DISRUPTIVE EFFECTS OF PSEUDODISCRIMINATION AND SINGLE STIMULUS TRAINING ON TRANSFER OF TRAINING

by

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Previous experiments with pigeons have shown that generalization gradients are markedly affected by discrimination training carried out with stimuli that are on a different stimulus dimension than those employed during testing (i.e., when training stimuli are "extradimensional" to testing stimuli). For example, Honig (1969) trained pigeons to respond differentially in the presence of two successively presented stimuli along the wavelength dimension. This procedure, called TD or "true discrimination" training, was followed by acquisition of responding to three dark vertical lines on a white background. Subjects trained in this way provided a steeper generalization gradient on the dimension of line orientation than others which had been reinforced equally for responding to the two wavelength stimuli ("pseudodiscrimination" or PD training). Similar effects on generalization gradients have been reported by Reinhold and Perkins (1955), Thomas, Freeman, Svinicki, Burr and Lyons (1970), Bresnahan (1970) and Hall and Honig (1974).

Extradimensional discrimination training also results in positive transfer of training; i.e., TD training with one stimulus dimension has been found to facilitate subsequent discrimination learning involving novel stimulus dimensions. In 1970 Eck and Thomas demonstrated this finding by giving one group of pigeons TD training and another group PD

training using two line angles as stimuli. Both groups were then trained to discriminate between two wavelengths. The TD group learned the second discrimination more rapidly than did the PD group. Such transfer of training results have also been observed by Eck, Noel and Thomas (1969), Keilitz and Frieman (1970), Thomas, Miller and Svinicki (1971), Frieman and Goyette (1973) and Goyette (1973).

In interpreting the effects of extradimensional training on generalization and transfer studies, Thomas (1969, 1970) proposed the concept of general attentiveness. He suggests that during true discrimination training subjects learn to attend not only to the relevant stimuli (i.e., those correlated with reward and non-reward), but also to stimulus differences in general. This enhanced attentiveness to stimulus differences is then carried over by the subject into future problems. It can either steepen generalization gradients or increase the rate of acquisition of new discriminations involving different stimulus dimensions. Pseudo-discrimination training, on the other hand, teaches the subject that it is not necessary to attend to stimulus differences. Theoretically, such nondifferential training should flatten gradients and disrupt subsequent discrimination learning.

The control condition in general attention studies has

typically been single stimulus (SS) training, which involves reinforcing responses emitted in the presence of one stimulus only. This procedure is considered an appropriate comparison condition since subjects are not exposed to stimulus differences prior to being tested along another dimension. According to the general attention explanation, TD training should enhance attention and PD should reduce it relative to SS training.

Although TD training has frequently been shown to steepen generalization gradients and facilitate the learning of new discriminations relative to PD and SS training, the latter two conditions have not consistently differed from each other. In only one study (Bresnahan, 1970) has it been demonstrated that PD training produces reliably flatter generalization gradients than SS training; Honig (1969) observed a small but statistically insignificant flattening effect and Thomas (1969, 1970) reported no difference in gradient slope between SS and PD trained subjects. In studies of transfer of training, no statistically reliable differences have been reported between PD and SS conditions (Eck, Noel and Thomas, 1969; Thomas, Miller and Svinicki, 1971; Goyette, 1973).

A possible explanation for the similarity between PD and SS conditions has recently been suggested by Honig (1969,

Experiments 5 and 6; 1974). He hypothesized that if the level of attention to stimulus differences is low prior to training, then PD training may not be able to reduce it any further. To test this idea, a three stage experiment was conducted. First, pigeons were given true discrimination training between two line angles to presumably increase their level of general attention. The subjects then experienced either TD, PD, SS or no training along the wavelength dimension. The gradient of the group given TD followed by PD training was significantly flatter than the gradients obtained from the other groups. Honig concluded that PD training will reduce the amount of attention to stimulus differences only if a high level of general attention has previously been established through TD training.

The purpose of Experiment I reported in this paper was to determine whether differences between PD and SS conditions could be obtained in a similar manner with a transfer of training paradigm. As in Honig's study, three groups of pigeons were given discrimination training with wavelengths to initially increase their level of attention, and then they received either PD, SS or no training along the line angle dimension. For comparison purposes, three additional groups were given the same training but in reverse order; i.e., PD, SS or no training was given with the wavelengths, followed

by discrimination training between two line angles. During the final phase of the experiment, all six groups experienced discrimination training between two auditory stimuli. The question of interest was whether PD training would disrupt transfer on the auditory problem relative to the SS and no training conditions.

EXPERIMENT I

METHOD

Subjects

Subjects were 34 experimentally naive homing pigeons obtained from a local supplier and maintained at 70-75% of their free feeding weights for the duration of the experiment.

Apparatus

The experiment was performed in two identical operant conditioning chambers with associated automatic programming equipment. Both chambers have internal dimensions of 32 cm x 26 cm x 34.5 cm. Located on one wall of each chamber is a Grason-Stadler response key 17.5 cm from the floor. Directly below the key, 5 cm from the floor, is an opening (5.2 cm x 6.4 cm) allowing access to a grain hopper. Stimuli were projected onto the response key by Industrial Electronic display cells equipped with G.E. No. 44 miniature lamps. The display cells contained Kodak Wratten filters No. 65, 74, 99, 73 and 72B, which provided relatively monochromatic lights, with peak transmission at 501, 538, 555, 576 and 606 nm respectively. The display cells also produced a white line .32 cm wide x 2.22 cm high in differing angular orientations, 30°, 60°, 90° (vertical), 120° and 150° from horizontal. White noise, produced by a homemade white noise generator,

and a 1000 Hz tone, produced by a Hewlett Packard audio osciolator Model 201CR, were used as auditory stimuli. Except for the grain-hopper light during reinforcement, the response key provided the only source of light in the experimental chambers.

Procedure

Subjects were randomly assigned to one of six experimental conditions: A True Discrimination-Pseudodiscrimination (TD-PD), a True Discrimination-Single Stimulus (TD-SS), a True Discrimination-Hold (TD-HOLD), a Pseudodiscrimination-True Discrimination (PD-TD), a Single Stimulus-True Discrimination (SS-TD), and a Hold-True Discrimination (HOLD-TD) group. The group names designate the nature of Phase 1 and Phase 2 training. Six subjects were assigned to the TD-SS, TD-HOLD, SS-TD and HOLD-TD groups, while five birds were placed in the TD-PD and PD-TD groups[1].

Preliminary Training. On Day 1, subjects in all groups were magazine trained, key-peck trained, and given 30 reinforcements of 3-sec access to the grain hopper on a continuous schedule (CRF). The subjects were given 30 more reinforcements on a continuous schedule on Day 2. On Day 3, the schedule was changed so that every fifth response was reinforced (FR-5), and on Day 4 the ratio was increased to FR-20. This procedure facilitated the subsequent transition

to a variable interval (VI) schedule.

For the next 3 days, responses were reinforced on a VI 30-sec schedule for 17.5 min each day. Each daily session consisted of 15 stimulus presentations of 1-min duration separated by 10-sec blackout periods which the response key was darkened and no responses were reinforced. Throughout preliminary training, the response key was illuminated with a 555 nm light for all groups.

Phase 1. Following keypeck training, subjects in the TD-PD, TD-SS and TD-HOLD conditions were given discrimination training with 555 nm as the positive stimulus (S^+) and 538 nm as the negative stimulus (S^-). In the presence of S^+, responses were reinforced on a VI 30-sec schedule, and in the presence of S^- no responses were reinforced. For all three groups, each session of discrimination training consisted of 30 stimulus periods of 1-min duration separated by 10-sec blackouts. Positive and negative stimulus periods were presented in a quasi-random order with the restrictions that no more than two S^+ or S^- periods appear successively and that within each block of 10 stimulus presentations S^+ and S^- appear five times each. Discrimination training continued for each bird until a criterion of 10 S^+ responses for each S^- response was attained in four consecutive daily sessions.

During Phase 1 the other three groups received either

PD, SS or no training with the wavelength stimuli. The PD-TD group experienced the same sequence of color stimuli as the discrimination groups, but the stimuli were not correlated with the reinforcement contingency. For half the time (determined on a random basis), the VI 30-sec reinforcement schedule was in effect during presentations of the 555 nm stimulus, and for the other half, reinforcement accompanied the 538 nm stimulus. Subjects in the SS-TD group were given reinforced keypeck training with 555 nm projected on the response key. Responses were reinforced on a VI 30-sec schedule of reinforcement. Each daily session of training consisted of 15, 1-min stimulus-on periods separated from each other by 10-sec blackouts. In this phase, birds in the HOLD-TD condition were weighed daily but experienced no training with the wavelength stimuli. To determine the length of time they should remain in Phase 1 training, subjects in these three groups were randomly matched to individual birds that were to have the same type of training but in reverse order; i.e., PD-TD birds were paired with TD-PD subjects, SS-TD with TD-SS, and HOLD-TD with TD-HOLD. Thus, each PD-TD, SS-TD and HOLD-TD bird remained in Phase 1 until the subject with which it was matched had reached criterion on the wavelength discrimination (i.e., for an equivalent number of sessions).

Phase 2. In the second phase of the experiment, the three groups which experienced PD, SS or no training during Phase 1 (the PD-TD, SS-TD, and HOLD-TD groups) were given true discrimination training between a 90° line angle (S^+) and a 60° line angle (S^-). During both the positive and negative stimulus periods the line angle was illuminated on a 555 nm surround. Other procedural details were identical to the discrimination training given in Phase 1 of this experiment.

The three groups which received true discrimination training in Phase 1 (the TD-PD, TD-SS and TD-HOLD groups) were placed in either the PD, SS or HOLD condition during Phase 2. The TD-PD group experienced the same sequence of line angle stimuli as the discrimination groups, but responses were reinforced half the time in the presence of the 90° stimulus and the other half the time in the presence of the 60° stimulus. Both line angles were illuminated on a 555 nm surround. Subjects in the TD-SS group were reinforced on a VI 30-sec schedule of reinforcement for responding to the 90° stimulus on a 555 nm surround. Finally, the birds in the TD-HOLD group were not trained with the line angle stimuli, but were simply weighed daily during Phase 2. Subjects in all three groups remained in Phase 2 until their match in the reverse order condition reached criterion on the

line angle discrimination.

Phase 3. All six groups of birds were then trained for nine days on an auditory discrimination between a 1000 HZ tone (S^+) and white noise (S^-). Responses were reinforced on a VI 20-sec schedule in the presence of S^+, and no responses were reinforced in the presence of S^-. Each daily session of discrimination training consisted of 20 stimulus periods of 1-min duration, separated from each other by 10-sec blackouts. To facilitate responding in the presence of the novel stimuli: 1) the first stimulus period on Day 1 was a positive (reinforcement) period; 2) subjects were immediately given 3-sec access to mixed grain at the beginning of the first stimulus-on period; and 3) the duration of the first stimulus period was extended by the length of time it took the subject to emit an initial response. During both the positive and negative stimulus periods, the response key was illuminated with the 90° white line on a 555 nm surround. Other procedural details were identical to the discrimination training given in Phase 1 of this experiment. A summary table of the design of this study is presented in Table I.

The rates of responding to positive and negative stimuli, and the percentage of the total responses to S^+ were computed each day of discrimination training for each subject. This percentage was taken as an index of the overall

TABLE I. Summary Table of the Design Used in Experiment I.

Condition	Phase 1		Phase 2		Phase 3[a]	
	555 nm	538 nm	90° 555 nm	60° 555 nm	1000 Hz	White Noise
TD-PD	VI 30-sec	ext	VI 30-sec ext	VI 30-sec ext	VI 20-sec	ext
TD-SS	VI 30-sec	ext	VI 30-sec	___		
TD-HOLD	VI 30-sec	ext	_____			
PD-TD	VI 30-sec ext	VI 30-sec ext	VI 30-sec	ext		
SS-TD	VI 30-sec	___	VI 30-sec	ext		
HOLD-TD	_____		VI 30-sec	ext		

[a]During Phase 3, a 90° white line angle on a 555 nm surround illuminated the response key.

discrimination performance and transfer of training effects in Phase 3.

RESULTS

Phase 1. The average number of days required to reach criterion on the wavelength discrimination was as follows: TD-PD = 6.40, range = 6-7; TD-SS = 6.17, range = 6-7; and TD-HOLD = 7.67, range = 6-9[2]. A one-way analysis of variance of the mean days to criterion scores revealed no statistically significant differences between the three groups during Phase 1, $F(2, 14) = 1.31$.

Phase 2. The three groups which experienced either PD, SS or no training during Phase 1 were given the line angle discrimination task in Phase 2. A discrimination index score (i.e., the percentage of total responses emitted in the presence of S^+) was calculated for each subject, for the first nine days of Phase 2 training.

The mean group discrimination index scores for the PD-TD, SS-TD and HOLD-TD groups during Phase 2 are presented in Figure 1. The values plotted represent group means calculated from individual indices. In addition, the number of sessions presented for each group equals the upper extreme of the group's range. For subjects reaching criterion before the last session, the data points obtained from the criterion

Figure 1. Mean discrimination index scores for the three groups given line angle discrimination training during Phase 2, Experiment I.

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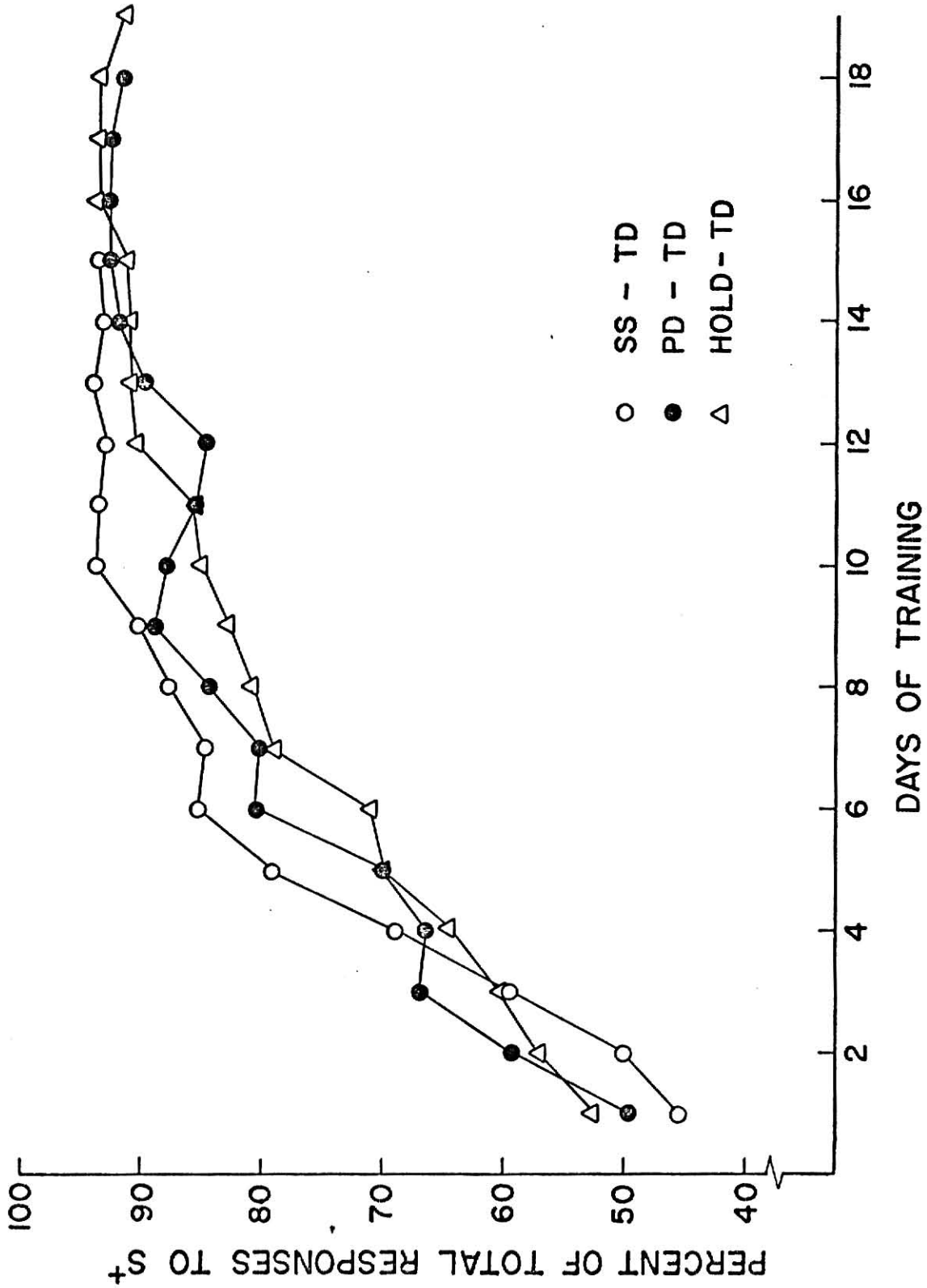

PERCENT OF TOTAL RESPONSES TO S+
100
90
80
70
60
50
40
2
4
6
8
10
12
14
16
18
DAYS OF TRAINING
SS - TD
PD - TD
HOLD - TD

day were taken as estimates for the remaining sessions.

