TRANSFER OF TRAINING FOLLOWING DISCRIMINATION LEARNING INVOLVING TWO REINFORCED RESPONSES

by

CHARLES H. GOYETTE

B.A., University of Vermont, 1969

5-24

A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Psychology

KANSAS STATE UNIVERSITY

Manhattan, Kansas

1971

Approved by:

Major Professor

THIS BOOK CONTAINS NUMEROUS PAGES WITH THE ORIGINAL PRINTING BEING SKEWED DIFFERENTLY FROM THE TOP OF THE PAGE TO THE BOTTOM.

THIS IS AS RECEIVED FROM THE CUSTOMER.

Table of Contents

Acknowledgements

This research was conducted during the author's tenure as a NIMH Predoctoral Trainee, Grant MH 08359. I am grateful to Drs. Jerome Frieman, William B. Griffitt, and Charles C. Perkins, Jr. for their assistance. I am especially indebted to Dr. Jerome Frieman for his continuous support and guidance during all phases of research and writing of this thesis.

List of Tables

List of Illustrations

Recently there have been a number of experiments reported in which successive operant discrimination training with one stimulus dimension was found to facilitate the acquisition of a new discrimination along a second stimulus dimension (Eck, Noel & Thomas, 1969; Eck & Thomas, 1970; Keilitz & Frieman, 1970). In each of these experiments one group of pigeons was given successive operant discrimination training between two visual stimuli projected on the response key (e.g., line orientations), while a second group experienced only a single stimulus. Following this training, all Ss were trained on a second successive operant discrimination involving different visual discriminative stimuli (e.g., colors). Subjects given discrimination training in the first phase of the experiment learned this second discrimination problem faster than those given single stimulus training. This facilitation of learning is called positive transfer of training.

Thomas (1970) has suggested that positive transfer of training occurs in this situation because during discrimination training the S learns to pay attention to stimulus differences, and this increased attention carries over to facilitate the acquisition of the new discrimination. Additional support for the notion that these transfer of training effects are mediated by learning to attend to stimulus differences has been provided by Thomas, Miller and Svinicki (1971) and Goyette (1971). For example, Thomas, et. al. found that rats given successive discrimination training between two light intensities learned a tone discrimination faster than rats given either single stimulus or

pseudo-discrimination training in the first phase of the experiment. These results demonstrate the generality of the positive transfer effect following successive operant discrimination training by: (1) extending the concept to situations involving different species (rats); and (2) utilizing stimulus cues of a different sense modality in the second discrimination. In addition Goyette (1971) reported that discrimination training in one stimulus modality and with one response class facilitates the acquisition of a discrimination between new stimuli presented in a separate modality and with a new response class. In this experiment two groups of pigeons were given training with chromatic stimuli involving a key pecking response: one group experienced only a single color,while the second group was given successive discrimination training between two chromatic stimuli. The discrimination group subsequently acquired an auditory discrimination (tone vs. white noise) with a ring pulling response faster than the group given single stimulus training. These results indicate that the occurrence of transfer of training is not limited by the similarity between the stimulus dimensions or the response classes in the two discriminations, and provide further support for a general attention concept in the analysis of transfer experiments.

An alternative interpretation (without using an attention construct) could be offered to explain these same data. That is, it could be hypothesized that transfer of training is the result of training Ss to discriminate periods when responses are reinforced from periods when responses are not reinforced in the

first discrimination problem. This notion was originally used to explain the partial reinforcement effect (Sheffield, 1949) and faster extinction following repeated reconditioning (Perkins & Cacioppo, 1950; Bullock & Smith, 1953). Further support for this explanation of transfer comes from the accurate prediction that following discrimination training Ss would be expected to exhibit rapid extinction in the presence of the negative stimulus during the acquisition of a second discrimination. In fact, this response rate decrease over trials was primarily responsible for the positive transfer effect found in all but one of the transfer studies mentioned (Thomas, et. al., 1971)[1].

Keilitz and Frieman (1970), however, rejected this explanation of transfer on the basis of a recent experiment. Incorporating an errorless transfer of training paradigm, they found that errorless discrimination training between two colors results in positive transfer to a subsequent line-tilt discrimination of the same magnitude as transfer following successive discrimination training with errors. They argued that since Ss learning the

---

[1] In this experiment the authors reported that the transfer effect appeared to be entirely attributable to a rapid increase in S+ response rate over blocks (behavioral contrast) by the True Discrimination group. Further examination of their results, however, reveal other unusual occurrences in addition to this significant behavioral contrast effect. For example, the percentage of total responses to S+ for the True Discrimination group in Phase 2 reached only 75% after 2400 1-min. stimulus periods as compared to 90 - 95% after an average of 115 1-min. stimulus periods (range 60 - 160) in the other transfer experiments. This difference is mainly a function of the differences in extinction in the presence of the S- stimulus: these Ss resisted extinction to a much greater extent and for a longer duration than pigeons. Although these anomalies exist (whether a result of species-specific characteristics, different requirements or levels of difficulty, etc.) positive transfer was none-the-less demonstrated.

first discrimination without errors would not experience nonreinforced responding (i.e., errors) one would not expect such Ss to exhibit positive transfer. Since the errorless group did show facilitated acquisition in the second discrimination, the reinforced periods versus nonreinforced periods discrimination explanation of positive transfer was rejected by Keilitz and Frieman.

One could still argue, however, that the necessary and sufficient condition for obtaining the nonspecific positive transfer effect is the occurrence of withholding responses in the presence of the negative stimulus in the first discrimination. Justification for such an explanation of transfer comes from the fact that in the successive operant discrimination training (regular or errorless) used in all of the above mentioned experiments, a given operant is reinforced in the presence of, or after, one stimulus (S^D); reinforcement is withheld for that same operant in the presence of, or after, another stimulus (S^Δ). Schematically this procedure can be represented as follows:

$$\left[\begin{array}{l} S^D \\ R \longrightarrow S^R \end{array}\right] \quad \text{and} \quad \left[\begin{array}{l} S^\Delta \\ R \not\longrightarrow S^R \end{array}\right]$$

where: S^D = positive stimulus; S^Δ = negative stimulus;
R = response; S^D = food reinforcement

This paradigm results in the Ss responding in the presence of one stimulus and withholding the response in the presence of the other stimulus.

There seems to be no question that withholding of responses occurs during presentations of the negative stimulus in discrimination training with errors, but the point is not so readily accepted with the errorless variety of discrimination learning. This skepticism seems to stem from the unwarrented belief that since Ss learning a discrimination without errors cannot (by definition) experience periods of nonreinforced responding, one can assume that in errorless training Ss do not learn to withhold the execution of the instrumental response. This assumption seems no more justified than an alternative assumption that errorless training establishes a capacity to withhold responses during all times except those in which S+ is present. Support for a withholding response position in errorless discrimination tasks comes from an experiment by Marsh and Johnson (1968). In this experiment it was found that pigeons trained on an errorless discrimination and subsequently given a discrimination reversal failed to learn the reversal because they did not respond to the previously negative cue. Marsh and Johnson, therefore, concluded that the negative stimulus following errorless training must have strong control over not responding.

