0	.04
8	.45	2.18	.43	.62	0	0	0	.02
9	1.30	8.57	.18	.54	0	0	.14	0
10	2.47	2.89	.41	.44	0	.02	.50	.01
11	.78	2.89	.26	.45	0	0	0	.02
12	.93	1.49	.46	.40	0	0	.71	0
13	.89	1.20	.45	.34	0	.03	.14	.02
14	.41	.80	.34	.62	0	.01	.41	.02
15	.50	.75	.39	.09	0	.02	.14	0
16	1.82	1.18	.90	.27	0	.08	.14	.03
17	.73	.42	.94	.19	0	.02	.14	0
18	1.81	.28	1.44	1.86	.03	.03	0	0
19	.70	.36	.52	2.97	.01	.04	0	0
20	1.21	.81	.34	1.42	.01	.02	0	.02
21			.18	.64			.39	.01
22			.25				0	

Table 5 (cont.)

Pecks per min. in the Variable Component Phases IV and V

Days	Houselight Exp.				Houselight Controls			
	509	595	425	421	537	491	395	458
1	48.49	34.26	26.84	33.62	2.13	.75	.18	.43
2	71.06	52.13	35.40	28.60	0	.21	0	0
3	76.60	42.13	48.80	16.00	0	1.80	0	0
4	70.85	34.19	43.83	20.75	.23	0	0	.19
5	63.80	39.79	22.00	18.25	.21	0	.50	2.63
6	61.40	40.80	39.40	24.39	.60	0	.20	0
7	68.94	41.06	49.57	20.00	0	0	0	0
8	63.19	41.89	42.20	16.23	.57	.21	0	0
9	61.20	34.72	16.83	14.15	0	0	2.67	3.77
10	64.04	52.28	47.31	19.06	0	0	0	0
E 1	7.56	12.73	6.39	.57	.28	0	.30	.03
V 2	65.96	45.85	39.80	6.54	0	0	3.40	1.50
E 3	82.00	39.57	44.66	22.33	0	0	0	0
V 4	77.36	42.26	45.32	20.00	.94	0	.43	.60
E 5	72.05	44.00	30.34	30.43	0	0	0	.14
V 6	72.98	35.96	17.95	31.91	.53	0	0	0
E 7	64.66	39.14	21.92	43.13	.14	.14	0	.15
V 8	85.11	42.99	30.80	36.42	0	0	2.60	0
E 9	60.27	37.95	24.33	35.34	0	0	0	0
V10	60.00	43.21	27.37	30.40	0	0	0	0

THE ROLE OF CLASSICALLY CONDITIONED KEY PECKS  
IN BEHAVIORAL CONTRAST

by

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## ABSTRACT

This experiment examined the hypothesis that classically conditioned (auto-shaped) key pecks play a role in behavioral contrast. Eight White King pigeons were randomly assigned to a key light experimental group or a houselight experimental group. Each experimental group was treated the same except for the location of the external stimuli associated with the components of the multiple schedules (i.e., the stimuli were localized on the response key for the key light group and in the ceiling for the houselight group). Each experimental bird had a yoked control that received the same stimulus conditions and reinforcements.

Differential training (Phase III) consisted of Mult VI 15-sec. Ext. Red and blue (or green) were associated with VI and Ext components respectively. The constant (VI) component was on for 20 sec. periods and alternated with 4 min. periods of the variable (Ext) component. The houselight groups had a white key light and the key light groups always had a white houselight.

In Phase IV the variable component stimulus was changed to green (blue) and the schedule of reinforcement from Ext to VI 15-sec. This Phase lasted 10 days. During Phase V, Mult VI 15-sec. Ext was alternated with Mult VI 15-sec. VI 15-sec. every day for a total of ten days.

The results of the key light groups, experimental and yoked control, supported the hypothesis. The stimulus conditions which produce contrast in this case also produced classically conditioned key pecks in yoked controls. Although the magnitude of the contrast effect between Phases III and IV was not significantly different between the houselight experimental and the key light experimental groups there was a trend for the key light experimental

subjects to show greater contrast than the houselight experimental subjects. In Phase V the key light experimental group showed contrast between the Mult VI Ext and Mult VI VI days. The houselight experimental subjects did not show a contrast effect but their index of differential responding indicated that they were not discriminating. Thus, only the results of the key light groups, experimental and yoked control, are consistent with the hypothesis that classically conditioned key pecks play a role in behavioral contrast.