To determine whether the preceding PD, SS or HOLD conditions had any differential effects on the acquisition of the line angle discrimination, a 3 x 9 (Group x Day) analysis of variance of these scores was conducted. This analysis yielded a statistically significant Day effect, $F(8, 112) = 49.164$, $p < .01$, but no reliable Group effect, $F(2, 14) = 0.928$, or Group x Day interaction, $F(16, 112) = 1.538$.

Another way to analyze the data obtained in Phase 2 is to examine the mean number of sessions to criterion scores, which were as follows: PD-TD = 14.40, range = 10-18, SS-TD = 12.17, range = 10-15; and HOLD-TD = 13.33, range = 9-19. A one-way analysis of variance yielded no statistically reliable differences between these sessions to criterion scores, $F(2, 14) = 0.573$.

The results from Phase 2 are consistent with past observations that PD and SS training produce no differences in performance on subsequent discrimination problems. It should be noted that the HOLD-TD group which was not run during Phase 1 did have single stimulus training with the 555 nm stimulus during preliminary training and may not have differed from the SS-TD group during Phase 2 for this reason.

Phase 3. The subjects in all six groups were maintained

on the auditory discrimination for nine consecutive days. Discrimination index scores were obtained from each subject, for each day of Phase 3 training. These scores were subjected to a 3 x 9 (Group x Day) analysis of variance, and revealed statistically significant group, $\underline{F}(5, 28) = 4.966$, $p < .01$, and Day effects, $\underline{F}(8, 224) = 92.281$, $p < .01$, and a Group x Day interaction, $\underline{F}(40, 224) = 1.737$, $p < .01$ (See Table II). Neuman-Keuls comparison of the group means of the discrimination index scores (averaged over days) revealed that the means of the TD-HOLD ($\bar{x} = 72.38$), PD-TD ($\bar{x} = 73.86$), SS-TD ($\bar{x} = 71.94$) and HOLD-TD ($\bar{x} = 70.86$) groups were not reliably different from each other, but were reliably different from the means of the TD-PD ($\bar{x} = 65.00$) and TD-SS ($\bar{x} = 60.54$) groups, which also were not reliably different.

In Figure 2 the average group discrimination index scores for each daily session are presented. As can be seen, subjects in the TD-HOLD, PD-TD, SS-TD and HOLD-TD groups learned the auditory discrimination at a faster rate and reached a higher level of performance than did TD-PD and TD-SS subjects after nine days of training.

The differences in performance illustrated in Figure 2 could reflect a more rapid increase in response rate to S^+ for the TD-HOLD, PD-TD, SS-TD and HOLD-TD groups, a more rapid decrease in response rate to S^- for these groups, or

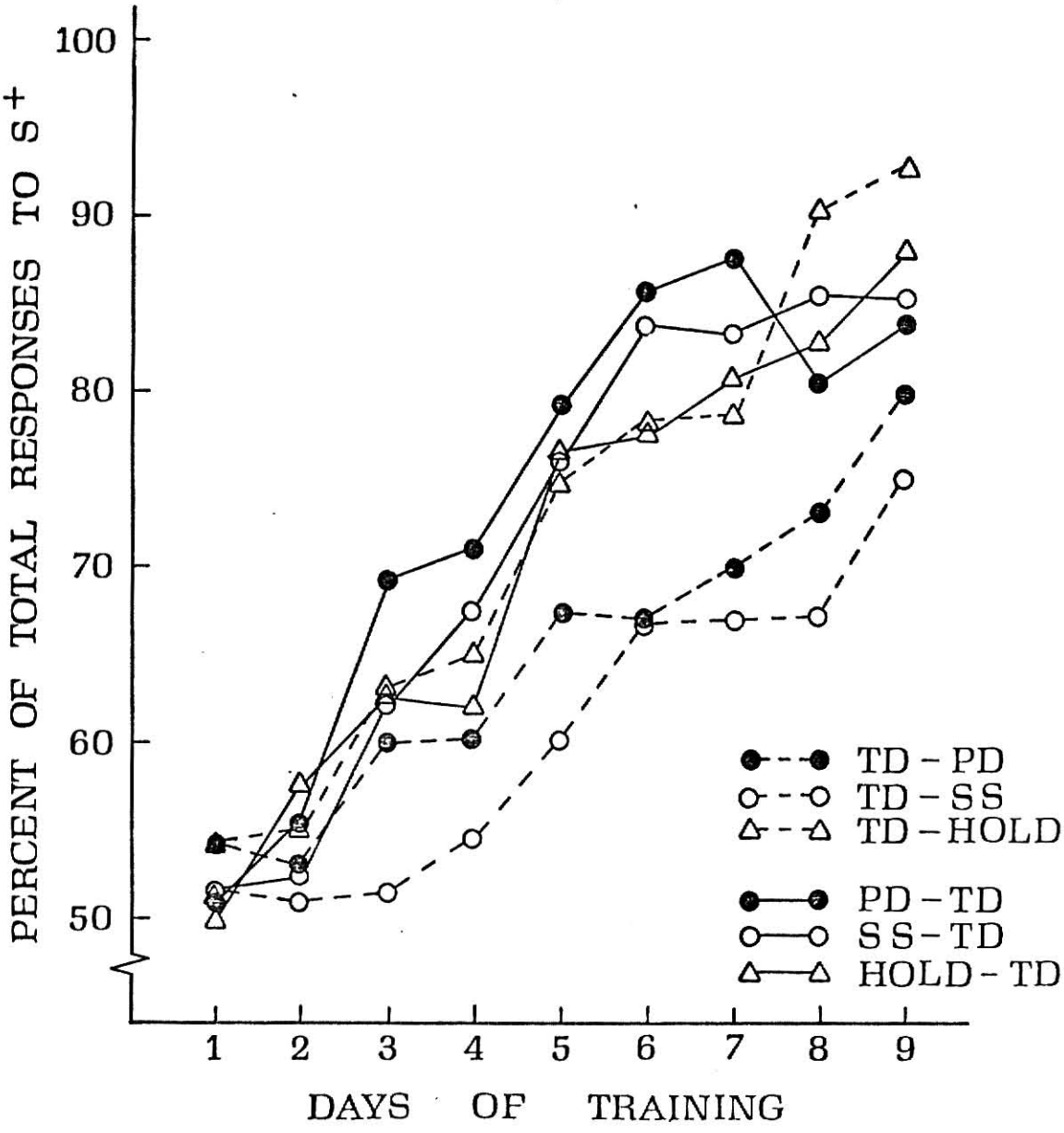
TABLE II

Analysis of variance summary table (F ratios) of the discrimination index scores, response rates emitted in the presence of S^+, and response rates emitted in the presence of S^- during Phase 3, Experiment I.

Source of Variance	Degrees of Freedom	Discrimination Index	S^+ Response Rate	S^- Response Rate
Between Ss	33			
Groups	5	4.966**	0.759	1.271
Error	28			
Within Ss	272			
Days	8	92.281**	9.198**	39.235**
Gps x Days	40	1.737	1.050	1.893**
Error	224			

** $p < .01$

Figure 2. Mean discrimination index scores for all experimental conditions over the nine days of discrimination training in Phase 3, Experiment I.

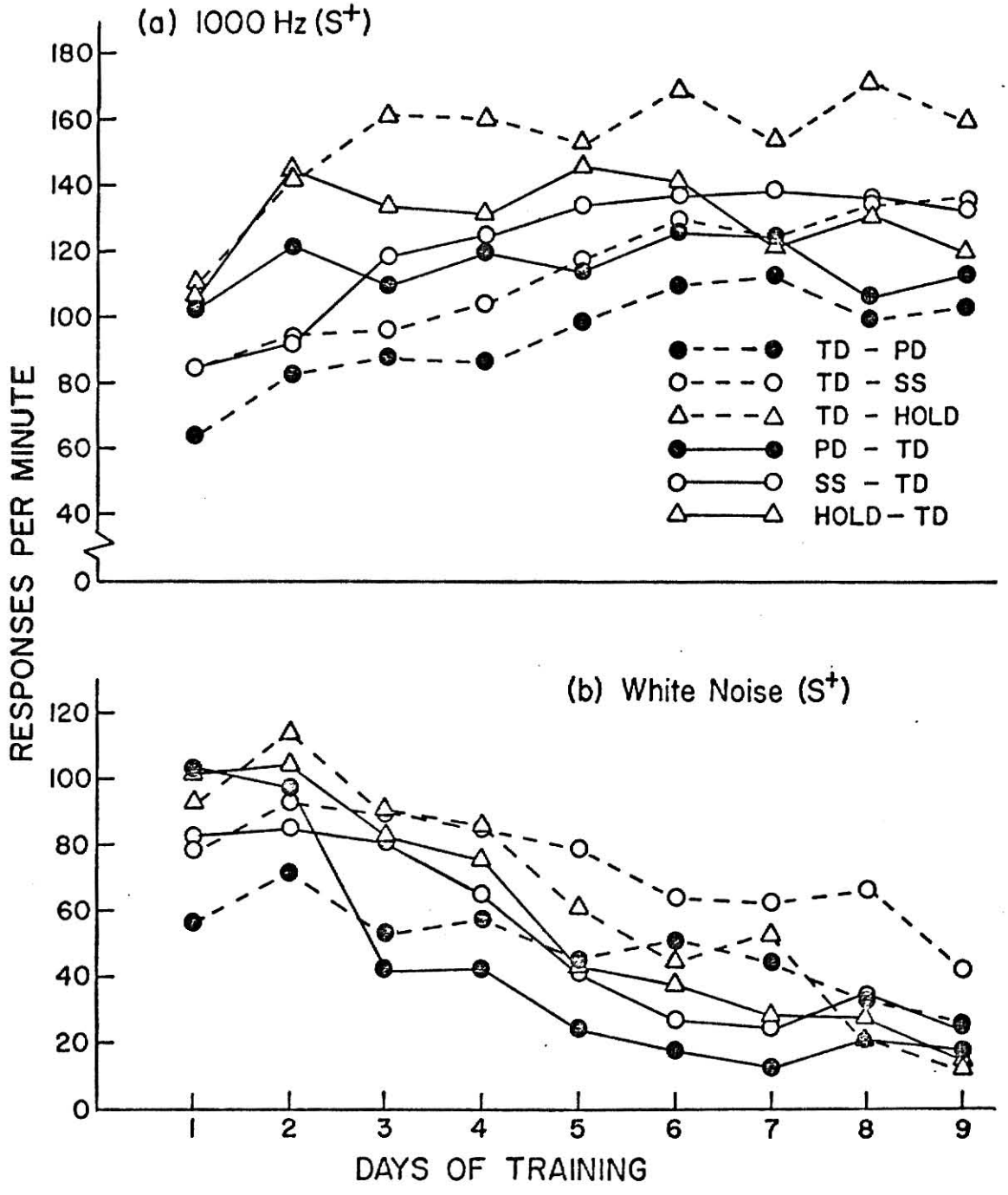

PERCENT OF TOTAL RESPONSES TO S+
100
90
80
70
60
50
1
2
3
4
5
6
7
8
9
DAYS OF TRAINING
TD - PD
TD - SS
TD - HOLD
PD - TD
SS - TD
HOLD - TD

both. To select among these alternatives, response rates in the presence of the two training stimuli (S^+ and S^- components) were analyzed separately over the nine days.

Figure 3a depicts the mean group response rates emitted in the presence of the positive stimulus, plotted as a function of days. An analysis of variance of S^+ response rate indices yielded only a statistically reliable Day effect, $F(8,224) = 9.198$, $p < .01$ (See Table II). From Figure 3a it can be seen that the lack of a Group x Day interaction is due to the fact that all groups exhibited some increase in responding in the presence of the positive stimulus during the nine days of Phase 3 training.

The average group response rates emitted in the presence of S^- over the nine days of Phase 3 are presented in Figure 3b. An analysis of variance of S^- response rate scores revealed a statistically reliable Day effect, $F(8, 224) = 39.235$, $p < .01$, and reliable Group x Day interaction, $F(40, 224) = 1.893$, $p < .01$ (See Table II). In Figure 3b a general decreasing trend is apparent in all groups; however, the subjects in the TD-PD and TD-SS groups did not exhibit as rapid a decline in responding as the TD-HOLD, PD-TD, SS-TD and HOLD-TD subjects. These latter four groups began the nine days of Phase 3 training with a higher rate of response to the S^- stimulus, but by the final

Figure 3. (a) Mean response rates in the presence of the positive stimulus (S^+) and (b) mean response rates in the presence of the negative stimulus (S^-) for all six groups over nine days of discrimination training in Phase 3, Experiment I.


(a) 1000 Hz (S+)
180
160
140
120
100
80
60
40
0
TD - PD
TD - SS
TD - HOLD
PD - TD
SS - TD
HOLD - TD
(b) White Noise (S+)
120
100
80
60
40
20
0
1
2
3
4
5
6
7
8
9
DAYS OF TRAINING
RESPONSES PER MINUTE

day they had reached a lower rate of response to the negative stimulus than the TD-PD and TD-SS subjects. This pattern of responding is reflected in the statistically reliable Group x Day interaction.

The analyses of the response rates in the presence of the positive and negative stimulus indicate that the discrimination performance differences among the groups in Phase 3 (See Figure 2) are primarily a function of differences between groups in response rate reduction in the presence of the negative stimulus (See Figure 3b).

DISCUSSION

Experiment I showed that groups given PD and SS training prior to any discrimination training performed no differently on the Phase 3 auditory transfer problem than the groups that never received any PD or SS training during Phase 1 or Phase 2. However, when either PD or SS training intervened between the two discrimination problems, the acquisition of the auditory discrimination was markedly retarded. The finding that PD disrupts transfer under these conditions is consistent with Honig's results (1969, 1974) and provides some support for Thomas' general attention hypothesis. It appears that once a subject has been taught to attend to stimulus differences, such a set can be

disrupted by non-differential PD training.

The surprising result was that SS training also disrupted the acquisition of the transfer discrimination. As mentioned previously, Thomas considers SS training a neutral comparison condition since the subject learns nothing about stimulus differences. Theoretically, it should not disrupt transfer.

Thomas also assumes that stimulus generalization and transfer of training paradigms reflect similar attentional processes (Thomas, 1970; Eck, et al., 1969; Eck, et al., 1970; and Hansen, et al., 1971). According to this aspect of the general attention hypothesis, the decrease in general attention which presumably occurred during intervening SS training in Experiment I should be measurable by a generalization test as well as by a transfer problem. However, in the study cited previously, Honig (1969, 1974) reported that only intervening PD training flattened generalization gradients, not intervening SS training. Contrary to Thomas' assumption, this experimental evidence suggests that transfer performance and generalization slope may not be independent indicators of the same attentional process.