Thus, one could justifiably maintain that in successive operant discrimination training (with or without errors) the S learns to withhold responses in the presence of the negative stimulus, and this learned withholding property facilitates transfer of training in the new situation. The present transfer experiment was designed to eliminate Ss withholding of responses in the first phase of the experiment. Essentially this was accom-

plished by errorlessly establishing a discrimination between successively presented chromatic stimuli where reinforcement for stimulus A (e.g., green houselight) was contingent upon the occurrence of response A (e.g., key pecking), and reinforcement for stimulus B (e.g., red houselight) was contingent upon the occurrence of response B (e.g., ring pulling). Observation of this paradigm reveals the fact that this discrimination closely resembles the successive discrimination, but instead of a null contingency prevailing in one of the two stimulus situations, a second reinforcement contingency is acting in conjunction with a second response class. In addition, since all Ss are errorlessly trained to respond to each stimulus in only one specific way, incorrect responses to the stimuli are practically nonexistant. Schematically this procedure can be represented as follows:

$$\left[\begin{array}{l} S_A \\ R_A \longrightarrow S^R \end{array}\right] \quad \text{and} \quad \left[\begin{array}{l} S_B \\ R_B \longrightarrow S^R \end{array}\right]$$

where: S_A = stimulus condition A; S_B = stimulus condition B; R_A = response A; R_B = response B; S^R = food reinforcement

The present experiment was conducted to determine if the positive transfer effects obtained following successive operant discrimination training will be obtained when no withholding of responses occurs in the first discrimination problem. To implement this purpose, pigeons were given errorless discrimination

training between two chromatic stimuli in which differential reinforced responding (key pecking vs. ring pulling) was required. Following completion of this phase of training, the Ss were transferred to a successive auditory discrimination incorporating either one of the two responses. To determine if a positive transfer effect facilitated acquisition of the second discrimination, Ss were compared to single stimulus control Ss trained on only one response and transferred to the auditory discrimination utilizing the same response class. The occurrence of positive transfer in this situation would seriously question the applicability of a withholding response concept of transfer, and further support the notion of a general attention mediator of transfer of training.

Method

Subjects

Subjects were 32 experimentally naive Silver King pigeons obtained from a local supplier and maintained at 70 - 75% of their free feeding weights.

Apparatus

The experiment was performed in two identical operant conditioning chambers for pigeons with associated programming equipment. A detailed description of the apparatus has been presented elsewhere (Keilitz & Frieman, 1970). A stimulus of 555 nm. was projected onto the response key by Industrial Electronic No. 44 miniature lamps (Kodak Wratten Filter No. 99). The intensity of this 555 nm. light was adjustable by means of a variable resistor (range 0 - 80 ohms) in series with the lamp illuminating that filter. Additional visual stimuli were provided by red and green 7 Watt, 110 Volt houselights (G.E. models 7C7-R and 7C7-G) mounted in the upper corner of the wall opposite the response key; the intensity of the green light was adjustable by means of a variable resistor (range 0 - 10 K ohms) in series with the light. White noise and a 1000 Hz. tone, produced by a home-made tone generator, were introduced into the chambers as auditory stimuli.

Suspended from the ceiling of both chambers, 9.5 cm. from the feeder wall and 5 cm. from the side wall, was a 2 cm. long flexible insulated copper wire to which was attached a ring (1.5 cm. in diameter). The ring had to be pulled down 1.5 mm. with a force of 25 gms. to record a response. Each ring-pull response resulted in a flicker of the visual stimulus for 0.1 sec.

thus providing feedback to the Ss for successful responses. Except for the grain-hopper light during reinforcement, the specific visual stimuli mentioned provided the only source of light in the experimental chambers.

Procedure

Subjects were randomly assigned to each of four experimental conditions: a Discrimination - Key Peck (D-KP), a Discrimination-Ring Pull (D-RP), a Single Stimulus - Key Peck (SS-KP), or a Single Stimulus - Ring Pull (SS-RP) group, with eight pigeons in each group.

Preliminary Training. On Day 1, birds in the Discrimination groups (D-KP & D-RP) received magazine and key-peck training with a 555 nm. key light followed by 30 reinforcements of 4-sec. access to the grain-hopper on a continuous schedule (every response reinforced). The next day these Ss received 30 more reinforcements on a continuous schedule. Day 3 consisted of continuous reinforcement for the first 15 responses and then the schedule was changed to a variable interval (VI 10-sec.) reinforcement schedule for the remaining 15 reinforcements. For the next three days these Ss received identical training with a ring-pull response and a red houselight. On Days 7 and 8 these Ss were placed on a VI 20-sec. reinforcement schedule involving key pecking and ring pulling on the respective days.

Subjects in the SS-KP group received key-peck training identical to Days 1 - 3 and Day 7 of Preliminary training for the Discrimination groups. Subjects in the SS-RP group received ring-pull training identical to Days 4 - 6 and Day 8 of Prelimi-

nary training for the Discrimination groups.

Phase 1. On the first day following Preliminary training, Ss in the Discrimination groups (D-KP & D-RP) were given discrimination training between 555 nm. projected on the response key and a red houselight, where the appropriate response for each stimulus was reinforced on a VI 20-sec. schedule of reinforcement. This session of discrimination training consisted of 10 stimulus periods of 1-min. duration each separated by a 10-sec. blackout. Stimulus periods were presented in a quasi-random order with the restrictions that no more than two identical stimulus periods appeared successively and that within each block of 10 stimulus presentations each stimulus appeared five times each.

On the second day, the number of stimulus periods were increased to 18 under a VI 30-sec. reinforcement schedule. From the third to the seventh day (with identical schedule as Day 2: VI 30-sec., 18 stimulus presentations) a green houselight was faded in during the 555 nm. stimulus period (i.e., key pecking); and on the eighth and ninth days the 555 nm. stimulus was faded out (See Table I). The brightness intensity of the stimulus in question was changed after every third presentation of that stimulus or stimulus combination (i.e., three changes per day) by varying the variable resistor in series with the stimulus light. Following this fading procedure three additional days of discrimination training were given to ensure that the red and green houselights were the discriminative stimuli. This fading procedure produces learning of the discrimination with few, if any errors, and no need for Ss to extinguish or completely withhold responding.

THIS BOOK CONTAINS NUMEROUS PAGES WITH DIAGRAMS THAT ARE CROOKED COMPARED TO THE REST OF THE INFORMATION ON THE PAGE.

THIS IS AS RECEIVED FROM CUSTOMER.

Table I

Stimuli component values for the Discrimination group in Phase 1

Session	Intensity of 555 nm. (ohms in series with bulb)	Intensity of green houselight (K ohms in series with bulb)
1	0	10
2	0	10
3	0	10, 7.5, 5.5
4	0	5.5, 4.5, 3
5	0	3 , 2 , 1.25
6	0	1.25, .75, .25
7	0	.25, 0 , 0
8	0 , 2.5, 5	0
9	5 , 15 , 50	0
10	50	0
11	50	0
12	50	0

Note: at 50 ohms and at 10 K ohms the respective visual stimuli are not observable to the experimenter; and at 0 ohms the visual stimuli are at maximal intensity

Subjects in the SS-RP group were placed and maintained on a VI 30-sec. schedule for an equivalent amount of time (i.e., 18 stimulus periods per day for six days). As in the Preliminary training, Ss in the SS-RP group utilized a red houselight as the visual stimulus.

Subjects in the SS-KP group were also placed and maintained on a VI 30-sec. schedule, but these Ss were transferred from the 555 nm. visual stimulus used in Preliminary training to a green houselight through a fading procedure similar to the one used with the Discrimination groups (i.e., the brightness intensity of the stimulus in question was changed after every third presentation of that stimulus or stimulus combination) (See Table II). As in the SS-RP group, training continued for six days with 18 stimulus presentations per day.