Experiment II was designed to examine the discrepancies between the results of Experiment I and the assumptions of the general attention hypothesis. Three groups of subjects

were given either TD training only, SS training only or TD training followed by SS training. All three groups received the same average amount of exposure to two stimulus dimensions during these training phases. A generalization test was then given, followed by another discrimination problem involving a third stimulus dimension. Finally, an attempt was made to correlate the transfer results with a measure of generalization gradient slope. The purpose of Experiment II was threefold: 1) to replicate the disruption of transfer by intervening SS training, 2) to determine to what extent intervening SS training disrupts the enhancing effects of initial TD training, and 3) to determine if transfer performance and generalization slope are correlated.

EXPERIMENT II

METHOD

Subjects

Subjects were 27 experimentally naive homing pigeons obtained from a local supplier and maintained at 70-75% of their free feeding weights for the duration of the experiment.

Apparatus

The apparatus consisted of three operant conditioning chambers that were identical to those described in Experiment I. In addition, a white key light, produced by a 0.4 neutral density filter in the display cell, was used as a stimulus during some parts of the experiment.

Procedure

Subjects were randomly assigned to one of three experimental conditions: a True Discrimination-Single Stimulus (TD-SS), a True Discrimination Only (TD-HOLD), and a Single Stimulus Only (HOLD-SS) group, with nine subjects in each group. The group names correspond to the nature of training prior to Phase 3 of the experiment.

Preliminary Training. All subjects were given preliminary training using the same procedures as described in Experiment I, except that throughout this period the response

key was illuminated with a white light for all groups.

Phase 1. Following keypeck training, subjects in the TD-SS group were given discrimination training with 555 nm as the positive stimulus (S^+) and 538 nm as the negative stimulus (S^-). The TD-HOLD group was trained on the same discrimination between 555 nm and 538 nm, but a vertical white line was also displayed on the response key during both positive and negative stimulus periods. Discrimination training continued for each bird in both groups until a criterion of 10 S^+ responses for each S^- response was attained in three consecutive daily sessions. Other procedural details were identical to the discrimination training given in Phases 1 and 2 of Experiment I.

During Phase 1 the HOLD-SS group received no training with the wavelength stimuli. The length of the hold was determined by randomly matching each HOLD-SS subject with either a TD-SS or TD-HOLD subject. Each HOLD-SS bird remained in Phase 1 until its match reached criterion on the wavelength discrimination (i.e., for an equivalent number of sessions). This procedure was used to maintain a constant amount of time between preliminary training and tests for generalization and transfer for all groups.

Phase 2. Subjects in the TD-SS and the HOLD-SS groups were next given single stimulus training with a 90^o white

line on a 555 nm surround. Each TD-SS and HOLD-SS subject was trained with the single stimulus for a number of days equivalent to the number of sessions required by a TD-HOLD subject to reach criterion in Phase 1. This procedure was used to assure that each group received the same average amount of training with the line angle stimulus. Other details of single stimulus training were identical to that given in Phases 1 and 2 of Experiment I.

During Phase 2 subjects in the TD-HOLD group were weighed daily but not run. Each bird in the TD-HOLD group was held a period of time equivalent to the number of sessions required by a different TD-HOLD subject to reach criterion in Phase 1. As in Phase 1, the purpose of this hold condition was to maintain a constant amount of time between preliminary training and testing for all groups.

Generalization Test. On the day following Phase 2, all subjects were given a five min warmup consisting of the training condition under which each subject acquired responses to the line angle (i.e., TD-SS and HOLD-SS subjects received single stimulus warmup and TD-HOLD subjects experienced true discrimination warmup). A generalization test was then carried out in extinction. The test stimuli were five different line angles (30^{o}, 60^{o}, 90^{o}, 120^{o} and 150^{o} from horizontal) presented with the 555 nm background

removed. Each subject received 10 different series of the five stimuli; within each series the five stimuli were randomly ordered. Stimulus presentations were for 30-sec each, with 10-sec blackout periods intervening. If the subject did not respond for three consecutive series, the generalization test was terminated. On the day following the generalization test, twelve of the subjects were placed into Phase 3 training. The other fifteen subjects (5 per group) were given a second day of generalization testing. The extra day of testing was added to determine whether the length of the one-day test was sufficient to obtain accurate data on the shape of the generalization gradients. No warm-up was given prior to the second test, but other procedures were identical to those of the initial day of generalization testing.

Phase 3. In the third phase of Experiment II all three groups were given twelve days of discrimination training between a 1000 Hz tone (S^+) and white noise (S^-). This transfer discrimination problem was procedurally the same as that given in Phase 3 of Experiment I. A summary table of the design of Experiment II is presented in Table III.

RESULTS

Phase 1. The mean number of daily sessions to reach

TABLE III. Summary Table of the Design Used in Experiment II.

Condition	Phase 1[a]	Phase 2		Phase 3[b]	
	S^+ S^-	90° 555 nm		1000 Hz	White Noise
TD-SS	VI 30-sec ext	VI 30-sec	Line Angle Generalization Test	VI 20-sec ext	
TD-HOLD	VI 30-sec ext	———			
HOLD-SS	———	VI 30-sec			

[a]During Phase 1, S^+ = 555 nm and S^- = 538 nm for the TD-SS group; S^+ = 555 nm superimposed with a 90 degree line angle and S^- = 538 nm superimposed with a 90 degree line angle for the TD-HOLD group.

[b]During Phase 3, the response key was illuminated with a 555 nm light superimposed with a 90 degree line angle.

criterion for subjects in the TD-SS and TD-HOLD groups was as follows: TD-SS = 6.11, range = 5-8; TD-HOLD = 5.67, range = 5-8. A t-test conducted on these days to criterion scores indicated no significant differences existed between the two groups, $\underline{t}(16) = 0.915$. Subjects in the HOLD-SS group were weighed daily for an average of 5.89 sessions, range = 5-8.

Mean response rates emitted in the presence of the positive stimulus ranged from 59.68 on Day 1 to 88.04 on Day 8 for birds in the TD-SS group (S^+ = 555 nm) as compared with 54.71 and 110.65 respectively, for subjects in the TD-HOLD group (S^+ = 90^o white line on 555 nm surround). The number of sessions represented in these mean response rate scores equals the upper extreme of each group's range. For subjects run fewer than eight days in this condition, the data points obtained from the last day were taken as estimates for the remaining sessions. A 2 x 8 (Group x Day) analysis of variance of the positive rates showed no significant Group effect, $\underline{F}(1, 16) = 1.006$, but revealed a statistically reliable Day effect, $\underline{F}(7, 112) = 10.182$, $p < .01$, and a Group x Day interaction, $\underline{F}(7, 112) = 2.619$, $p < .05$. The response rate in the presence of the positive stimulus increased over sessions for both groups. This increase could be due to the occurrence of behavioral

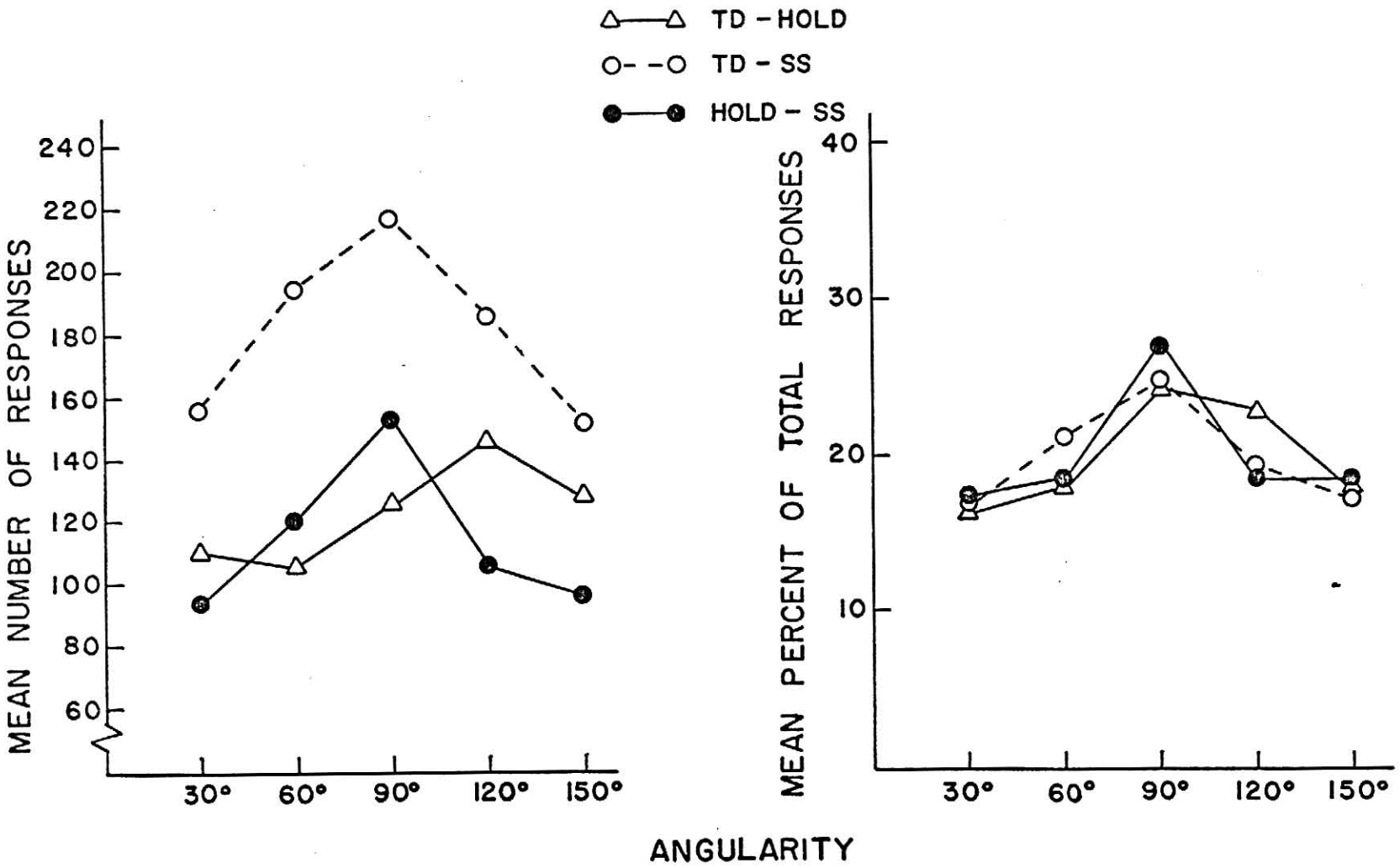
contrast, or may be the result of an initial generalization decrement caused by the change in chromatic stimuli, or both. Since both groups were given the same wavelength discrimination, it is not clear why the significant interaction occurred. A statistical analysis of the mean response rates emitted in the presence of the negative component revealed no significant differences.

Phase 2. Subjects in the TD-SS and HOLD-SS groups were maintained in this phase for an average of 5.67 daily sessions, range = 5-8. Birds in the TD-HOLD group were not run for 5.67 mean daily session, range = 5-8.

The average response rate per min in the presence of the 90^{o} line on the 555 nm surround ranged from 81.97 on Day 1 to 77.17 on Day 8 for birds in the TD-SS group, as compared with 48.87 and 58.48 respectively, for HOLD-SS subjects. The high rate of response established in the TD-SS group during the Phase 1 color discrimination appears to have carried over into Phase 2.

Generalization Test. The mean absolute generalization gradients for Day 1 testing of all 27 subjects are presented in Figure 4a. The gradients from different groups differed both in absolute level and shape. The TD-SS group emitted the highest number of responses to all the stimuli, and its gradient peaked at the training stimulus (90^{o}). The

Figure 4. (a) Mean absolute generalization gradients and (b) mean relative gradients for all groups on Day 1 of the line angle generalization test (includes nine subjects per group).


TD - HOLD
TD - SS
HOLD - SS
MEAN NUMBER OF RESPONSES
240
220
200
180
160
140
120
100
80
60
MEAN PERCENT OF TOTAL RESPONSES
40
30
20
10
30°
60°
90°
120°
150°
ANGULARITY

gradient of the HOLD-SS group also peaked at the vertical line angle, but these subjects emitted a lower number of responses to each of the line angle stimuli. The TD-HOLD group emitted approximately the same total number of responses as the HOLD-SS group, but the highest number of responses was made in the presence of the 120° stimulus. A 3 x 5 (Group x Stimulus) analysis of variance of the mean absolute gradients revealed only a significantly reliable Stimulus effect, $\underline{F}(4, 96) = 2.456$, $p = .05$.

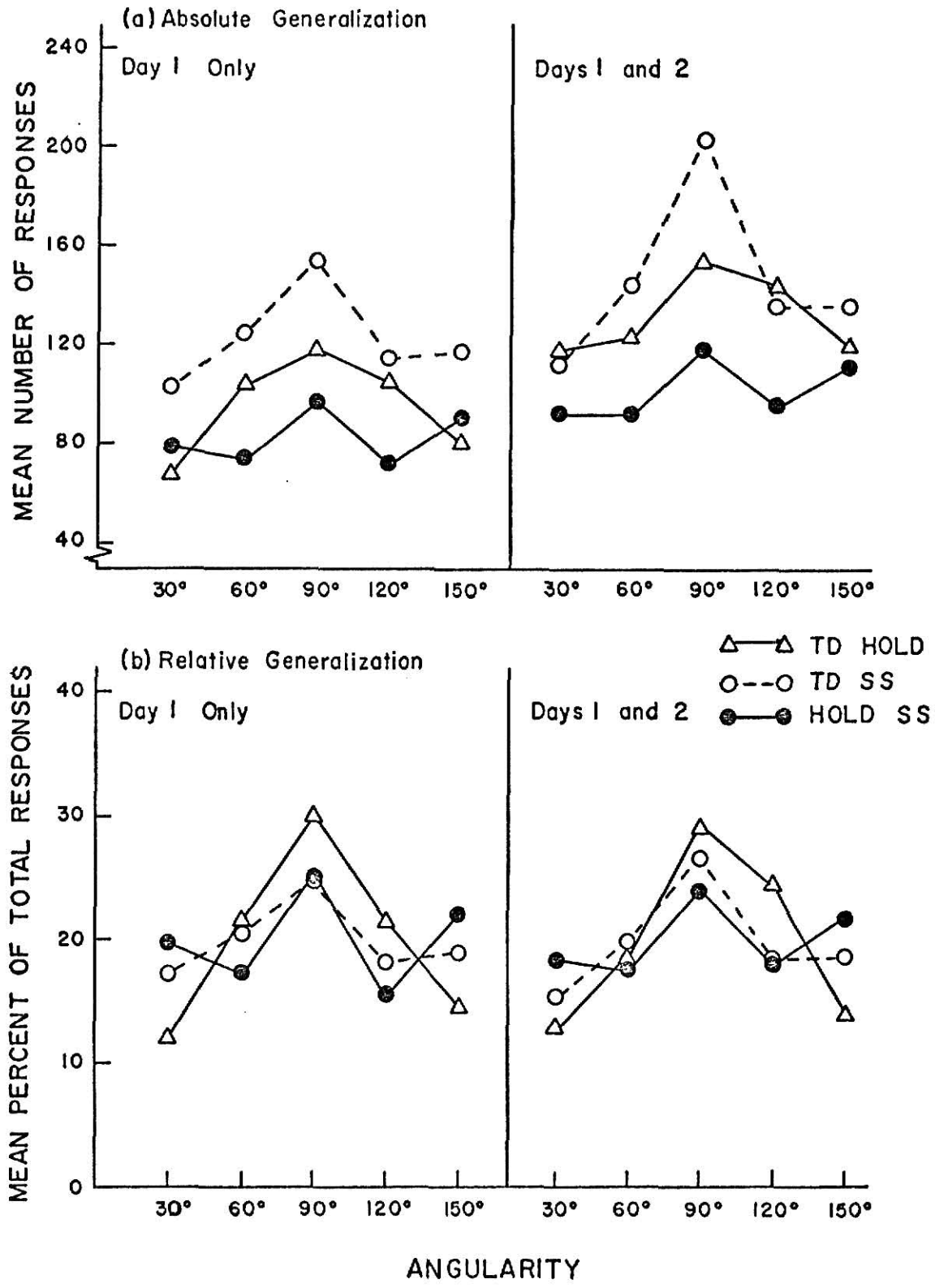
Figure 4b depicts the mean relative gradients obtained from all subjects during the Day 1 test. For each subject, the percentage of total responses emitted in the presence of the five generalization test stimuli was determined. The values plotted in Figure 4b represent group means calculated from these individual percentage transformations. A 3 x 5 (Group x Stimulus) analysis of variance of the mean relative gradients yielded a statistically reliable Group effect, $\underline{F}(2, 24) = 4.208$, $p < .05$, and a reliable Stimulus effect, $\underline{F}(4, 96) = 3.180$, $p < .05$. In Figure 4b it can be seen that the relative gradients peak at 90° for all three groups, and the HOLD-SS group appears to have a steeper relative gradient than the other two groups. However, no statistically reliable Group x Stimulus interaction was found.