Phase 2. In the second phase of the experiment, all four groups were given discrimination training between two auditory stimuli. The positive stimulus was a 1000 Hz. tone and the negative stimulus was white noise. In the presence of S+ responses were reinforced on a VI 20-sec. schedule and in the presence of S- no responses were reinforced. During both the positive and negative stimulus periods the response class incorporated and the visual stimulus illuminating the chambers were as follows: Ss in the D-RP and SS-RP group utilized the ring-pull response with a red houselight present; Ss in the D-KP and SS-KP group utilized the key-peck response with 555 nm. illuminating the response key. (See Table III)

Table II

Stimuli component values for the SS-KP group in Phase 1

Session	Intensity of 555 nm. (ohms in series with bulb)	Intensity of green houselight (K ohms in series with bulb)
1	0	10
2	0	10, 7.5, 5.5, 4.5, 3, 2
3	0	2, 1.25, .75, .25, 0, 0
4	0, 2.5, 5, 15, 50, 50	0
5	50	0
6	50	0

Note: at 50 ohms and at 10 K ohms the respective visual stimuli are not observable to the experimenter; and at 0 ohms the visual stimuli are at maximal intensity

Table III

Summary table of the procedures used in Phase 1 & 2 of the experiment across conditions

Condition	Phase 1		Phase 2	
	Key Peck	Ring Pull	Key Peck	Ring Pull
D-KP	Green HL VI 1/2	Red HL VI 1/2	Tone WN 555 nm 555 nm VI 1/3 ext	
D-RP	Green HL VI 1/2	Red HL VI 1/2		Tone WN Red HL Red HL VI 1/3 ext
SS-KP	Green HL VI 1/2		Tone WN 555 nm 555 nm VI 1/3 ext	
SS-RP		Red HL VI 1/2		Tone WN Red HL Red HL VI 1/3 ext

Note: HL = houselight, Tone = 1000 Hz., WN = white noise, VI 1/2 = variable interval-30 sec., VI 1/3 = variable interval 20-sec., ext = extinction

During this phase the percentage of total responses to S+ (1000 Hz.) was computed for each block of ten trials during which the positive and negative stimuli were each presented five times. This percentage was taken as an index of overall discrimination performance and transfer of training effects in Phase 2. All four groups were given eight daily training sessions each consisting of two blocks of 10 stimulus presentations. Procedural details for Phase 2 were otherwise identical to those of Phase 1.

Results

Phase 1. All Ss in the Discrimination groups (D-KP & D-RP) progressed through the 12 days of the wavelength discrimination task without falling below the preset daily criterion (i.e., 90% correct responding to both red and green houselights). Over the 12 days of Phase 1 training, the total number of correct responses in the presence of the green houselight (key pecks) ranged from 3,266 to 7,311 ($\bar{X}$ = 4,614.6), while the total number of errors (ring pulls) ranged from 2 to 106 ($\bar{X}$ = 39.0). The percentage of correct responses to the green houselight over this period ranged from 97.9 to 99.9% ($\bar{X}$ = 99.17%). During this same period, the total number of correct responses in the presence of the red houselight (ring pulls) ranged from 2,113 to 3,706 ($\bar{X}$ = 2,895.1), while the total number of errors (key pecks) ranged from 0 to 25 ($\bar{X}$ = 6.3). The percentage of correct responses to the red houselight over this period ranged from 99.3 to 100.0% ($\bar{X}$ = 99.79%).

Phase 2. In Figure 1, the percentage of total responses emitted in the presence of the S+ stimulus during each 10-min. block is presented for all groups. A 2 X 2 X 16 (Group X Response Class X Block) analysis of variance of these scores revealed statistically reliable group, F (1, 28) = 42.463, $p < .001$, block, F (15, 420) = 186.476, $p < .001$, and Group X Block effects, F (15, 420) = 17.450, $p < .001$ (See Table IV). From Figure 1, it can be seen that Ss in the Discrimination groups learned the auditory discrimination at a faster rate and reached a higher level of performance than did Single Stimulus Ss after eight days (16 blocks) of training. In addition, this effect was found to

Figure Caption

Figure 1. Average percentage of total responses to 1000 Hz. tone (S+) over 16 blocks of 10 trials during Phase 2 for all experimental conditions

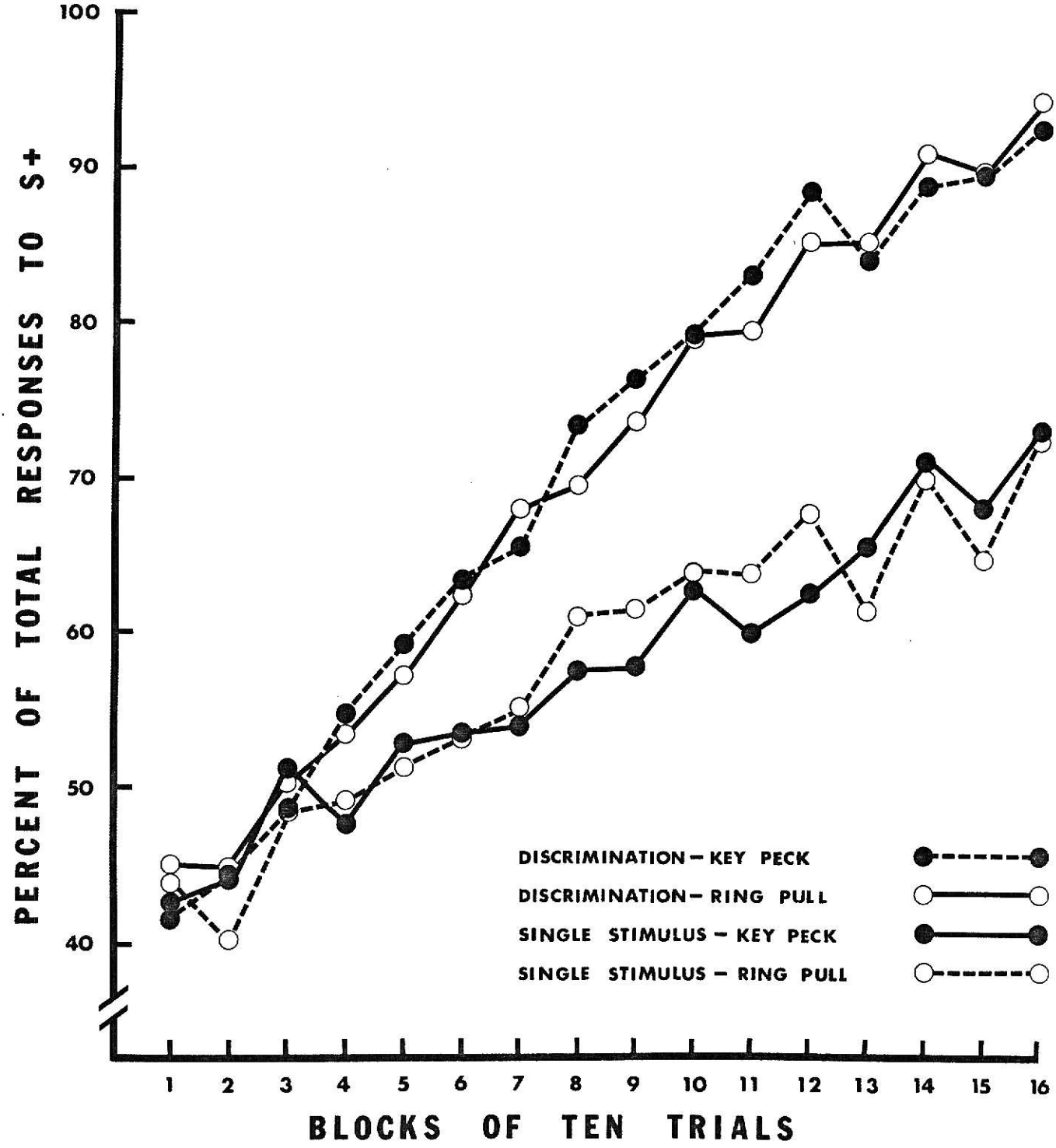
100
90
80
70
60
50
40
PERCENT OF TOTAL RESPONSES TO S+
DISCRIMINATION – KEY PECK
DISCRIMINATION – RING PULL
SINGLE STIMULUS – KEY PECK
SINGLE STIMULUS – RING PULL
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
BLOCKS OF TEN TRIALS

Table IV

Analysis of variance of the percentage of total responses emitted in the presence of the S+ stimulus during Phase 2

Source of Variance	Degrees of Freedom	Mean Square	F	P
Betw. Subj	31			
Groups (Disc vs. SS)	1	20490.000	42.463	<0.0001
Response Class	1	86.000	0.178	0.6791
Gps X Resp Class	1	76.000	0.158	0.6964
Error	28	482.536		
Within Subj	480			
Blocks	15	5489.930	186.476	<0.0001
Group X Block	15	513.733	17.450	<0.0001
Resp Class X Blk	15	6.867	0.233	0.9985
Gp X R C X Block	15	47.333	1.608	0.0681
Error	420	29.440		
Total	511			

be independent of the response class used in the second discrimination (i.e., no response class main effects or interactions).

The differences in performance illustrated in Figure 1 could reflect a more rapid increase in response rate to S+ for the Discrimination groups, a more rapid decrease in response rate to the S- stimulus for these groups, or both. To select among these alternatives, response rates to the two training stimuli were analyzed separately over the 16 blocks of trials.

The average key-peck response rates emitted in the presence of the S+ stimulus for both groups over the 16 blocks of trials are presented in Figure 2(a). A 2 X 16 (Group X Block) analysis of variance of these scores revealed a statistically reliable block effect, F (15, 210) = 12.571, $p < .001$, and Group X Block interaction, F (15, 210) = 3.960, $p < .001$ (See Table V). The statistically reliable Group X Block interaction reflects the profound behavioral contrast effects in the D-KP group. When collapsed over blocks, however, overall group differences were not present.

Figure 2(b) presents the average key-peck response rates in the presence of the S- stimulus for both groups over the 16 blocks of trials. An analysis of variance of these scores revealed statistically reliable group effect, F (1,14) = 11.835, $p < .005$, as well as a reliable block effect, F (15,210) = 28.234, $p < .001$, and Group X Block interaction, F (15, 210) = 3.639, $p < .001$ (See Table VI). From Figure 2(b) it can be seen that the statistically reliable group effect and Group X Block interaction were due to the fact that Ss in the SS-KP group did not exhibit as rapid

Figure Caption

Figure 2. (a) Average key-peck response rates to 1000 Hz. tone (S+) and (b) average key-peck response rates to white noise (S-) over 16 blocks of 10 trials during Phase 2 for the two groups

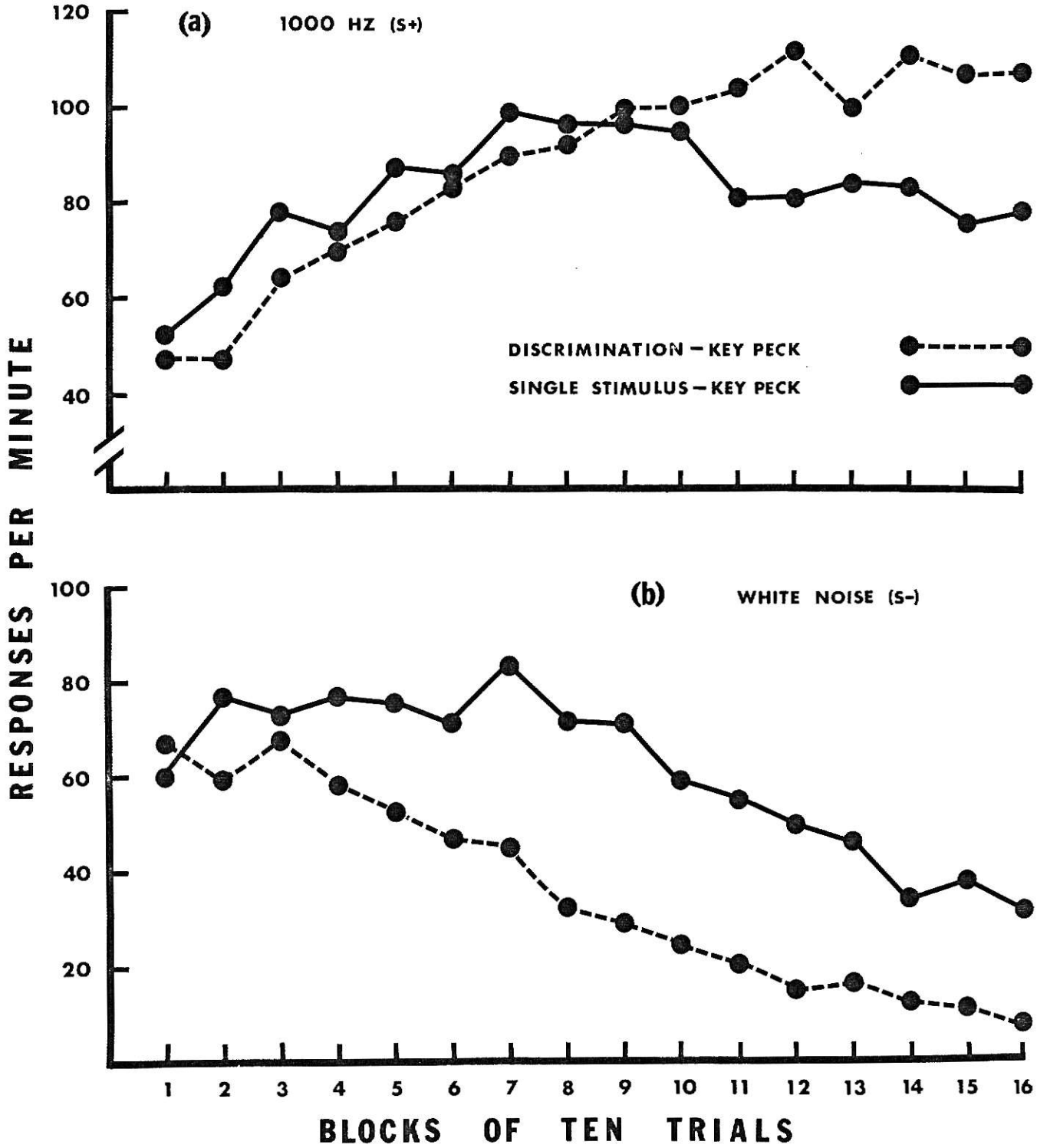
(a)
1000 HZ (S+)
120
100
80
60
40
DISCRIMINATION – KEY PECK
SINGLE STIMULUS – KEY PECK
(b)
WHITE NOISE (S–)
100
80
60
40
20
RESPONSES PER MINUTE
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
BLOCKS OF TEN TRIALS