Fifteen of the 27 subjects (5 per group) also experienced

an additional day of testing. Mean absolute generalization gradients for the fifteen birds given two days of testing are presented in Figure 5a. The left half of Figure 5a depicts the number of responses emitted in the presence of the line angle stimuli by the fifteen subjects on the first day of testing. On the right half is the total number of responses which they emitted during both days of testing. Although the total number of responses increased for all groups during the second day of testing, the overall shape of the gradients and the ordering of the groups appeared essentially the same as they did after one day of testing. A 3 x 5 (Group x Stimulus) analysis of variance of the mean absolute gradients after two days of testing revealed no statistically reliable between-group differences.

Mean relative generalization gradients for the subjects given two days of testing are shown in Figure 5b. The left half of the graph represents the percentage transformations from the first day of testing and the right half shows the relative gradients from both days of testing. The second day of testing steepened the relative gradient of the TD-SS group and slightly flattened the gradients of the other two groups. A 3 x 5 (Group x Stimulus) analysis of variance of the mean relative gradients after two days of testing

Figure 5. (a) Mean absolute generalization gradients and (b) mean relative generalization gradients for Day 1 only (left-hand graphs) and Days 1 and 2 combined (right-hand graphs) of the line angle generalization test (includes five subjects per group).


(a) Absolute Generalization
Day 1 Only
Days 1 and 2
MEAN NUMBER OF RESPONSES
240
200
160
120
80
40
30° 60° 90° 120° 150°
30° 60° 90° 120° 150°
(b) Relative Generalization
Day 1 Only
Days 1 and 2
MEAN PERCENT OF TOTAL RESPONSES
40
30
20
10
0
30° 60° 90° 120° 150°
30° 60° 90° 120° 150°
TD HOLD
TD SS
HOLD SS
ANGULARITY

yielded only statistically reliable Group, $F(2, 12) = 5.273$, $p < .05$, and Stimulus effects, $F(4, 48) = 2.681$, $p < .05$.

Phase 3. Subjects in all three experimental conditions were placed in an auditory discrimination for 12 consecutive days. Discrimination index scores were obtained from each subject, for each day of Phase 3 training. A 3 x 12 (Group x Day) analysis of variance of these scores revealed statistically reliable Group, $F(2, 24) = 3.49$, $p < .05$, and Day effects, $F(11, 264) = 75.494$, $p < .01$. No significant Group x Day interaction was found, $F(22, 264) = 0.452$ (See Table IV). A Newman-Keuls comparison of the group means of the discrimination index scores (averaged over days) showed that the means of the TD-SS ($\bar{x} = 64.27$) and HOLD-SS ($\bar{x} = 65.50$) groups were not reliably different from each other, but were reliably different from the mean of the TD-HOLD ($\bar{x} = 72.79$) group.

The mean group discrimination index scores for each daily session are presented in Figure 6. In this figure the values plotted represent group means calculated from individual indices. As Figure 6 indicates, subjects in the TD-HOLD group learned the auditory discrimination at a faster rate and reached a higher level of performance than did TD-SS and HOLD-SS subjects after 12 days of training.

The differences in performance illustrated in Figure 6

TABLE IV

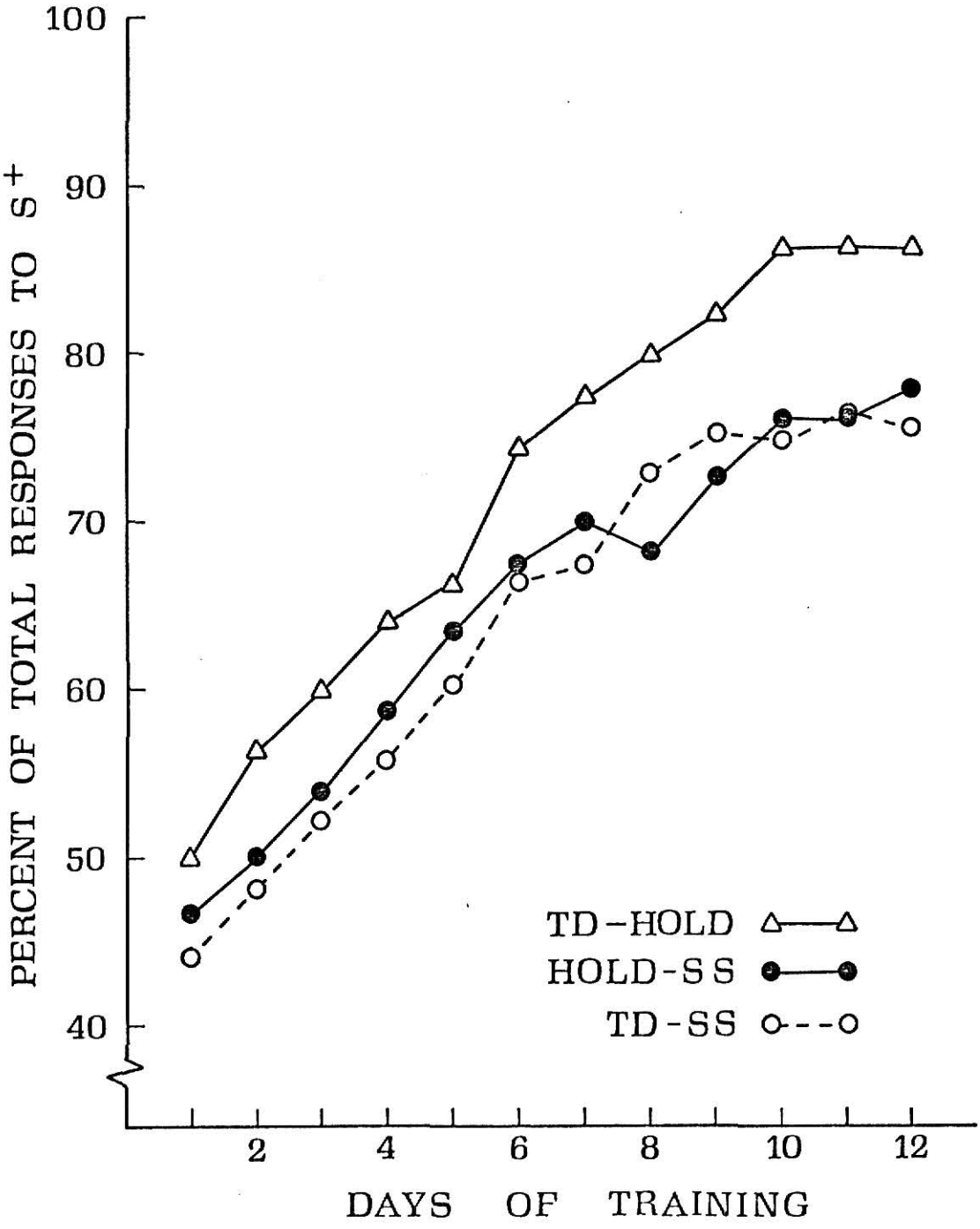
Analysis of variance summary table (F ratios) of the discrimination index scores, response rates emitted in the presence of S^+, and response rates emitted in the presence of S^- during Phase 3, Experiment II.

Source of Variance	Degrees of Freedom	Discrimination Index	S^+ Response Rate	S^- Response Rate
Between Ss	26			
Groups	2	3.490*	9.498**	1.802
Error	24			
Within Ss	297			
Days	11	75.494**	15.860**	36.087**
Gps X Days	22	0.452	1.120	1.622*
Error	264			

* $p < .05$

** $p < .01$

Figure 6. Mean discrimination index scores for all three groups over the twelve days of discrimination training in Phase 3, Experiment II.

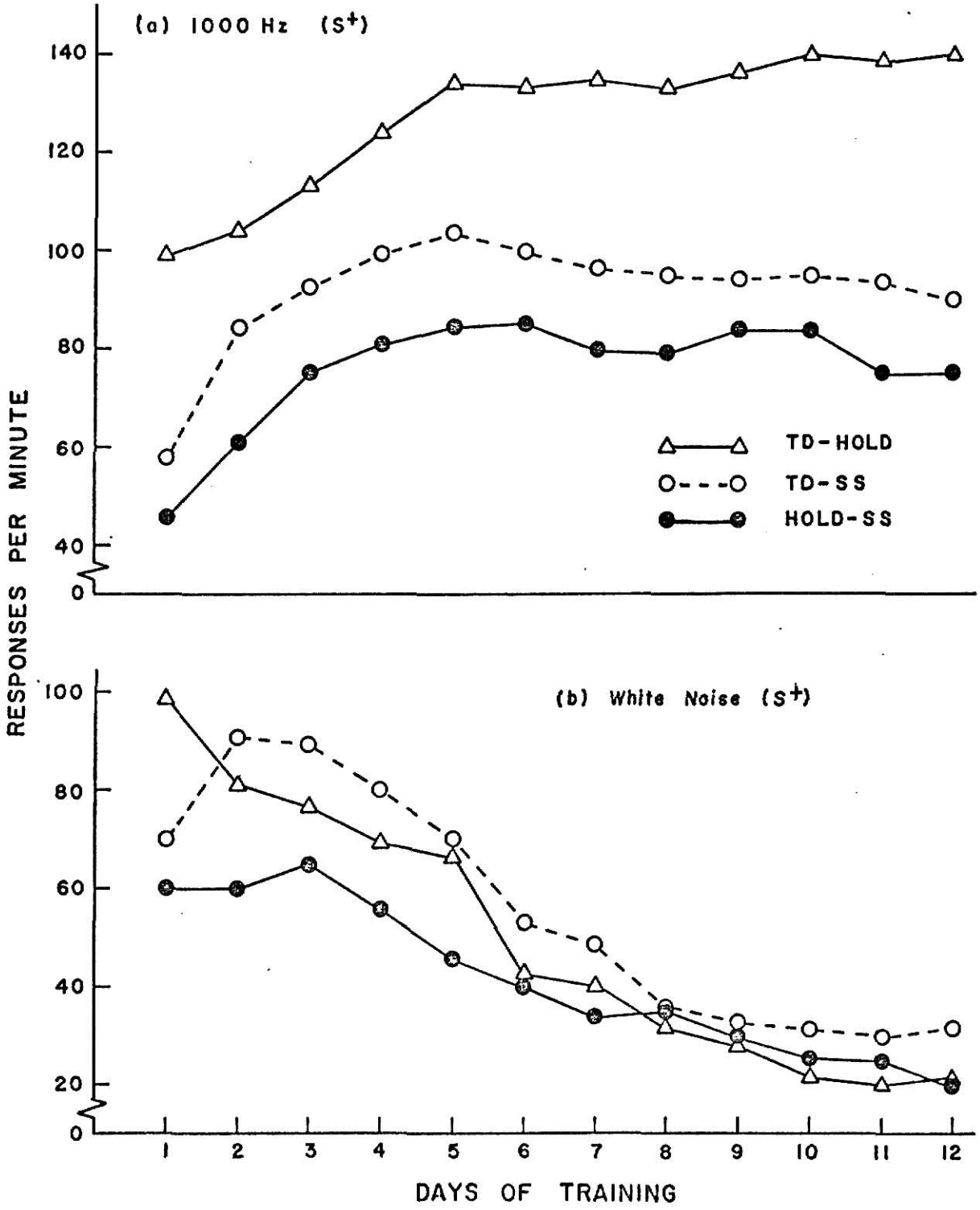

100
90
80
70
60
50
40
PERCENT OF TOTAL RESPONSES TO S+
2
4
6
8
10
12
DAYS OF TRAINING
TD-HOLD
HOLD-SS
TD-SS

could reflect a more rapid increase in response rate to the positive stimulus for the TD-HOLD group, a more rapid decrease in response rate to the negative stimulus for this group, or both. To select among these alternatives, response rates in the presence of the two stimuli were analyzed separately over the 12 days.

In Figure 7a the mean group response rates emitted in the presence of the positive stimulus are plotted as a function of days. An analysis of variance of S^+ response rate scores yielded a statistically reliable Group, $F(2, 24) = 9.498$, $p < .01$, and Day effects, $F(11, 264) = 75.494$, $p < .01$. Figure 7a illustrates that the lack of a significant Group x Day interaction was due to the fact that all groups exhibited an increase in responding in the presence of the positive stimulus during Phase 3. The statistically reliable Group effect was analyzed using a Newman-Keuls test. This comparison of the group means of the positive rates (averaged over days) revealed that the mean of the TD-HOLD ($\bar{x} = 127.77$) group was reliably different from the means of the TD-SS ($\bar{x} = 92.05$) and HOLD-SS ($\bar{x} = 75.99$) groups, which were not reliably different from each other.

Mean group response rates emitted in the presence of S^- over the 12 days of Phase 3 are presented in Figure 7b.

Figure 7. (a) Mean response rates in the presence of the 1000 Hz tone (S^+) and (b) mean response rates in the presence of white noise (S^-) for the three groups over the twelve days of discrimination training in Phase 3, Experiment II.


(a) 1000 Hz (S+)
140
120
100
80
60
40
0
TD-HOLD
TD-SS
HOLD-SS
(b) White Noise (S+)
100
80
60
40
20
0
1
2
3
4
5
6
7
8
9
10
11
12
DAYS OF TRAINING
RESPONSES PER MINUTE

An analysis of variance of S^- response rate scores revealed a statistically reliable Day effect, $F(11, 264) = 36.087$, $p < .01$, and reliable Group x Day interaction, $F(22, 264) = 1.622$, $p < .05$ (See Table IV). As seen in Figure 7b, there is a general decreasing trend over days in all groups; however, the subjects in the TD-HOLD group exhibited a more rapid decline in responding than did the TD-SS and HOLD-SS subjects. This is reflected in the statistically reliable Group x Day interaction. The TD-HOLD group showed response rate decreases on each succeeding day following Day 1, while subjects in the TD-SS and HOLD-SS groups initially increased their rates of responding to the S^- component. The TD-SS and HOLD-SS groups maintained rates above that occurring on Day 1 until Day 6 or Day 4, respectively.

The analyses of the response rates in the presence of the S^+ and S^- components indicate that the discrimination performance differences among the groups in Phase 3 (See Figure 6) are due to differences between groups in response rate in the presence of both the positive and the negative stimulus (See Figures 7a and 7b).