Table V

Analysis of variance of the key-peck response rates emitted in the presence of the S+ stimulus during Phase 2

Source of Variance	Degrees of Freedom	Mean Square	F	P
Betw. Subj	15			
Groups	1	2927.000	0.349	0.5699
Error	14	8377.711		
Within Subj	240			
Blocks	15	3753.467	12.571	<0.0001
Group X Block	15	1182.467	3.960	<0.0001
Error	210	298.571		
Total	255			

Table VI

Analysis of variance of the key-peck response rates emitted in the presence of the S- stimulus during Phase 2

Source of Variance	Degrees of Freedom	Mean Square	F	P
Betw. Subj	15			
Groups	1	41398.938	11.835	0.0042
Error	14	3498.018		
Within Subj	240			
Blocks	15	5088.957	28.234	< 0.0001
Group X Block	15	655.825	3.639	0.0001
Error	210	180.240		
Total	255			

a decline in responding as did D-KP Ss.

Turning now to the ring-pull rates, the average response rates emitted in the presence of the S+ stimulus for both groups over the 16 blocks of trials are presented in Figure 3(a). An analysis of variance of these scores revealed only a statistically reliable block effect, F (15, 210) = 15.816, $p < .001$ (See Table VII). Thus, the differences exhibited in the ring-pull percentage data are not a function of an increased rate of responding in the presence of the S+ stimulus by the D-RP group.

In Figure 3(b) the average ring-pull response rates in the presence of the S- stimulus for both groups over the 16 blocks of trials are presented. An analysis of variance of these scores revealed a statistically reliable group effect, F (1, 14) = 12.742, $p < .005$, as well as a reliable block, F (15, 210) = 16.765, $p < .001$, and Group X Block interaction, F (15, 210) = 4.143, $p < .001$ (See Table VIII). Since the statistically reliable group effect and Group X Block interaction are of the same magnitude and direction as the effects found for the key-peck response rates in the presence of the S- stimulus, the explanation provided for the former case also applies in this situation.

The preceeding analyses indicate that the performance differences exhibited among the groups in Figure 1 are primarily a function of a more rapid extinction of responses to the S- stimulus on the part of the D-KP and D-RP groups.

Figure Caption

Figure 3. (a) Average ring-pull response rates to 1000 Hz. tone (S+) and (b) average ring-pull response rates to white noise (s-) over 16 blocks of 10 trials during Phase 2 for the two groups

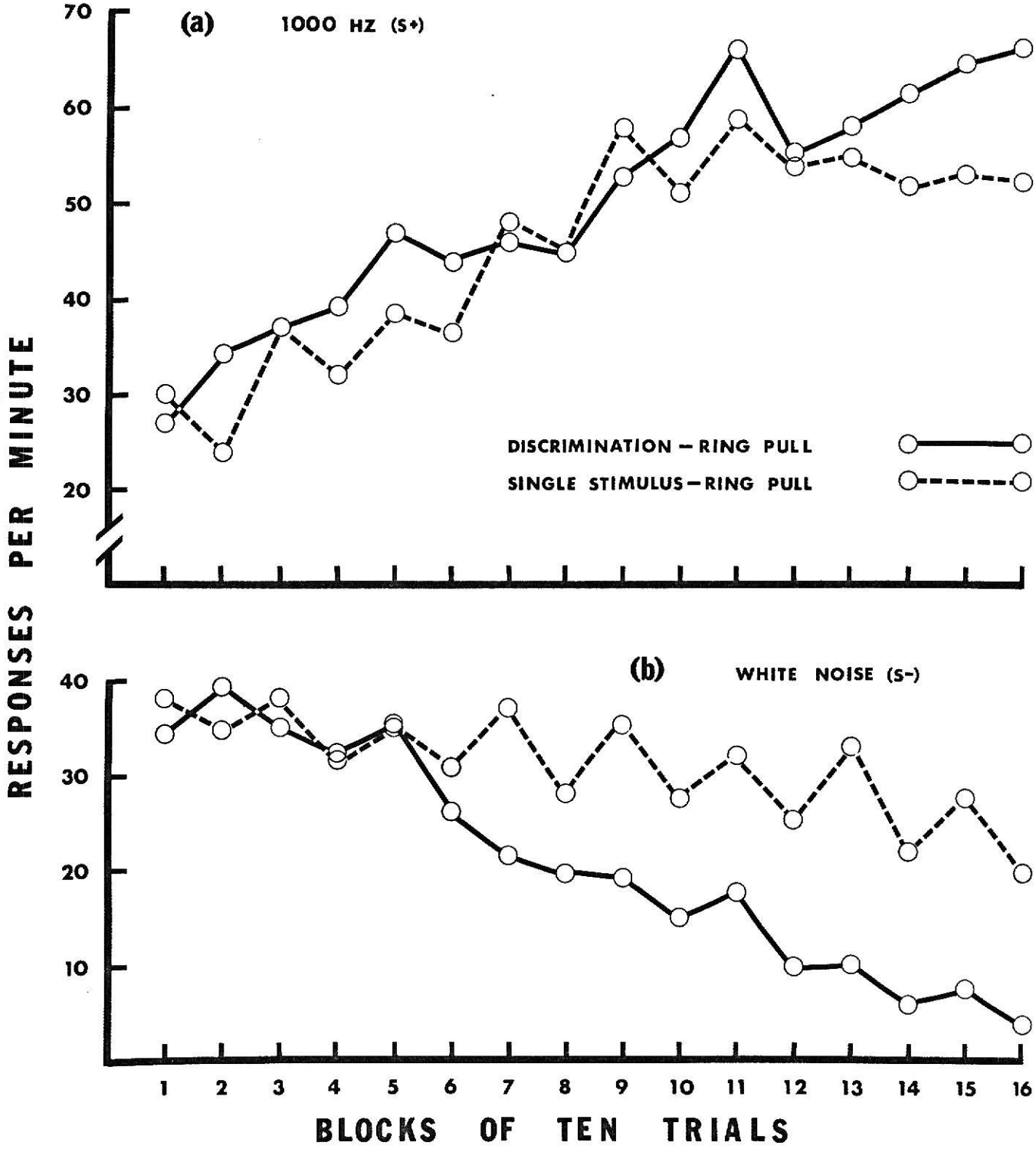
(a)
1000 HZ (S+)
70
60
50
40
30
20
DISCRIMINATION – RING PULL
SINGLE STIMULUS – RING PULL
(b)
WHITE NOISE (S-)
40
30
20
10
RESPONSES PER MINUTE
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
BLOCKS OF TEN TRIALS

Table VII

Analysis of variance of the ring-pull response rates emitted in the presence of the S+ stimulus during Phase 2

Source of Variance	Degrees of Freedom	Mean Square	F	P
Betw. Subj	15			
Groups	1	1523.250	0.369	0.5592
Error	14	4126.016		
Within Subj	240			
Blocks	15	1993.625	15.816	<0.0001
Group X Block	15	126.308	1.002	0.4546
Error	210	126.049		
Total	255			

Table VIII

Analysis of variance of the ring-pull response rates emitted in the presence of the S- stimulus during Phase 2

Source of Variance	Degrees of Freedom	Mean Square	F	P
Betw. Subj	15			
Groups	1	6579.250	12.742	0.0033
Error	14	516.353		
Within Subj	240			
Blocks	15	1090.971	16.765	<0.0001
Group X Block	15	269.587	4.143	<0.0001
Error	210	65.073		
Total	255			

Discussion

The occurrence of positive transfer of training exhibited by the Discrimination groups in the present experiment is congruent with the transfer studies previously mentioned (Eck, et. al., 1969; Eck & Thomas, 1970; Keilitz & Frieman, 1970; Thomas, et. al., 1971; Goyette, 1971). The present results indicate that Ss trained on an errorless wavelength discrimination in which differential reinforced responding (key pecking vs. ring pulling) was required will be facilitated in the learning of a subsequent auditory discrimination involving only one response class. Such findings support the hypothesis that these transfer of training effects are mediated by a general attention construct as proposed by Thomas (1970).

Conceivably, one could still argue that withholding of responses occurs in the first phase of this experiment thereby mediating the observed transfer of training phenomena. The rationale behind this criticism comes from the fact that even though Ss have been errorlessly trained to discriminate stimuli by differentially responding to them, they are none-the-less withholding all other incompatable responses. Specifically, it can be argued that in order for a S to key peck in the presence of a green houselight, he must withhold not only ring-pull responses, but also responses of not-pecking. Although this reasoning cannot be discredited, it is this author's contention that it is more parsimoneous to hypothesize that the S is actively responding as in the presence of two positive stimuli, rather than withholding responses as in the presence of two negative stimuli.

Several interesting possibilities for further experimentation in this area of transfer of training can be derived from the present study. For example, an experiment could be designed to specifically reinforce withholding responses, comparing subsequent transfer to regular successive discrimination and single stimulus Ss. This procedure could be accomplished by making reinforcement for stimulus A contingent upon the occurrence of response A, and reinforcement for stimulus B contingent upon the withholding of response A (i.e., a DRO schedule). From a withholding response hypothesis one would expect Ss in the withholding discrimination group to exhibit at least as much transfer to the new discrimination task as Ss in the regular successive discrimination group. Another possibility of determining to what extent withholding of responses facilitates the acquisition of a second discrimination in the transfer of training paradigm is by varying the amount of exposure to the S- stimulus component of the first discrimination; the degree of transfer to the second discrimination can then be measured as a function of amount of withholding responses developed in the S- component of the first discrimination.

Appendix A

Phase 2 Discrimination Index Scores
Discrimination - Ring Pull Group

BLOCKS	SUBJECTS 1	2	3	4	5	6	7	8
1	44.4	53.6	38.7	45.6	35.2	45.8	50.7	45.6
2	42.4	39.0	54.3	51.2	39.7	46.3	42.2	43.6
3	46.8	42.3	56.3	59.5	55.6	46.4	47.7	48.4
4	53.2	48.1	56.9	64.4	52.4	50.3	48.4	50.8
5	59.8	51.0	57.2	60.2	60.3	51.5	58.6	57.2
6	63.4	53.1	57.7	70.6	75.8	55.9	61.2	58.9
7	65.1	56.8	67.3	83.5	82.7	56.9	62.3	69.3
8	71.0	61.4	63.5	78.2	84.2	63.0	63.4	69.8
9	73.7	63.8	71.2	76.2	91.2	69.6	69.3	74.9
10	80.5	72.4	77.7	86.4	93.1	71.4	72.9	77.7
11	81.3	76.2	78.6	75.5	95.7	66.2	78.4	85.0
12	87.4	83.3	75.0	93.3	98.7	70.2	81.0	94.2
13	86.3	82.5	81.6	84.3	93.6	77.2	84.4	92.4
14	93.3	89.3	84.3	96.1	96.6	84.9	90.1	94.0
15	91.2	88.0	84.2	89.0	98.8	81.6	91.0	94.0
16	97.0	93.5	88.8	97.4	99.1	90.2	93.2	96.1

Phase 2 Response Rates (S+ stimulus, top; S- stimulus, bottom): Discrimination - Ring Pull Group

BLOCKS	SUBJECTS 1	2	3	4	5	6	7	8
1	31.5	32.8	36.2	36.5	23.1	21.1	7.0	28.8
	39.4	28.4	57.4	43.6	42.6	25.0	6.8	34.4
2	30.3	29.3	73.7	63.8	21.9	26.7	5.4	26.4
	41.2	45.8	62.0	60.8	33.2	31.0	7.4	34.2
3	35.4	29.0	48.9	74.0	26.3	26.8	19.0	36.8
	40.2	39.6	38.0	50.4	21.0	31.0	20.8	39.2
4	43.5	33.8	40.4	86.4	27.5	28.3	14.8	39.3
	38.2	36.4	30.6	47.8	25.0	28.0	15.8	38.2
5	50.3	39.5	57.1	79.7	27.3	29.3	40.1	54.8
	33.8	38.0	42.8	52.6	18.0	27.6	28.4	41.0
6	48.6	29.0	52.6	75.5	43.3	31.9	29.0	43.2
	28.0	25.6	38.6	31.4	13.8	25.2	18.4	30.2
7	52.5	28.7	45.2	49.7	51.7	27.2	46.7	67.4
	28.2	21.8	22.0	9.8	10.8	20.6	28.2	29.8
8	55.3	35.0	37.5	59.0	47.0	27.3	43.3	56.3
	22.6	22.0	21.6	16.4	8.8	16.0	25.0	24.4
9	52.8	47.2	61.3	83.9	45.8	37.1	41.5	54.8
	18.8	26.8	24.8	26.2	4.4	16.2	18.4	18.4
10	50.3	53.0	74.5	99.5	37.8	44.5	40.8	55.8
	12.2	20.2	21.4	15.6	2.8	17.8	15.2	16.0
11	72.3	47.3	112.3	106.5	48.4	31.3	51.6	62.5
	16.6	14.8	30.6	34.6	2.2	16.0	14.2	11.0
12	55.3	50.8	82.6	69.1	44.8	25.4	57.2	58.5
	8.0	10.2	27.6	5.0	0.6	10.8	13.4	3.6
13	55.4	67.8	92.0	79.3	38.0	30.5	33.5	71.0
	8.8	14.4	20.8	14.8	2.6	9.0	6.2	5.8
14	72.7	77.1	81.6	84.8	34.4	24.8	52.6	65.4
	5.2	9.2	15.2	3.4	1.2	4.4	5.8	4.2
15	66.0	64.3	92.0	98.9	49.3	23.1	62.5	62.8
	6.4	8.8	17.2	12.2	0.6	5.2	6.2	4.0
16	76.8	60.8	96.9	107.0	44.0	29.3	49.3	69.5
	2.4	4.2	12.2	2.8	0.4	3.2	3.6	2.8