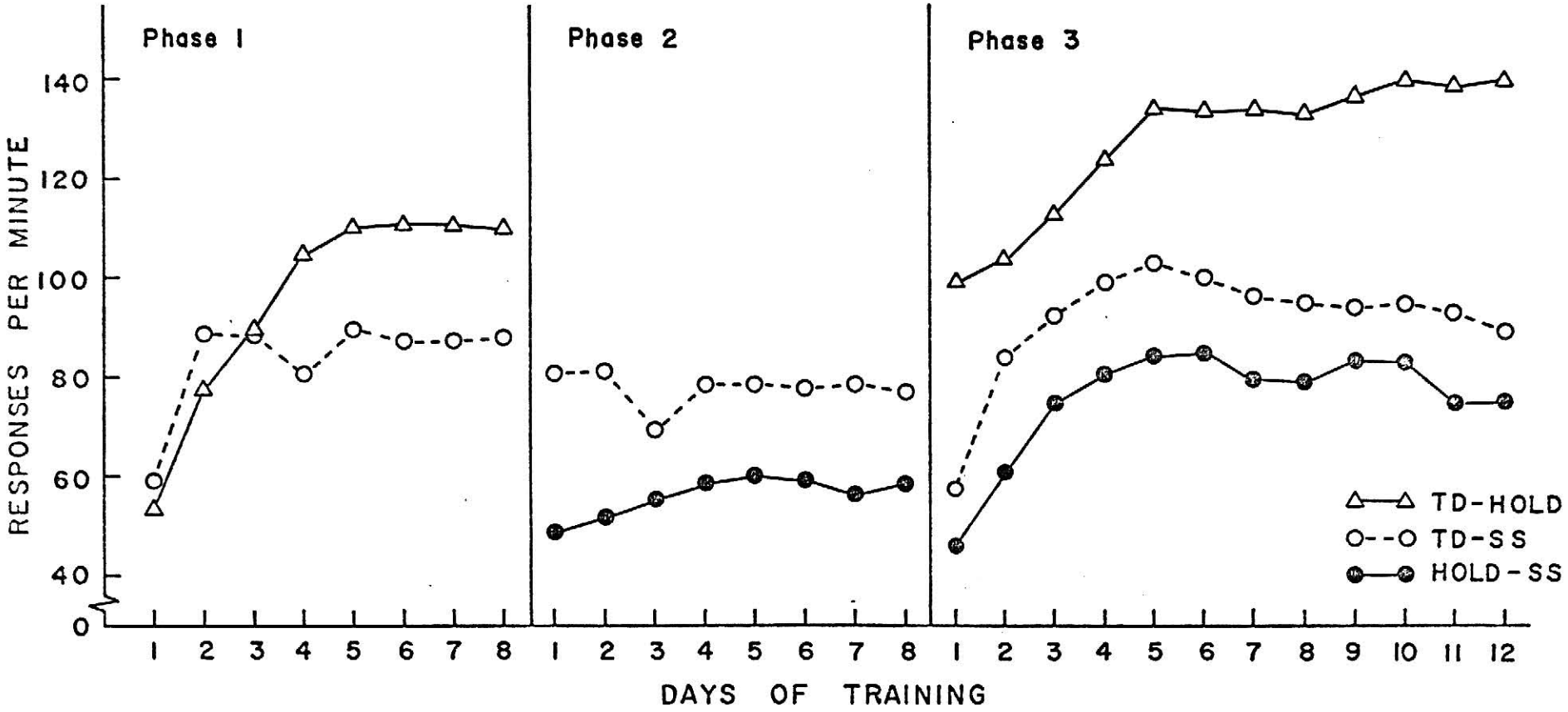
Previously, no significant positive response rate differences have been found in transfer of training studies using pigeons (See Thomas, et al., 1971; Frieman and Goyette, 1973). The results from this study may be

clarified by examining Figure 8, which depicts the mean response rates emitted in the presence of the positive stimulus in all three phases of the study for the three experimental groups. The difference between the TD-HOLD and the other two groups in Phase 3 may be attributed to the fact that the TD-HOLD group reached a higher rate of response to the positive stimulus in Phase 1. This higher rate of responding appeared to continue during Phase 3. No explanation is available to account for the initial positive rate difference between the TD-HOLD and TD-SS groups.

Correlation. The line angle generalization gradients were correlated with discrimination index scores using the Pearson Product Moment correlation coefficient. The value used as an index of gradient slope was the percentage of total responses emitted to the training stimulus (90^{o}) by subjects within each group (only the first day of generalization testing was considered). To estimate the rate of acquisition of the transfer discrimination problem, each subject's discrimination index scores were averaged over the 12 days of Phase 3. Thus, within each group, each subject's mean discrimination index (averaged over days) was correlated with the percentage of total responses which that subject emitted to the vertical line angle.

The correlation for each group was as follows: HOLD-SS,

Figure 8. Mean response rates in the presence of the positive stimulus (S^+) in all three phases of Experiment II for all three groups.


Phase 1
Phase 2
Phase 3
RESPONSES PER MINUTE
140
120
100
80
60
40
0
1 2 3 4 5 6 7 8
1 2 3 4 5 6 7 8
1 2 3 4 5 6 7 8 9 10 11 12
DAYS OF TRAINING
TD-HOLD
TD-SS
HOLD-SS

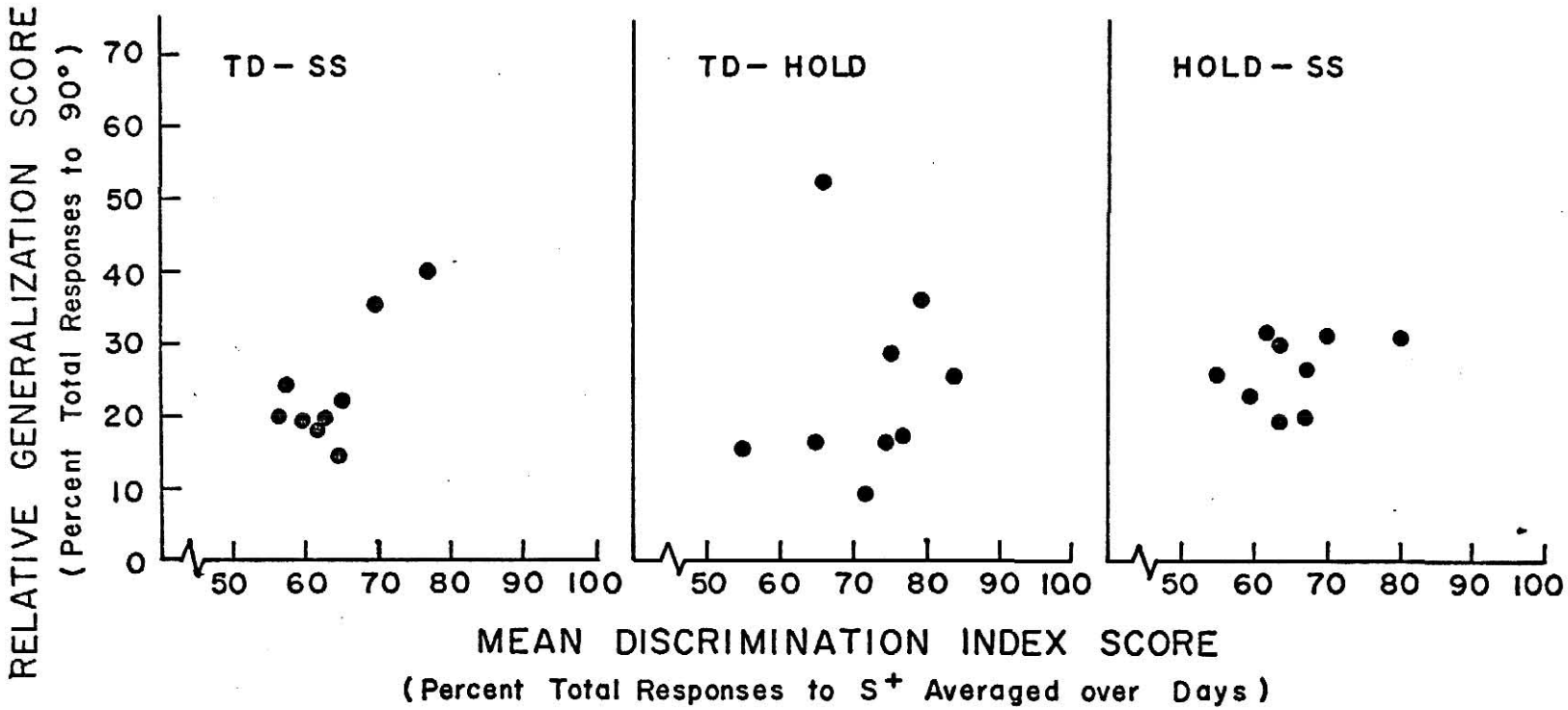
$r = +0.3068$; TD-HOLD, $r = +0.0255$; and TD-SS, $r = +0.8068$. The only statistically reliable positive correlation was that of the TD-SS group, which was significant at the .05 level for 7 degrees of freedom. Scattergrams in which individual values from the three groups are plotted are presented in Figure 9, with the TD-SS group on the left, the TD-HOLD group in the center, and the HOLD-SS group on the right. It appears that the significant correlation for the TD-SS group is due to the two points in the upper right portion of that group's scattergram.

DISCUSSION

Experiment II clearly demonstrated that intervening SS training does disrupt the acquisition of a subsequent discrimination problem. The TD-SS group which received TD followed by SS training acquired the subsequent auditory discrimination significantly slower than the TD-HOLD group which experienced TD training only. In addition, the transfer performance of the TD-SS group was no better than that of the HOLD-SS group which was given SS training only; thus, intervening SS training appears to completely eliminate the positive effects of initial TD training.

In contrast to the transfer data, the results of the test for stimulus generalization were both unexpected and unclear. The two groups given TD training in Phase 1 were

Figure 9. Scattergram illustrating the correlation between each subject's mean discrimination index score (averaged over days) and its percentage of total responses to 90^{o} during the line angle generalization test. Data from the TD-SS group is presented on the left, the TD-HOLD in the center, and the HOLD-SS on the right.


RELATIVE GENERALIZATION SCORE
(Percent Total Responses to 90°)
TD – SS
TD – HOLD
HOLD – SS
0
10
20
30
40
50
60
70
50 60 70 80 90 100
MEAN DISCRIMINATION INDEX SCORE
(Percent Total Responses to S+ Averaged over Days)

expected to have significantly steeper line angle gradients relative to the HOLD-SS group, since the treatments given groups TD-SS and TD-HOLD are standard procedures used to demonstrate the steepening effects of extradimensional TD training on generalization gradients. One of these standard procedures involves giving TD training along one stimulus dimension, then SS "acquisition" training along a second dimension; this is basically the training experienced by TD-SS subjects. In the other procedure, TD training is given along one dimension, and an irrelevant stimulus (i.e., one that is not correlated with reward and non-reward) from a second dimension is concurrently presented on all trials; this resembles the treatment given the TD-HOLD subjects. Following either of these training procedures, TD training has been found to steepen generalization gradients around the second stimulus dimension relative to SS training (Thomas, 1969; Honig, 1969; Thomas, et al., 1970; Bresnahan, 1970; and Mackintosh and Honig, 1970). In this experiment no differences between groups in steepness of slope were apparent. Even if a statistically significant Group x Stimulus interaction had been found, the meaningfulness of the slope differences would be in question since the absolute gradients did not cross.

There is no clear explanation for the discrepancies

between these generalization data and the results reported in the literature. It has been noted previously (Turner and Mackintosh, 1972) that the steepening effect of extra-dimensional TD training on generalization gradients has been small in magnitude and somewhat elusive. In the present study, any comparisons among group gradients are further complicated by the unstable nature of this data. The average absolute and relative gradients obtained on Day 1 from fifteen of the subjects appear different from the average gradients produced by all 27 subjects (Compare Figures 4a and 5a, 4b and 5b). In addition, the conclusions drawn about slope differences depend on whether one or two days of testing are considered (See Figure 5b). The reasons for these unstable data are not obvious.

Although generalization gradients and discrimination performance have been assumed to be determined by the same underlying attentional process, a highly significant positive correlation between these two procedures was not obtained. However, there are several difficulties in interpreting the correlational data. Larger sample sizes may be needed to provide more points for an accurate indication of correlation. In addition, a clearer picture of the relationship between generalization slope and discrimination performance might have emerged if less variability

had existed in the generalization data. Yet this large degree of variability in the generalization data may itself be an indicator that measures of generalization and discrimination are not reflecting identical underlying processes. A graphic examination of individual measures for both generalization and discrimination showed a remarkable similarity in performance between subjects within each group on the transfer discrimination problem, and considerable variability within each group on the line angle generalization test. For example, 67% (6 out of 9) of the subjects in the TD-HOLD group had attained a 90% criterion discrimination score by Day 12, while only 11% (1 out of 9) and 22% (2 out of 9) had reached the same level in the TD-SS and HOLD-SS groups, respectively. On the other hand, there were no systematic differences between groups in the generalization data (See Figure 4) due to extensive variability within each group. If the two procedures were measuring the same attentional process, then it is not unreasonable to expect similar degrees of variability within each group on each measure.

Although in this study extradimensional training did not have the same systematic effect on generalization that it did on discrimination learning, performance on transfer discrimination problems is frequently related to the

steepness of generalization gradients; e.g., Experiment I, which showed that intervening PD training disrupts transfer, was based on Honig's finding (1969, 1974) that PD training flattens generalization gradients when it follows initial TD training. Further investigation is called for to clarify the relationship between stimulus generalization and discrimination learning.

GENERAL DISCUSSION

The major finding in Experiments I and II is that either PD or SS training, intervening between two successive operant discrimination problems, disrupts the acquisition of the second discrimination. Since PD training presumably teaches the subject that stimulus differences are not important, Thomas' general attention hypothesis can account for the disruptive effects of intervening PD training. However, his hypothesis cannot explain why intervening SS training, which should not teach the subject anything about stimulus differences, also eliminates the facilitative effects of initial TD training.

Turner and Mackintosh (1972) have developed an alternative explanation for the effects of extradimensional training. Based on a suggestion by Wagner (1969), they propose that in addition to the obvious sources of stimulus

control, such as the stimuli presented to the pigeon on the response key, there is another factor in free-operant situations which might influence performance on generalization tests and transfer problems; namely, the subject's own pattern or rate of responding.

To test this hypothesis, Turner and Mackintosh conducted a free-operant study in which two groups of pigeons received TD training between blue and green, with a vertical white line superimposed on the color. Two other groups were given PD training with the same stimuli. In the second phase of the experiment, one of the TD and one of the PD groups experienced single stimulus training with red only. The other two groups both were given TD training with red positive and yellow negative. Thus, each group experienced one of the following treatments: TD-TD, TD-SS, PD-TD or PD-SS. All groups were then given a generalization test on the dimension of line orientation. The group which received TD-SS training produced steeper line angle generalization gradients than the PD-SS group, confirming the results obtained by Thomas et al.(1970). However, the gradients of the TD-TD and PD-TD groups did not differ from each other, and both were similar to that obtained from the TD-SS group. The flattening effect of PD training was counteracted completely by subsequent TD training.

Turner and Mackintosh concluded that PD training must affect performance during test trials rather than what is learned about stimulus differences during initial training. They suggest that during PD training attention to internal, proprioceptive cues increases, so that each response becomes controlled by the occurrence of a prior response. These powerful internal stimuli are present during all test trials and tend to produce a constant rate of responding during testing. Thus, following PD training, stimulus control by experimentally manipulated stimuli is masked by a pattern of repetitive responding. In contrast, during TD training subjects must attend to the external, relevant stimuli (i.e., those correlated with reward and non-reward). Control by irrelevant, internal stimuli is suppressed, allowing TD subjects to demonstrate control acquired by experimentally manipulated stimuli during testing.

Turner and Mackintosh's hypothesis is supported by a second experiment in which they used discrete-trial procedures to eliminate repetitive responding. Under these conditions, PD-TD training resulted in sharper line angle gradients than TD-TD training. Turner and Mackintosh concluded that TD training actually produces a selective attention effect in both free-operant and discrete-trial situations; i.e., relative to PD, TD training reduces the amount

of attention available to other stimulus dimensions, including internal sources of stimulus control. In free-operant situations, TD training merely appears to enhance general attentiveness since the constant rate of responding established during PD training results in flattened generalization gradients. When repetitive responding is controlled, TD subjects have flatter gradients, demonstrating less control by irrelevant, external stimuli than PD subjects.