Appendix B

Phase 2 Discrimination Index Scores
Single Stimulus - Ring Pull Group

BLOCKS	SUBJECTS 1	2	3	4	5	6	7	8
1	52.8	40.5	43.9	37.3	35.8	43.5	49.8	50.9
2	33.3	34.7	37.5	47.6	38.1	44.6	40.6	44.8
3	43.8	43.9	50.0	48.1	52.7	56.3	45.7	44.5
4	44.9	44.1	50.5	53.5	53.7	57.7	42.0	47.4
5	38.2	46.4	51.3	55.7	45.6	63.9	55.2	55.2
6	50.1	49.5	42.9	65.4	44.8	64.7	53.8	54.1
7	47.7	46.9	51.9	73.9	48.4	69.4	53.4	53.3
8	50.3	57.1	53.2	83.9	54.9	76.6	58.8	53.2
9	55.9	57.3	55.0	76.1	55.0	76.7	59.1	57.3
10	62.3	54.9	62.8	81.3	55.3	77.9	55.4	62.9
11	58.4	56.5	60.6	74.8	60.3	75.8	59.8	64.8
12	64.0	60.1	65.7	85.2	60.7	87.0	55.6	64.9
13	55.4	57.8	59.2	81.1	61.0	68.7	59.6	52.7
14	62.8	57.7	66.5	86.5	66.2	87.0	52.4	80.4
15	56.4	63.7	60.4	78.6	56.0	84.6	59.3	57.7
16	63.6	67.9	71.1	90.0	71.0	86.6	57.6	74.8

Phase 2 Response Rates (S+ stimulus, top; S- stimulus, bottom): Single Stimulus - Ring Pull Group

BLOCKS	SUBJECTS 1	2	3	4	5	6	7	8
1	14.3	23.4	29.0	25.8	23.8	42.8	32.5	48.1
	12.8	34.4	37.0	43.4	42.6	55.6	32.8	46.4
2	17.3	17.3	20.2	29.8	20.1	39.2	21.5	26.5
	34.6	32.6	33.6	32.8	32.6	48.6	31.4	32.6
3	22.9	26.3	37.0	39.3	34.6	74.2	27.3	33.5
	29.4	33.6	37.0	42.4	31.0	57.6	32.4	41.8
4	21.0	25.1	33.1	32.2	28.3	62.2	24.5	29.2
	25.8	31.8	32.4	28.0	24.4	45.6	33.8	32.4
5	18.8	31.7	41.1	39.3	27.3	50.9	48.8	51.9
	30.4	36.6	39.0	31.2	32.6	28.8	39.6	42.2
6	29.5	23.7	31.5	36.6	14.8	69.8	43.8	44.5
	29.4	24.2	42.0	19.4	18.2	38.0	37.6	37.8
7	26.6	26.9	42.7	39.1	42.6	103.8	52.3	51.8
	29.2	30.4	39.6	13.8	45.4	45.8	45.6	45.4
8	34.6	28.5	34.5	32.2	28.0	100.4	60.8	41.3
	34.2	21.4	30.4	6.2	23.0	30.6	42.6	36.4
9	45.2	34.4	50.4	63.1	41.0	92.8	78.3	59.0
	35.6	25.6	41.2	19.8	33.6	28.2	54.2	44.0
10	41.7	33.3	51.4	59.0	24.5	94.5	65.1	41.0
	25.2	27.4	30.4	13.6	19.8	26.8	52.4	24.2
11	36.8	42.3	60.5	55.1	48.3	116.6	83.8	28.3
	26.2	32.6	39.4	18.6	31.8	37.2	56.4	15.4
12	36.9	49.8	59.5	48.3	44.7	106.8	66.0	20.0
	20.8	33.0	31.0	8.4	29.0	16.0	52.6	10.8
13	51.6	50.5	58.3	66.0	49.8	93.3	29.8	41.0
	41.6	36.8	40.2	15.4	31.8	42.6	20.2	36.8
14	48.3	47.5	51.5	66.5	54.5	88.5	32.6	27.9
	28.6	34.8	26.0	10.4	27.8	13.2	29.6	6.8
15	45.0	54.4	49.7	60.3	40.2	93.7	39.0	44.7
	34.8	31.0	32.6	16.4	31.6	17.0	26.8	32.8
16	39.8	54.5	50.7	62.9	54.9	79.8	37.2	41.6
	22.8	25.8	20.6	7.0	22.4	12.4	27.4	14.0

Appendix C

Phase 2 Discrimination Index Scores
Single Stimulus - Key Peck Group

BLOCKS	SUBJECTS 1	2	3	4	5	6	7	8
1	41.4	33.6	35.0	54.8	54.3	40.4	43.8	36.1
2	37.7	49.5	39.9	50.9	46.6	48.3	37.6	41.2
3	54.0	49.2	45.4	55.8	51.4	54.4	45.9	53.2
4	38.4	49.1	46.4	53.1	47.3	54.3	43.0	51.7
5	44.3	44.1	55.4	65.0	52.2	57.4	46.1	59.5
6	45.3	47.1	57.7	65.4	52.3	57.7	34.7	68.7
7	52.5	54.5	62.4	52.5	51.1	49.6	53.8	57.7
8	51.7	61.0	68.6	57.9	53.9	50.3	54.5	63.7
9	63.3	66.3	60.0	52.4	55.9	46.9	54.8	64.9
10	61.3	68.4	71.3	59.2	54.8	59.1	59.0	73.3
11	59.6	54.0	63.6	58.9	57.3	68.1	58.0	59.2
12	58.7	67.8	74.3	62.2	57.8	61.7	59.3	62.5
13	55.5	70.1	78.0	63.4	61.3	69.9	63.4	65.9
14	70.4	73.1	74.8	70.2	67.2	74.9	69.8	70.2
15	69.1	65.1	84.8	75.3	62.3	69.4	62.9	55.3
16	80.0	78.0	84.4	80.1	50.8	70.8	80.6	61.4

Phase 2 Response Rates (S+ stimulus, top; S- stimulus, bottom): Single Stimulus - Key Peck Group

BLOCKS	SUBJECTS 1	2	3	4	5	6	7	8
1	33.5	16.6	33.1	128.6	112.3	30.0	30.5	31.8
	47.4	32.8	61.4	106.2	94.4	44.2	39.2	56.4
2	50.4	50.9	27.5	111.0	123.4	50.7	53.5	36.4
	83.2	52.0	41.4	107.0	141.6	54.2	88.6	52.0
3	55.6	44.8	36.9	155.8	134.5	76.0	60.0	62.3
	47.4	46.2	44.4	123.6	127.2	63.8	70.8	54.8
4	44.3	66.6	47.0	124.8	119.3	82.6	48.9	54.9
	71.2	69.0	54.4	110.2	132.8	69.4	64.8	51.2
5	67.6	57.7	76.0	143.8	134.7	74.2	71.2	72.8
	85.0	73.2	61.2	77.6	123.4	55.0	83.4	49.6
6	75.0	61.0	80.8	122.7	123.9	82.6	35.5	104.7
	90.6	68.6	59.2	64.8	113.2	60.6	66.8	47.8
7	84.6	86.0	94.7	122.7	121.3	58.3	98.3	118.1
	76.4	71.8	57.0	111.2	116.0	59.2	84.4	86.6
8	80.2	92.5	93.6	90.0	118.1	87.2	113.6	95.3
	75.0	59.2	42.8	65.4	101.0	86.0	94.8	54.2
9	94.0	89.0	86.6	114.9	113.1	71.7	97.9	102.8
	54.4	45.2	57.8	104.2	89.2	81.2	80.6	55.6
10	100.3	80.2	60.5	113.1	102.2	98.1	118.0	93.0
	63.4	37.0	24.4	77.8	84.4	67.8	82.0	33.8
11	60.2	40.1	88.5	101.4	119.8	66.6	97.3	77.5
	40.8	34.2	50.6	70.8	89.2	31.2	70.6	53.4
12	69.0	70.8	73.3	88.4	114.4	99.4	77.5	59.3
	48.6	33.6	25.4	53.8	83.6	61.8	53.2	35.6
13	98.0	69.4	68.6	78.7	114.8	97.1	95.5	59.8
	78.6	29.6	19.4	45.4	72.6	41.8	55.2	31.0
14	101.9	51.6	60.5	79.1	122.7	109.2	84.5	55.5
	42.8	19.0	20.4	33.6	59.8	36.6	36.6	23.6
15	60.0	37.7	76.0	96.9	121.9	75.7	82.0	61.2
	26.8	20.2	13.6	31.8	73.8	33.4	48.4	49.4
16	65.8	45.3	80.1	91.7	99.8	101.0	89.8	54.0
	16.4	12.8	14.8	22.8	96.6	41.6	21.6	34.0

Appendix D

Phase 2 Discrimination Index Scores
Discrimination - Key Peck Group

BLOCKS	SUBJECTS 1	2	3	4	5	6	7	8
1	39.6	52.3	35.1	42.4	43.5	39.4	35.2	46.0
2	45.5	53.8	42.7	39.1	46.7	45.4	36.3	45.3
3	54.6	51.5	50.4	50.5	48.4	43.5	41.9	45.9
4	63.1	64.1	54.4	57.0	49.1	49.8	49.1	49.3
5	62.5	73.3	63.4	58.0	53.0	57.7	44.8	59.1
6	72.4	83.7	62.5	61.2	56.0	59.8	49.7	61.4
7	75.5	78.0	63.6	65.9	57.8	63.8	54.2	64.9
8	88.5	88.0	68.4	70.6	60.5	77.9	63.2	69.1
9	84.3	90.2	72.8	77.1	69.3	78.0	68.7	70.8
10	88.0	92.5	73.4	83.1	73.1	83.7	71.9	67.9
11	91.9	92.1	78.8	84.5	78.4	84.4	77.7	76.3
12	93.8	96.1	82.0	92.2	85.2	95.8	75.5	85.9
13	86.1	90.6	79.1	88.8	81.2	88.8	77.0	83.6
14	90.6	93.3	84.4	91.9	86.7	93.4	87.8	86.7
15	94.1	93.0	82.8	92.2	84.5	96.0	87.2	85.9
16	95.3	96.3	85.3	93.1	89.2	97.8	93.5	91.2

Phase 2 Response Rates (S+ stimulus, top; S- stimulus, bottom): Discrimination - Key Peck Group

BLOCKS	SUBJECTS 1	2	3	4	5	6	7	8
1	58.3	38.0	16.9	45.8	64.8	74.5	34.8	49.5
	88.8	34.6	31.2	62.2	84.0	114.8	64.2	58.2
2	64.8	40.3	22.5	29.3	56.5	75.8	35.1	57.3
	77.6	34.6	30.2	45.6	64.4	91.2	61.6	69.2
3	116.5	72.5	61.9	57.0	55.4	43.6	49.1	64.6
	97.0	69.4	60.8	55.8	59.0	56.6	68.0	76.0
4	120.0	78.9	66.3	59.3	47.0	70.2	56.1	64.4
	70.2	44.2	55.6	44.8	48.8	70.8	58.2	66.2
5	143.6	91.5	44.3	77.2	68.6	101.3	42.5	44.5
	86.0	33.4	25.6	55.8	60.8	74.2	52.4	30.8
6	143.4	111.6	44.7	83.0	75.3	95.5	64.1	52.2
	54.6	21.8	26.8	52.6	59.2	64.2	64.8	32.8
7	149.5	114.6	39.9	80.7	79.0	121.0	59.2	69.8
	48.4	32.4	22.8	41.8	57.6	68.8	50.0	37.8
8	156.8	123.3	52.5	89.8	82.5	64.8	91.8	77.8
	20.4	16.8	24.2	37.4	53.8	18.4	53.4	34.8
9	149.0	130.9	80.7	91.7	99.9	113.4	72.8	60.2
	27.8	14.2	30.2	27.2	44.2	32.0	33.2	24.8
10	147.3	128.5	69.5	87.3	110.3	85.4	92.8	80.0
	20.0	10.4	25.2	17.8	40.6	15.6	36.2	37.8
11	155.0	125.5	95.9	80.9	79.7	114.8	107.5	87.8
	13.6	10.8	25.8	14.8	22.0	21.2	30.8	27.2
12	153.3	134.5	74.7	99.3	115.1	105.0	124.6	90.5
	10.2	5.4	16.4	8.4	20.0	4.6	40.4	14.8
13	159.6	134.8	42.4	85.6	75.2	133.8	69.1	100.9
	25.8	14.0	11.2	10.8	17.4	16.8	20.6	19.8
14	162.5	144.5	82.5	95.3	92.3	106.8	104.8	101.8
	16.8	10.4	15.2	8.4	14.2	7.6	14.6	15.6
15	162.1	143.4	73.0	95.1	87.5	123.6	80.7	100.8
	10.2	10.8	14.2	8.0	16.0	5.2	11.8	16.6
16	153.8	144.5	78.0	86.8	92.8	87.5	118.7	108.3
	7.6	5.6	13.4	6.4	11.2	2.0	8.2	10.4

References

Bullock, D. H., & Smith, W. C. An effect of repeated conditioning-extinction upon operant strength. Journal of Experimental Psychology, 1953, 46, 349-352.

Eck, K. O., Noel, R. C., & Thomas, D. R. Discrimination learning as a function of prior discrimination and nondifferential training. Journal of Experimental Psychology, 1969, 82, 156-162.

Eck, K. O., & Thomas, D. R. Discrimination learning as a function of prior discrimination and nondifferential training: A replication. Journal of Experimental Psychology, 1970, 83, 511-513.

Goyette, C. H. Transfer of training across response class and stimulus modality. Paper presented at the meeting of the Midwestern Psychological Association, Detroit, 1971.

Keilitz, I., & Frieman, J. Transfer following discrimination learning with and without errors. Journal of Experimental Psychology, 1970, 85, 293-299.

Marsh, G., & Johnson, R. Discrimination reversal following learning without "errors." Psychonomic Science, 1968, 10, 261-262.

Perkins, C. C., Jr., & Cacioppo, A. J. The effects of intermittent reinforcement on the change in extinction rate following successive reconditionings. Journal of Experimental Psychology, 1950, 40, 794-801.

Sheffield, V. F. Extinction as a function of partial reinforcement and distribution of practice. Journal of Experimental Psychology, 1949, 39, 511-526.

Thomas, D. R. Stimulus selection, attention, and related matters. In J. H. Reynierse (Ed.), Current issues in animal learning. Lincoln: University of Nebraska Press, 1970.

Thomas, D. R., Miller, J. T., & Svinicki, J. G. Non-specific transfer effects of discrimination training in the rat. Journal of Comparative and Physiological Psychology, 1971, 74, 96-101.

TRANSFER OF TRAINING FOLLOWING DISCRIMINATION LEARNING INVOLVING TWO REINFORCED RESPONSES

by

CHARLES H. GOYETTE

B.A., University of Vermont, 1969

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Psychology

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1971

Abstract

Two groups of pigeons were given training with chromatic stimuli: one group experienced only a single color and response class, while the second group was given errorless discrimination training between two chromatic stimuli in which differential reinforced responding (key pecking vs. ring pulling) was required. The discrimination group subsequently acquired a successive auditory discrimination (utilizing either response class) faster than the group given single stimulus training. These results further support the notion that transfer of training effects are mediated by a general attention construct.