These findings suggest an interesting interpretation of the data collected in Experiments I and II. It is feasible to view free-operant PD and SS conditions as quite similar types of training: the reinforcement schedules differ, but subjects in both groups learn that it pays to "keep pecking". In both PD and SS conditions control by internal stimuli may increase. During subsequent discrimination test problems, the repetitive pattern of responding that results from PD and SS training would directly interfere with the reduction of response rate in the presence of the negative stimulus. This effect has been observed in Experiments I and II and in other transfer studies. TD training, on the other hand, suppresses control by internal cues; therefore, differential response rates develop more rapidly during subsequent discrimination problems. The

Turner-Mackintosh hypothesis can account for the fact that no differences occurred between groups given either PD or SS training prior to the transfer problem, and also can explain why PD and SS subjects learn transfer tasks slower than TD subjects.

Transfer performance following the HOLD condition appears to depend on the amount of control acquired by internal stimuli during the condition immediately preceding it. In Experiment I, a repetitive pattern of responding had been established in preliminary training for all three groups given the Phase 2 line angle discrimination. This may have been the reason the PD-TD, SS-TD and HOLD-TD groups did not differ during Phase 2. However, when PD, SS or HOLD conditions followed initial TD training, the repetitive pattern of responding that was suppressed by initial TD training was not re-established in the TD-HOLD group prior to the Phase 3 auditory discrimination. Therefore, the intervening HOLD group learned the auditory discrimination faster than either the intervening PD or SS groups. In free-operant situations, the amount of control acquired by irrelevant, internal stimuli in the training condition immediately preceding the test phase may be a major determinant of subsequent performance on generalization tests and transfer problems.

Although Turner and Mackintosh's explanation does seem to fit the data from Experiments I and II, it can not account for other findings, such as why SS training has not been observed to flatten generalization gradients. In addition, general attention explanations of the effects of intervening PD and SS training cannot be ruled out; i.e., it is conceivable that both PD and SS conditions produce an overall reduction in attention to both relevant and irrelevant cues, relative to TD training. Thus, the question remains open as to whether intervening PD and SS training result in retroactive interference, disrupting an established attentional mechanism as Honig and Thomas suggest, or in proactive interference, establishing a repetitive pattern of response as Turner and Mackintosh propose.

Conclusions from many studies of transfer of training and stimulus generalization have been based on the use of SS training as a comparison condition. Clearly, when SS training follows TD training it does not have a neutral effect on subsequent transfer performance. The HOLD condition might be seen as an alternative control procedure; when subjects are not run they cannot learn any response or conceptual strategies. However, since all subjects must be exposed to SS training during response acquisition in pretraining, the HOLD condition does not always provide an

adequate comparison condition. For instance, the lack of difference between the HOLD-TD and SS-TD groups in the Phase 2 discrimination of Experiment I cannot be clearly interpreted, for the only training each group experienced prior to the line angle discrimination problem was single stimulus training with the color dimension. The analysis of SS and HOLD conditions must be continued, employing discrete-trial as well as free-operant procedures. Not until an appropriate control condition is determined can any final conclusions be drawn concerning the effects of extradimensional TD and PD training on stimulus generalization and transfer of training.

FOOTNOTES

[1]Six birds were initally assigned to both the TD-PD and PD-TD groups. During preliminary training, one subject in the TD-PD group died. A subject in the PD-TD group which had been matched to the dead bird was subsequently dropped from the study, leaving 5 birds in the TD-PD and PD-TD groups.

[2]Due to an error by the experimenter, two birds in the TD-PD group were run only 3 days at criterion instead of 4 days. One day each was added to these two birds' days to criterion score before obtaining the TD-PD group average.

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APPENDIX

ILLEGIBLE DOCUMENT

THE FOLLOWING DOCUMENT(S) IS OF POOR LEGIBILITY IN THE ORIGINAL

THIS IS THE BEST COPY AVAILABLE

S+ RESPONSE RATES (TOP), S- RESPONSE RATES (MIDDLE), AND DISCRIMINATION INDEX SCORES (BOTTOM) IN EXPERIMENT 1, PHASE 1

TD - PD GROUP

SUBJECT	DAY 1	2	3	4	5	6	7
1	29.481	50.787	46.418	45.259	39.410	51.343	
	38.533	34.800	13.933	2.533	0.067	1.267	
	43.346	59.339	76.913	94.699	99.831	97.592	
2	63.657	77.899	86.642	62.362	55.055		
	44.933	22.667	1.200	0.200	0.067		
	58.621	77.460	98.634	99.680	99.879		
3	104.074	141.859	100.593	135.556	143.657	119.852	
	73.200	21.867	0.733	5.933	1.200	3.333	
	58.708	86.644	99.276	95.807	99.172	97.294	
4	66.374	77.343	97.612	90.855	103.048	121.185	
	60.200	19.933	7.467	2.400	1.400	11.467	
	52.439	79.509	92.894	97.426	98.660	91.356	
5	50.929	111.365	131.492	122.453	108.625	129.926	98.662
	33.200	35.867	29.067	1.933	1.600	0.133	0.200
	60.537	75.639	81.897	98.446	98.548	99.897	99.798

S+ RESPONSE RATES (TOP), S- RESPONSE RATES (MIDDLE), AND DISCRIMINATION INDEX SCORES (BOTTOM) IN EXPERIMENT 1, PHASE 1

TD - SS GROUP

DAY

SUBJECT	1	2	3	4	5	6	7
1	84.519	69.898	91.630	62.657	148.222	160.148	
	77.533	28.400	7.400	0.933	11.733	10.800	
	52.155	71.105	92.527	98.532	92.665	93.682	
2	72.000	90.815	82.296	111.037	114.963	105.185	
	67.067	37.600	2.600	3.600	3.867	4.067	
	51.774	70.720	96.937	96.860	96.746	96.278	
3	61.185	97.852	47.111	77.993	91.185	108.963	106.370
	42.400	44.200	12.933	7.133	8.067	1.533	0.867
	59.067	68.385	78.460	91.620	91.873	98.612	99.192
4	153.558	125.874	182.444	177.844	158.593	169.037	
	88.467	31.533	0.800	1.000	9.267	11.333	
	63.447	79.967	99.563	99.441	94.479	93.717	
5	66.565	81.402	87.704	97.630	90.963	80.074	
	55.600	31.200	4.467	0.467	1.067	0.400	
	54.489	72.292	95.154	99.524	98.841	99.503	
6	126.241	107.063	121.778	146.518	158.806	149.815	
	106.867	31.733	4.733	0.800	3.067	6.400	
	54.156	77.137	96.259	99.457	98.105	95.903	

S+ RESPONSE RATES (TOP), S- RESPONSE RATES (MIDDLE), AND DISCRIMINATION INDEX SCORES (BOTTOM) IN EXPERIMENT 1, PHASE 1

TD - -- GROUP

DAY

SUBJECT	1	2	3	4	5	6	7	8	9
1	41.891	63.690	60.945	50.441	65.353	57.343	70.332	70.562	59.777
	25.933	18.200	13.400	12.467	19.600	2.667	3.267	0.533	0.467
	61.764	77.775	81.976	80.183	76.928	95.556	95.562	99.250	99.225
2	165.948	154.741	232.148	274.627	178.893	294.740	313.857	303.745	
	123.800	68.667	56.933	65.933	16.800	14.933	30.533	13.800	
	57.273	69.264	80.305	80.640	91.415	95.178	91.134	95.654	
3	65.693	74.962	44.413	101.324	87.565	114.667	120.595	97.612	83.838
	41.667	17.400	7.133	41.867	35.533	7.667	40.667	7.733	3.400
	61.190	81.161	86.161	70.761	71.134	93.733	74.782	92.659	96.103
4	117.669	191.760	160.361	30.883	141.624	209.926	160.522		
	70.333	54.933	44.333	0.133	7.467	5.867	0.867		
	62.589	77.732	78.342	99.570	94.992	97.281	99.463		
5	35.036	79.265	89.219	91.418	83.048	91.004			
	12.800	12.333	0.533	6.333	0.600	2.533			
	73.242	86.535	99.406	93.521	99.283	97.292			
6	60.738	95.018	101.778	107.836	145.799	136.729	105.799		
	47.933	52.400	26.200	0.933	10.667	0.667	1.067		
	55.891	64.455	79.528	99.142	93.183	99.515	99.002		

S+ RESPONSE RATES (TOP), S- RESPONSE RATES (MIDDLE), AND DISCRIMINATION INDEX SCORES (BOTTOM) IN EXPERIMENT 1, PHASE 2

PD - TD GROUP

DAY

SUBJECT	1	2	3	4	5	6	7	8	9	10
1	48.750	7.929	49.527	82.353	108.413	119.559	108.593	119.259	90.074	113.955
	49.333	4.800	22.000	45.067	29.800	16.733	9.000	8.133	6.333	10.000
	49.703	62.290	69.243	64.631	78.439	87.722	92.346	93.616	93.431	91.933
2	39.851	57.353	106.347	152.536	164.280	171.618	158.518	151.556	108.296	140.150
	37.200	37.400	55.933	93.733	50.467	35.267	74.400	42.667	34.800	29.467
	51.720	60.529	65.533	61.939	76.499	82.953	68.057	78.032	75.681	82.627
3	68.529	117.828	146.691	165.000	187.341	180.741	194.701	203.456	230.672	218.074
	72.067	92.200	65.400	68.333	55.467	16.200	12.667	59.067	12.333	19.600
	48.742	56.101	69.164	70.714	77.156	91.774	93.892	77.500	94.925	91.753
4	48.699	85.204	103.717	107.361	80.818	97.949	100.295	96.679	97.868	90.000
	45.067	51.600	42.467	54.933	52.200	35.067	29.600	16.200	4.667	14.733
	51.937	62.282	70.950	66.152	60.757	73.637	77.212	85.648	95.449	85.933
5	31.896	55.390	86.766	127.212	153.755	183.088	184.667	175.498	200.000	173.507
	42.333	49.800	61.933	74.467	104.133	71.867	71.067	27.867	34.533	23.267
	42.969	52.657	58.350	63.077	59.621	71.812	72.211	86.297	85.276	98.176

S+ RESPONSE RATES (TOP), S- RESPONSE RATES (MIDDLE), AND DISCRIMINATION INDEX SCORES (BOTTOM) IN EXPERIMENT 1, PHASE 2

PD - TD GROUP

DAY

SUBJECT	11	12	13	14	15	16	17	18
1								
2	115.401	172.289	175.165	176.324	131.291			
	28.800	12.267	15.400	9.400	7.600			
	80.028	93.353	91.919	94.939	94.528			
3	191.822	200.386						
	8.067	15.133						
	95.964	92.994						
4	83.209	95.129	84.191	84.148	81.418	73.432	64.890	58.074
	31.667	35.400	14.067	11.733	5.800	1.733	1.600	5.000
	72.434	72.820	85.684	87.763	93.350	97.694	97.594	92.073
5	169.474	148.104	159.118	157.926	157.910	121.778	118.828	
	19.267	58.533	28.333	5.200	4.667	4.800	3.800	
	89.792	71.673	84.885	96.812	97.130	96.208	96.901	

S+ RESPONSE RATES (TOP), S- RESPONSE RATES (MIDDLE), AND DISCRIMINATION INDEX SCORES (BOTTOM) IN EXPERIMENT 1, PHASE 2

SS - TD GROUP

DAY

SUBJECT	1	2	3	4	5	6	7	8	9	10
1	37.527	53.308	71.642	99.259	99.927	102.222	118.229	92.741	113.456	122.296
	38.667	61.800	59.600	71.733	27.533	18.600	20.733	6.133	3.600	2.267
	49.252	46.311	54.588	58.049	78.398	84.605	85.080	93.797	96.925	98.180
2	56.134	70.186	104.478	142.612	147.286	136.741	156.963	122.222	147.926	145.683
	65.267	77.133	84.667	67.867	21.933	13.533	27.533	1.200	2.867	2.667
	46.239	47.642	55.237	67.756	87.039	90.994	85.076	99.028	98.099	98.202
3	53.309	85.926	90.667	120.956	134.296	148.635	139.111	138.450	132.000	144.519
	73.400	77.533	32.067	20.800	24.267	13.267	4.533	6.267	5.733	7.067
	42.072	52.567	73.873	85.327	84.696	91.806	96.844	95.670	95.837	95.338
4	82.074	106.963	103.556	146.518	154.370	163.395	169.740	122.518	211.037	200.519
	110.667	102.467	64.933	40.667	40.533	33.867	41.933	44.467	26.133	6.000
	42.583	51.073	61.461	78.215	79.203	82.832	80.190	73.371	88.981	97.095
5	36.148	48.487	72.593	98.216	126.171	120.659	109.442	110.148	84.833	101.190
	39.733	52.000	66.933	64.000	33.933	27.133	31.133	23.333	25.133	19.400
	47.638	48.252	52.028	60.546	78.805	81.641	77.853	82.519	77.144	83.912
6	62.156	68.955	80.000	91.760	106.444	85.630	82.222	67.435	78.657	82.602
	67.267	57.933	57.933	61.067	64.000	19.933	19.467	14.867	9.667	5.000
	48.026	54.343	57.699	60.042	62.451	81.117	80.857	81.336	89.055	94.232

S+ RESPONSE RATES (TOP), S- RESPONSE RATES (MIDDLE), AND DISCRIMINATION INDEX SCORES (BOTTOM) IN EXPERIMENT 1, PHASE 2

SS - TD GROUP

DAY

SUBJECT	11	12	13	14	15
1	111.587				
	0.800				
	99.288				
2	151.642				
	1.667				
	98.913				
3					
4	240.595	209.630	197.556		
	4.533	5.867	5.400		
	98.151	97.278	97.339		
5	93.852	96.929	86.045	98.352	95.407
	14.933	7.200	5.400	7.067	4.933
	86.273	93.085	94.095	93.297	95.083
6	88.000	83.585	71.896		
	5.533	6.733	4.800		
	94.084	92.573	93.742		

S+ RESPONSE RATES (TOP), S- RESPONSE RATES (MIDDLE), AND DISCRIMINATION INDEX SCORES (BOTTOM) IN EXPERIMENT 1, PHASE 2

-- - TC GROUP

DAY

SUBJECT	1	2	3	4	5	6	7	8	9	10
1	63.321	55.955	116.045	115.203	121.926	140.372	146.642	146.543	148.971	
	81.467	51.467	66.067	65.267	41.667	25.200	10.667	6.600	3.000	
	43.734	52.089	63.722	63.835	74.530	84.780	93.219	95.690	98.026	
2	48.444	70.929	88.550	101.407	92.620	117.463	142.593	120.970	138.529	
	43.733	52.000	80.667	64.400	52.333	21.267	10.933	11.133	10.400	
	52.555	57.699	52.329	61.160	63.896	84.670	92.879	91.572	93.017	
3	48.635	37.970	64.851	90.949	107.037	90.000	69.185	76.519	111.481	126.568
	35.267	46.800	55.267	72.133	74.533	61.267	40.667	60.467	49.600	41.867
	57.966	44.792	53.989	55.769	58.951	59.498	62.980	55.859	69.208	75.144
4	92.573	81.493	112.884	124.088	120.222	125.895	134.667	122.388	56.310	65.259
	61.267	41.467	38.333	40.867	40.933	60.333	60.800	87.200	42.733	51.933
	60.175	66.276	74.650	75.225	74.600	67.603	68.895	58.395	56.854	55.685
5	69.556	100.815	87.761	100.000	95.316	108.000	74.243	104.853	105.468	90.332
	72.800	63.600	50.400	49.667	42.333	52.333	30.067	8.867	6.200	4.267
	48.860	61.317	63.521	66.815	69.245	67.360	71.176	92.203	94.448	95.490
6	35.720	53.801	116.803	115.836	133.183	102.836	115.735	100.513	84.833	82.148
	33.867	34.533	98.333	75.933	39.067	64.600	22.600	13.933	16.400	12.600
	51.331	60.806	54.203	60.404	77.320	61.418	83.663	87.825	83.300	87.762

S+ RESPONSE RATES (TOP), S- RESPONSE RATES (MIDDLE), AND DISCRIMINATION INDEX SCORES (BOTTOM) IN EXPERIMENT 1, PHASE 2

-- - TD GROUP

DAY

SUBJECT	11	12	13	14	15	16	17	18	19
1									
2									
3	103.469	100.448	153.284	137.621	146.370	142.657	133.284	116.324	
	43.333	22.800	25.800	11.533	28.200	7.067	3.467	7.067	
	70.482	81.501	85.593	92.268	83.846	95.280	97.465	94.273	
4	82.667	119.405	159.926	181.481	157.333	154.627	142.518	154.925	86.374
	21.667	19.067	34.533	40.800	19.067	17.067	9.933	8.733	6.067
	79.233	86.231	82.241	81.645	89.191	90.060	93.484	94.664	93.437
5									
6	62.426	80.586	89.299	75.259	81.255				
	8.600	5.467	6.800	5.867	4.067				
	87.332	89.499	92.924	92.768	95.234				

S+ RESPONSE RATES (TOP), S- RESPONSE RATES (MIDDLE), AND DISCRIMINATION INDEX SCORES (BOTTOM) IN EXPERIMENT 1, PHASE 3

TD - FD GROUP

SUBJECT	DAY 1	2	3	4	5	6	7	8	9	10
1	45.000	54.138	51.163	59.419	56.512	70.877	80.113	72.139	71.529	67.619
	43.500	52.100	29.900	32.500	22.100	34.400	23.700	25.900	8.400	9.100
	50.847	50.959	63.115	64.643	71.887	67.324	77.170	73.582	89.491	88.139
2	41.829	97.093	106.704	110.714	136.686	145.089	133.918	110.000	126.706	109.157
	23.700	72.800	61.000	68.600	45.300	69.400	58.600	30.600	41.000	17.800
	63.833	57.149	63.626	61.743	75.108	67.644	69.561	78.236	75.552	85.979
3	103.953	120.585	139.657	138.471	163.294	177.647	184.912	180.357	185.882	190.769
	85.700	83.200	54.900	103.800	42.100	52.100	20.300	20.300	44.100	24.700
	54.812	59.173	71.782	57.155	79.503	77.323	90.108	89.883	80.825	88.537
4	50.833	67.059	68.471	60.702	66.588	76.491	99.521	74.881	72.632	45.765
	84.800	102.700	72.900	44.200	79.300	56.600	60.100	56.900	21.100	12.600
	37.479	39.502	48.433	57.865	45.792	57.473	62.348	56.822	77.489	78.412
5	85.146	73.846	69.643	64.912	72.781	83.882	70.643	64.706	70.760	58.563
	48.600	50.400	62.200	44.500	38.300	44.000	68.600	32.600	22.300	43.200
	63.662	59.435	52.823	59.328	65.521	65.593	50.734	66.497	76.037	57.548

S+ RESPONSE RATES (TOP), S- RESPONSE RATES (MIDDLE), AND DISCRIMINATION INDEX SCORES (BOTTOM) IN EXPERIMENT 1, PHASE 3

PD - TD GROUP

DAY

SUBJECT	1	2	3	4	5	6	7	8	9	10
1	56.404	110.465	108.851	134.651	114.571	102.209	132.398	125.029	119.769	111.176
	30.100	97.000	40.200	53.900	19.800	10.400	15.400	9.900	39.800	10.400
	65.204	53.245	73.029	71.414	85.308	90.765	89.580	92.663	75.058	91.446
2	151.124	172.209	167.640	179.643	190.059	198.343	167.836	127.294	140.823	100.000
	175.800	103.700	29.200	27.300	11.600	4.600	7.100	18.600	8.400	10.100
	46.226	62.415	85.166	86.808	94.248	97.733	95.941	87.251	94.371	90.827
3	185.380	202.456	180.234	185.059	177.294	234.000	236.959	186.905	209.176	223.669
	163.500	178.200	73.200	78.000	58.300	49.100	29.300	43.800	14.400	29.700
	53.136	53.186	71.117	70.349	75.254	82.656	88.996	81.015	93.559	88.278
4	51.071	55.059	43.765	37.765	48.193	52.865	27.485	39.167	35.205	50.405
	62.100	41.400	22.300	22.200	10.000	8.800	9.400	18.500	7.500	9.600
	45.127	57.080	66.245	62.978	82.816	85.729	74.516	67.919	82.438	84.001
5	80.819	70.414	50.595	66.316	45.357	52.164	64.912	53.029	64.912	71.138
	88.300	65.400	48.500	37.900	31.500	19.600	7.000	19.500	23.100	23.000
	47.789	51.846	51.057	63.633	59.015	72.688	90.266	73.114	73.754	75.568

S+ RESPONSE RATES (TOP), S- RESPONSE RATES (MIDDLE), AND DISCRIMINATION INDEX SCORES (BOTTOM) IN EXPERIMENT 1, PHASE 3

TD - SS GROUP

DAY

SUBJECT	1	2	3	4	5	6	7	8	9	10
1	87.176	71.124	86.316	93.488	108.353	123.765	96.706	144.210	154.000	140.353
	85.000	74.700	97.000	77.300	86.000	97.500	56.700	88.900	66.900	48.400
	50.632	48.774	47.086	54.739	55.751	55.935	63.039	61.864	69.715	74.358
2	77.895	92.209	60.824	81.988	92.706	88.235	97.176	104.941	95.000	104.941
	65.300	66.200	69.700	78.400	76.300	52.800	67.900	65.600	47.600	46.200
	54.398	58.210	46.600	51.119	54.854	62.563	58.868	61.534	66.620	69.433
3	62.543	87.719	100.000	104.823	107.251	101.734	106.982	120.588	114.793	131.667
	68.200	74.300	66.700	84.300	77.400	55.600	35.500	44.000	43.300	37.200
	47.837	54.242	59.988	55.426	58.083	64.661	75.085	73.267	72.611	77.971
4	75.529	122.807	133.647	143.077	167.168	178.809	177.396	158.246	177.041	123.931
	85.100	134.700	124.100	106.800	57.100	36.500	31.600	37.000	12.200	9.400
	47.021	47.691	51.852	57.259	74.539	83.048	84.880	81.049	93.553	92.950
5	84.142	111.977	124.353	129.704	138.235	163.743	158.721	158.929	177.738	137.870
	69.000	116.000	118.800	107.900	122.700	102.100	101.400	88.500	41.200	58.500
	54.944	49.118	51.142	54.588	52.977	61.594	61.018	64.232	81.182	70.209
6	129.529	88.118	76.395	81.034	95.581	127.674	119.649	128.118	105.698	149.412
	104.000	97.100	68.600	68.800	55.100	47.000	87.900	77.500	50.600	24.900
	55.466	47.575	52.698	54.083	62.433	73.093	57.649	62.309	67.626	85.715

S+ RESPONSE RATES (TOP), S- RESPONSE RATES (MIDDLE), AND DISCRIMINATION INDEX SCORES (BOTTOM) IN EXPERIMENT 1, PHASE 3

SS - TO GROUP

DAY

SUBJECT	1	2	3	4	5	6	7	8	9	10
1	61.637	66.199	119.941	119.294	122.105	120.000	99.882	87.647	85.207	85.146
	67.200	68.800	69.000	81.900	59.700	32.700	30.200	8.300	10.600	15.000
	47.841	49.037	63.286	59.293	67.163	78.585	76.784	91.349	88.936	85.022
2	89.294	67.882	112.262	116.786	107.134	117.558	123.468	127.765	134.850	126.000
	94.100	79.700	63.900	36.400	23.000	21.900	18.900	7.900	21.900	6.500
	48.690	45.996	61.968	76.238	82.326	84.296	86.725	94.177	86.029	95.094
3	57.442	87.294	140.357	165.422	165.714	168.876	172.023	168.166	141.557	160.355
	63.600	101.400	100.700	80.300	40.900	31.200	48.000	116.400	59.300	30.000
	47.456	46.262	58.226	67.321	80.205	84.406	78.184	59.096	70.476	84.240
4	160.823	200.353	220.592	216.023	258.588	242.262	280.000	285.882	274.201	195.114
	155.100	148.100	175.400	124.800	54.700	55.300	39.400	61.400	44.800	67.400
	50.906	57.498	55.706	63.383	82.540	81.416	87.664	82.320	85.956	74.325
5	79.529	55.503	48.736	55.148	54.911	61.163	55.465	55.000	74.319	43.537
	53.900	28.000	17.100	18.800	18.600	14.400	15.600	5.500	13.400	3.500
	59.604	66.468	74.026	74.577	74.698	80.943	78.048	90.909	84.724	92.559
6	67.811	90.588	78.150	83.468	98.139	121.744	107.368	94.419	101.286	
	59.100	93.600	50.000	48.000	44.000	9.800	6.700	5.100	4.900	
	53.432	49.132	60.593	63.489	68.044	92.550	94.126	94.479	95.367	

S+ RESPONSE RATES (TOP), S- RESPONSE RATES
(MIDDLE), AND DISCRIMINATION INDEX SCORES
(BOTTOM) IN EXPERIMENT 1, PHASE 3

TD - -- GROUP

DAY

SUBJECT	1	2	3	4	5	6	7	8	9	10
1	256.117	334.083	393.571	347.059	283.571	351.479	248.721	283.690	254.524	
	196.100	256.700	223.100	188.000	151.000	65.800	140.600	60.000	25.400	
	56.636	56.549	63.822	64.864	65.253	84.231	63.886	82.542	90.926	
2	74.503	99.883	132.781	120.235	127.399	139.408	121.647	147.811	126.509	
	93.000	100.800	54.200	43.300	8.500	8.800	9.800	8.700	9.600	
	44.479	49.772	71.013	73.523	93.745	94.062	92.545	94.441	92.947	
3	82.235	133.136	156.235	149.647	117.816	136.331	115.412	130.353	78.372	
	101.100	116.600	48.800	47.300	33.400	24.000	9.400	7.100	6.700	
	44.855	53.311	76.199	75.983	77.912	85.031	92.469	94.835	92.124	
4	27.598	61.775	65.207	90.177	115.176	70.058	99.172	85.119	107.602	
	20.900	49.300	66.100	57.500	54.000	51.000	62.100	14.800	13.100	
	56.905	55.616	49.660	61.064	68.081	57.871	61.494	85.188	89.147	
5	93.491	116.140	121.176	141.059	140.710	115.621	128.941	112.515	119.290	
	39.000	75.800	74.200	100.900	30.600	38.300	15.700	6.100	5.500	
	70.564	60.509	62.022	58.299	82.138	75.117	89.146	94.857	95.593	
6	132.426	109.467	105.380	114.743	143.468	207.059	221.667	276.374	275.858	
	121.400	90.700	82.500	85.300	91.800	84.100	85.500	32.000	20.900	
	52.172	54.508	56.049	57.359	60.981	71.115	72.165	89.623	92.957	

S+ RESPONSE RATES (TOP), S- RESPONSE RATES
(MIDDLE), AND DISCRIMINATION INDEX SCORES
(BOTTOM) IN EXPERIMENT 1, PHASE 3

-- - TD GROUP

DAY

SUBJECT	1	2	3	4	5	6	7	8	9	10
1	117.442	180.952	130.175	175.349	153.721	148.521	107.953	115.030	152.544	
	103.200	119.600	54.100	94.800	56.700	38.100	43.800	46.500	16.700	
	53.227	60.207	70.642	64.908	73.054	79.584	71.137	71.213	90.133	
2	23.351	114.524	129.822	75.000	132.139	148.521	129.765	136.588	144.852	
	31.400	79.900	108.300	82.500	24.900	38.100	19.300	44.000	6.800	
	42.650	58.904	54.519	47.619	84.144	79.584	87.053	75.635	95.516	
3	131.930	132.982	120.698	129.059	108.953	145.917	91.086	128.284	86.395	
	122.100	117.500	82.800	88.300	62.100	51.100	39.700	25.400	27.500	
	51.935	53.091	59.312	59.376	63.656	74.063	69.645	83.473	75.855	
4	157.093	160.941	166.901	168.121	187.953	155.176	136.140	150.824	93.068	
	144.300	150.300	94.200	75.700	46.000	19.000	20.500	7.500	10.000	
	52.122	51.709	63.922	68.953	80.338	89.092	86.913	95.263	90.298	
5	76.158	106.784	95.906	82.890	91.813	68.000	105.647	101.647	78.140	
	90.700	98.000	51.500	57.500	30.600	41.900	22.000	23.200	11.100	
	45.642	54.822	65.063	59.043	75.003	61.874	82.765	81.417	87.562	
6	145.380	163.314	167.456	158.698	212.706	188.304	158.372	171.579	164.118	
	122.900	80.300	99.800	65.400	47.300	43.700	22.200	18.800	20.400	
	54.190	67.038	62.658	70.816	81.808	81.164	87.706	90.125	89.944	

S+ RESPONSE RATES (TOP), S- RESPONSE RATES (MIDDLE), AND DISCRIMINATION INDEX SCORES (BOTTOM) IN EXPERIMENT 2, PHASE 1

TD - SS GROUP

DAY

SUBJECT	1	2	3	4	5	6	7	8
1	47.361	93.480	74.834	52.734	62.628	54.380	60.000	
	37.800	40.800	27.867	13.400	2.133	1.533	4.067	
	55.613	69.616	72.866	79.738	96.706	97.258	93.652	
2	51.522	94.412	87.823	52.809	58.175			
	23.800	13.533	6.333	0.067	0.733			
	68.402	87.463	93.274	99.874	98.755			
3	112.509	147.116	151.250	138.806	130.487	111.941	108.476	
	80.267	57.133	27.867	26.467	12.267	2.667	11.000	
	58.363	72.028	84.442	83.966	91.407	97.673	90.793	
4	40.879	125.019	112.993	157.059	146.791	135.762		
	28.533	67.300	30.267	9.333	5.067	7.200		
	58.893	64.837	78.873	94.391	96.664	94.964		
5	42.583	66.498	99.350	90.073	108.791	106.036		
	44.067	45.200	29.800	8.733	4.733	10.733		
	49.144	59.534	76.926	91.161	95.831	90.808		

S+ RESPONSE RATES (TOP), S- RESPONSE RATES (MIDDLE), AND DISCRIMINATION INDEX SCORES (BOTTOM) IN EXPERIMENT 2, PHASE 1

TD - SS GROUP

DAY

SUBJECT	1	2	3	4	5	6	7	8
6	37.472	51.910	61.481	67.111	61.449	70.183	69.446	71.808
	25.067	12.400	7.733	6.200	8.000	1.067	6.933	0.933
	59.918	80.718	88.827	91.543	88.481	98.503	90.923	98.717
7	75.971	58.885	54.799	82.463	77.279			
	32.600	15.067	0.467	0.067	0.267			
	69.973	79.626	99.156	99.919	99.656			
8	46.886	80.368	62.156	55.556	78.657			
	32.200	15.067	2.200	1.533	4.867			
	59.285	84.213	90.582	97.333	94.173			
9	81.926	80.733	99.405	97.040	87.259	96.176		
	34.067	17.400	11.933	1.600	7.467	2.333		
	70.630	82.269	89.282	95.859	92.118	97.631		

S+ RESPONSE RATES (TOP), S- RESPONSE RATES (MIDDLE), AND DISCRIMINATION INDEX SCORES (BOTTOM) IN EXPERIMENT 2, PHASE 1

TD - HOLD GROUP

DAY

SUBJECT	1	2	3	4	5	6	7	8
1	48.478	134.775	140.956	146.618	150.706	155.867		
	32.533	42.733	15.133	13.733	7.333	7.733		
	59.841	75.927	90.305	91.435	95.360	95.273		
2	76.397	63.443	74.022	79.485	76.803	91.324		
	58.533	11.667	9.133	5.067	2.533	1.467		
	56.620	84.467	89.017	94.008	96.807	98.419		
3	123.616	143.173	126.269	132.667	131.045			
	87.733	23.000	0.667	0.267	0.067			
	58.489	86.159	99.475	99.799	99.949			
4	13.791	51.912	125.075	148.165	162.454	149.527		
	18.400	32.467	42.400	11.333	1.867	15.067		
	42.840	61.523	74.683	92.894	98.864	90.846		
5	55.531	67.168	39.303	116.397	137.836	136.753	140.517	124.755
	42.133	27.133	10.067	24.133	19.733	7.133	7.267	0.933
	56.859	71.227	79.610	82.827	87.476	95.042	95.083	99.257

S+ RESPONSE RATES (TOP), S- RESPONSE RATES (MIDDLE), AND DISCRIMINATION INDEX SCORES (BOTTOM) IN EXPERIMENT 2, PHASE 1

TD - FOLD GROUP

DAY

SUBJECT	1	2	3	4	5	6	7	8
6	44.030	65.201	82.206	103.529	114.478			
	33.400	21.667	8.333	2.067	2.267			
	56.864	75.058	90.796	98.043	98.058			
7	71.078	61.838	106.029	102.313	101.771			
	58.200	20.667	9.733	3.467	2.133			
	54.981	74.951	91.592	96.723	97.947			
8	29.925	50.187	64.599	73.875	80.815			
	18.000	11.400	3.600	4.067	0.800			
	62.442	81.490	94.721	94.782	99.020			
9	29.524	64.569	54.539	50.815	46.296			
	21.467	9.667	1.067	0.200	0.067			
	57.901	86.978	98.082	99.608	99.856			

S+ RESPONSE RATES IN EXPERIMENT 2, PHASE 2

HOLD - SS

DAY

SUBJECT	1	2	3	4	5	6	7	8
1	71.660	67.286	62.148	71.598	86.716	80.000		
2	61.259	62.059	62.974	63.259	79.851			
3	139.556	86.320	93.185	122.453	111.882	116.940		
4	130.615	124.593	92.251	93.234	99.630	93.309		
5	27.253	122.444	68.727	113.134	100.886			
6	62.074	60.294	55.407	59.625	52.788			
7	59.481	64.776	55.037	55.242	56.148			
8	85.943	77.037	72.985	65.259	54.052			
9	99.778	80.149	62.148	62.602	67.306	64.689	68.358	60.662

S+ RESPONSE RATES IN EXPERIMENT 2, PHASE 2

TD - SS

DAY

SUBJECT	1	2	3	4	5	6	7	8
1	41.259	39.185	49.044	54.908	50.224			
2	87.101	115.762	106.863	119.485	96.458	90.037		
3	20.851	27.372	43.941	18.790	53.284	48.309		
4	51.144	60.372	58.967	70.222	69.963	67.537		
5	48.699	45.353	60.595	63.824	78.819			
6	45.756	34.799	28.773	24.548	44.485			
7	39.333	35.333	53.881	38.309	31.439			
8	35.498	44.907	35.125	54.593	47.692	52.985	29.559	39.851
9	70.260	66.840	66.618	85.111	75.735			

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THE FOLLOWING DOCUMENT (S) IS ILLEGIBLE DUE TO THE PRINTING ON THE ORIGINAL BEING CUT OFF

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S+ RESPONSE RATES (TOP), S- RESPONSE RATES (MIDDLE), AND DISCRIMINATION INDEX SCORES (BOTTOM) IN EXPERIMENT 2, PHASE 3

FOLD - SS

DAY

SUBJECT	1	2	3	4	5	6	7	8	9	10	11	12
1	35.503	36.527	48.353	55.385	80.599	74.405	72.071	82.674	70.173	74.268	61.548	55.395
	57.300	46.200	35.700	40.100	47.100	54.600	38.900	52.800	34.300	47.300	29.300	19.600
	38.256	44.154	57.527	58.004	63.116	57.676	64.946	61.026	67.169	61.092	67.748	73.935
2	64.211	60.595	88.941	84.706	74.730	74.823	68.166	47.442	95.260	83.273	105.714	120.828
	105.400	72.000	77.900	61.400	48.900	26.800	36.500	14.700	45.100	32.100	45.700	40.400
	37.858	45.695	53.309	57.976	60.447	73.628	65.127	76.344	67.868	72.177	69.818	74.942
3	32.486	47.368	50.760	53.450	36.000	22.762	45.087	50.581	51.176	42.209	39.318	54.269
	22.700	55.800	44.300	50.300	23.600	7.900	39.500	29.000	30.600	11.800	19.700	14.000
	58.866	45.914	53.398	51.518	60.403	74.236	53.302	63.559	62.581	78.152	66.620	79.493
4	54.035	81.059	86.199	93.018	106.163	115.476	48.977	117.674	90.414	89.467	84.941	86.744
	10.000	36.500	85.000	59.300	19.900	44.200	7.400	21.300	15.500	5.400	2.200	6.200
	84.384	68.952	50.350	61.068	84.214	72.319	86.874	84.673	85.366	94.308	97.475	93.329
5	59.758	83.929	97.059	121.183	121.667	124.000	133.256	76.264	127.500	130.000	63.763	65.494
	74.500	85.900	105.600	88.700	66.700	83.300	27.100	36.000	22.000	31.600	10.600	14.200
	44.510	49.420	47.393	57.738	64.590	59.817	83.100	67.933	85.284	80.446	85.746	82.182

S+ RESPONSE RATES (TOP), S- RESPONSE RATES (MIDDLE), AND DISCRIMINATION INDEX SCORES (BOTTOM) IN EXPERIMENT 2, PHASE 3

HOLD - SS

DAY

SUBJECT	1	2	3	4	5	6	7	8	9	10	11	12
6	37.262	60.702	98.935	111.214	120.714	130.296	117.674	115.176	97.870	106.864	100.706	77.371
	65.000	62.700	88.400	63.800	64.400	34.200	28.700	41.300	13.900	37.500	33.900	33.000
	36.438	49.190	52.812	63.546	65.211	79.209	80.393	73.606	87.564	74.024	74.815	70.101
7	34.629	61.786	50.824	54.556	45.207	42.892	43.584	43.509	64.643	70.177	77.076	35.614
	43.100	62.700	37.900	30.300	31.800	29.100	22.400	22.600	32.900	13.000	16.100	24.600
	44.551	49.633	57.283	64.293	58.705	59.579	66.052	65.814	66.271	84.371	82.721	77.680
8	36.941	40.237	59.157	58.728	70.760	79.405	77.515	69.123	61.538	59.882	65.207	40.000
	59.000	42.000	37.800	39.900	50.200	43.300	68.500	51.700	50.400	48.600	51.500	29.900
	38.504	48.928	61.013	59.545	58.499	64.712	53.087	57.210	54.975	55.200	55.872	57.225
9	65.917	84.941	96.941	103.473	101.053	103.314	112.717	109.167	95.858	96.279	78.012	51.716
	104.700	79.300	80.500	76.400	67.600	48.900	29.100	53.400	19.800	10.400	7.000	6.300
	38.635	51.717	54.633	57.526	59.918	67.874	79.481	67.152	82.881	90.251	91.766	93.572

S+ RESPONSE RATES (TOP), S- RESPONSE RATES (MIDDLE), AND DISCRIMINATION INDEX SCORES (BOTTOM) IN EXPERIMENT 2, PHASE 3

TD - FCLD

DAY

SUBJECT	1	2	3	4	5	6	7	8	9	10	11	12
1	121.084	101.176	127.811	121.059	140.118	132.515	142.209	138.497	130.545	142.907	136.190	143.121
	92.400	39.600	24.400	53.100	63.000	35.200	11.200	2.700	16.900	7.200	0.700	1.500
	56.718	71.870	83.970	69.511	68.983	79.012	92.699	98.088	88.538	95.203	99.489	98.963
2	101.807	95.412	119.763	120.706	131.647	133.571	139.535	140.809	133.333	134.884	132.500	135.607
	78.400	57.500	72.200	103.800	88.300	57.100	104.800	66.600	43.200	29.200	55.900	57.100
	56.495	62.397	62.389	53.765	59.854	70.053	57.108	67.890	75.529	82.204	70.329	70.369
3	140.710	124.327	126.272	145.294	161.893	165.610	149.157	161.775	142.414	151.018	138.246	146.782
	120.100	101.000	102.800	75.800	75.200	28.100	12.200	10.600	30.600	22.100	12.800	8.600
	53.951	55.176	55.123	65.716	68.283	85.494	92.439	93.851	82.314	87.234	91.526	94.465
4	128.304	130.471	123.077	161.412	193.373	194.024	220.241	205.680	214.104	225.868	221.988	224.253
	157.000	122.200	106.300	102.900	92.000	43.800	24.500	34.500	25.200	28.900	6.700	14.800
	44.971	51.637	53.657	61.069	67.762	81.583	89.989	85.636	89.469	88.656	97.070	93.809
5	92.941	93.256	101.176	105.357	103.626	91.294	91.479	86.467	94.070	96.879	98.225	90.952
	99.200	90.500	90.200	99.900	91.800	84.400	73.400	68.300	55.700	63.700	64.800	66.000
	48.371	47.915	52.868	51.329	53.026	51.962	55.483	55.869	62.810	60.331	60.251	57.949

S+ RESPONSE RATES (TOP), S- RESPONSE RATES (MIDDLE), AND DISCRIMINATION INDEX SCORES (BOTTOM) IN EXPERIMENT 2, PHASE 3

TC - FCLD

DAY

SUBJECT	1	2	3	4	5	6	7	8	9	10	11	12
6	129.341	124.678	136.744	148.823	149.762	160.000	150.471	151.598	151.497	147.907	150.289	152.189
	133.800	104.700	77.600	62.500	69.300	27.300	32.000	32.300	29.500	6.700	6.100	9.000
	49.153	54.355	63.797	70.424	68.365	85.424	82.463	82.436	83.701	95.666	96.099	94.417
7	82.485	105.904	76.842	86.977	104.070	94.000	87.619	62.924	100.941	99.765	106.108	112.093
	102.300	87.600	54.600	58.900	59.600	27.800	21.600	9.700	7.200	6.100	3.800	4.900
	44.638	54.730	58.461	59.623	63.585	77.176	80.223	86.644	93.342	94.238	96.543	95.812
8	30.349	35.906	61.916	57.725	63.214	92.706	89.349	98.941	108.757	105.647	100.118	96.235
	35.700	32.200	57.300	32.000	39.600	44.300	50.600	36.300	26.700	23.300	31.000	23.500
	45.949	52.721	51.936	64.335	61.484	67.666	63.844	73.159	80.289	81.931	76.357	80.373
9	68.571	138.947	147.305	169.405	159.401	138.000	142.485	152.588	159.290	159.176	161.302	159.763
	69.600	97.900	109.000	35.500	24.000	39.200	30.300	29.800	13.600	12.300	11.300	13.600
	49.628	58.665	57.473	82.675	86.914	77.878	82.464	83.661	92.134	92.827	93.453	92.155

S+ RESPONSE RATES (TOP), S- RESPONSE RATES (MIDDLE), AND DISCRIMINATION INDEX SCORES (BOTTOM) IN EXPERIMENT 2, PHASE 3

TD - SS

DAY

SUBJECT	1	2	3	4	5	6	7	8	9	10	11	12
1	55.116	57.647	87.326	108.333	102.824	97.882	85.380	89.240	82.650	90.058	85.988	86.235
	64.500	76.800	42.000	48.400	37.700	24.700	57.000	17.700	23.700	38.000	29.800	18.300
	46.078	55.975	67.524	69.120	73.172	79.850	59.966	83.449	77.723	70.326	74.263	82.494
2	75.858	76.588	104.497	95.465	108.810	102.000	97.647	78.596	83.176	73.372	79.415	78.443
	84.700	68.500	87.500	85.500	82.500	64.700	46.000	43.800	31.200	25.200	21.800	39.200
	47.246	52.787	54.426	52.753	56.876	61.188	67.977	64.215	72.722	74.435	78.462	66.679
3	94.384	133.873	159.294	152.164	144.762	148.324	142.690	128.439	118.046	120.234	120.952	106.706
	80.600	168.300	170.700	148.100	121.600	86.100	76.100	44.400	35.400	37.500	27.500	41.800
	54.070	44.230	48.272	50.677	54.348	63.272	65.218	74.311	76.930	76.226	81.476	71.853
4	77.765	76.416	106.512	101.754	129.825	108.521	112.023	124.624	120.636	131.724	127.719	124.767
	108.800	94.500	118.500	99.100	88.300	72.300	72.300	68.100	46.300	58.300	76.000	76.100
	41.682	44.710	47.336	50.661	59.519	60.016	60.775	64.665	73.832	69.320	62.694	62.114
5	86.057	112.632	84.114	128.555	120.595	109.586	99.771	115.765	103.077	107.219	96.959	85.517
	105.800	117.800	85.500	56.200	44.000	17.000	15.100	5.400	6.300	6.100	4.700	11.700
	44.855	48.879	49.591	69.581	73.268	86.570	86.855	95.543	94.240	94.617	95.377	87.965

S+ RESPONSE RATES (TOP), S- RESPONSE RATES (MIDDLE), AND DISCRIMINATION INDEX SCORES (BOTTOM) IN EXPERIMENT 2, PHASE 3

TD - SS

DAY

SUBJECT	1	2	3	4	5	6	7	8	9	10	11	12
6	45.680	60.479	66.746	90.119	94.118	94.556	73.294	74.941	81.053	71.647	64.912	70.116
	59.000	58.600	61.100	53.700	50.400	43.500	31.700	29.000	22.300	26.700	19.600	26.500
	43.638	50.789	52.208	62.661	65.125	68.491	69.808	72.100	78.423	72.851	76.808	72.572
7	40.115	72.209	86.588	70.465	86.429	101.294	95.529	100.000	99.529	97.076	84.524	86.744
	56.400	88.300	93.900	94.800	86.300	72.500	53.400	44.300	68.100	30.100	31.000	11.200
	41.563	44.988	47.974	42.638	50.037	58.284	64.144	69.300	59.375	76.332	73.166	88.565
8	10.337	73.294	75.814	73.099	72.169	67.976	79.302	68.941	75.529	76.588	87.456	79.405
	17.000	86.000	80.000	69.800	48.000	29.900	23.500	27.800	23.600	23.400	16.700	20.600
	37.813	46.012	48.657	51.154	60.056	69.451	77.141	71.264	76.193	76.597	83.966	79.401
9	36.988	54.471	63.509	73.176	75.385	76.000	87.574	80.833	79.070	88.284	91.716	91.124
	54.900	64.400	62.900	68.700	66.900	71.900	58.500	46.800	36.700	43.600	43.000	43.100
	40.253	45.823	50.241	51.578	52.982	51.386	59.952	63.332	68.299	66.941	68.081	67.890

DISRUPTIVE EFFECTS OF PSEUDODISCRIMINATION AND SINGLE STIMULUS TRAINING ON TRANSFER OF TRAINING

by

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ABSTRACT

In experiment I, three groups of pigeons were given true discrimination (TD) training between two wavelengths. Following this training, one group received pseudodiscrimination (PD) training with two line angles, the second group was given single stimulus (SS) training with a vertical line, and the third group was not run. Three additional groups were given the same kinds of training but in reverse order. Subjects who received either PD or SS training following TD training acquired a subsequent auditory discrimination at a slower rate than the subjects given either no intervening training or the SS and PD training prior to initial TD training. Experiment II demonstrated that a group given intervening SS training did not differ from a group that received SS training only, and both acquired a new discrimination more slowly than a group given TD training only. A generalization test was given prior to the transfer problem, but no differential effects of the experimental conditions were observed. The effects of intervening PD and SS training on transfer were discussed in terms of interference from internal, irrelevant stimuli, and the appropriateness of SS as a control condition in transfer of training experiments was discussed.