STIMULUS GENERALIZATION AS A FUNCTION OF THE TIME BETWEEN TRAINING AND TESTING PROCEDURES

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The present experiment was designed, primarily, to study changes in the stimulus-generalization gradient as a function of the interpolation of a time interval between training and testing procedures. A second purpose of the study was to explore the retention of a conditioned discrimination, as reflected by changes in the generalization gradient. Considerable evidence (e.g., Hanson, 1957; Honig, Thomas, & Guttman, 1959) has been obtained that discrimination training produces a steepening of the gradient and a shift in the peak of responding away from the S^D value. It was anticipated that a decrease in the strength of the discrimination might be reflected by a reversal of these changes, i.e., a progressive flattening of the gradient and shift toward the S^D value.

METHOD

Subjects

The *S*s were 15 White Carneau pigeons maintained by restricted feeding at 70-80% of their free-feeding weights.

Apparatus

Four Skinner-type automatic key-pecking apparatuses were used. One box was set aside for generalization testing. The light source for the illumination of the key in this box was a Bausch and Lomb monochromator, in which a diffraction grating is used to disperse white light into the spectral continuum. The other three boxes have Bausch and Lomb interference filters. The brightness level and transmission band width of the monochromator and filter colors were approximately equal. In addition, each *S* received part of its training in the test box so as to have experience with both kinds of stimuli. The apparatus was essentially the same as that described in other reports from the Duke University laboratory.

Procedure

After magazine training, *S*s were trained to peck at the key, which was illuminated by a light of 550 millimicrons. When the response was well-established on a 100% schedule after 2 days of 50 reinforcements each, Ss were placed on a 60-second VI schedule for 2 days. Each training session consisted of 30 stimulus-on periods of 60 seconds, during which the data were recorded. Each of these periods alternated with 10-second blackout periods. In discrimination training the stimuli were changed.

After the completion of VI training, discrimination training was begun. For all *S*s a light of 550 millimicrons was the positive stimulus, and a light of 570 millimicrons was the negative. Reinforcement for responding to the positive stimulus followed the VI schedule previously used. The positive and negative stimuli were presented according to a prearranged random order. Fifteen 60-second intervals of S^D and fifteen of S^Δ were presented each day. These thirty presentations comprised three blocks of ten; and within each block,

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there were five positive and five negative stimuli. Blackout periods of 10 seconds each separated stimulus-on periods.

Discrimination training was carried out to a criterion of five successive periods of S^{Δ} without a response, provided that responding to S^{D} was maintained. Then, each *S* was assigned to one of three groups. Group 1 was tested for generalization on the next day; Group 2, 7 days later; and Group 3, 21 days later. Generalization testing was done under conditions of extinction. The stimulus-on, stimulus-off schedule was changed to 30-second, stimulus-on periods alternated with 10-second stimulus-off or blackout. Eleven stimuli (490 to 610 millimicrons in 10-millimicron steps, omitting 500 and 600 millimicrons) were randomized within a series, and six different random series comprised each generalization test. To provide data indicating the extent of retention of the discrimination, the *S*s in Groups 2 and 3 were given further discrimination training after the completion of generalization testing. These *S*s were run under the same conditions as in original learning until the same criterion was met. However, the single exception was that during retraining only one session was used, with the *S*s continuing beyond the 30-minute limit if necessary until they achieved the criterion. Unfortunately, these data were not collected for Group 1, which was run as part of a different experiment.

RESULTS

Figure 1 presents the postdiscrimination generalization gradients of the three experimental groups. All three curves show the typical effect of discrimination training on the

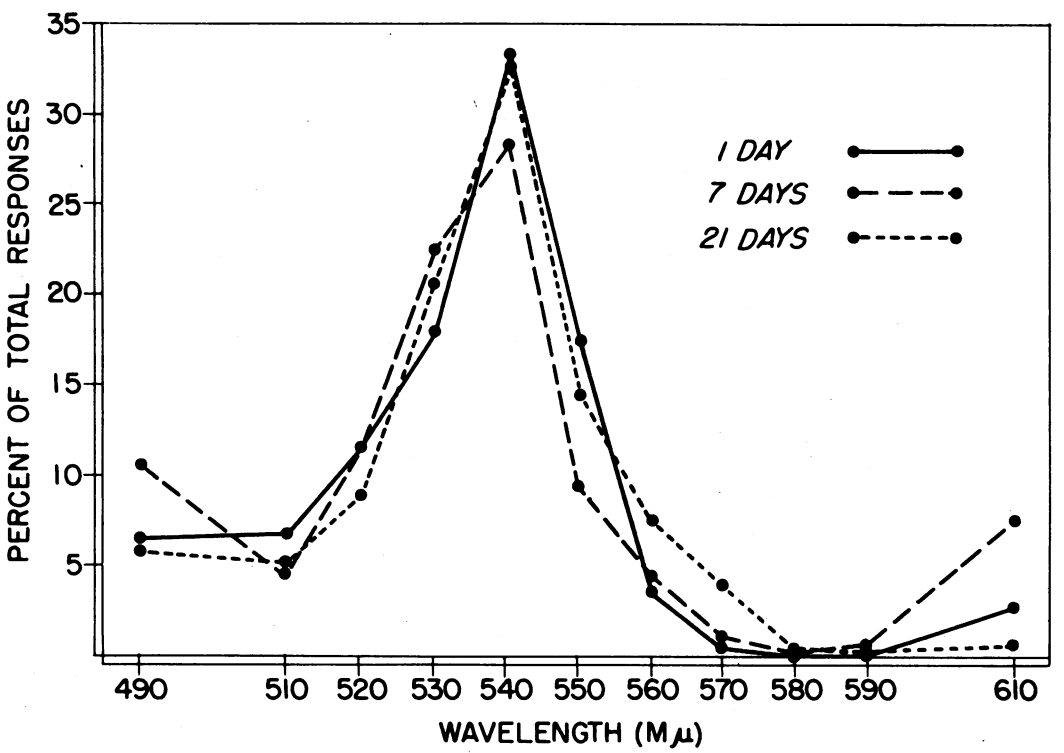

Figure 1. The generalization gradients of the three experimental groups.

generalization gradient. In all three cases, the mode is displaced away from the negative stimulus (570 millimicrons). The modes are the same, 540 millimicrons, in each case. A more sensitive measure of central tendency is the mean of the gradient, which is calculated by treating the gradient as a grouped frequency distribution. The means, in millimicrons, thus obtained are: Group 1, 534.23; Group 2, 538.90; and Group 3, 536.12. These differences are not significant ($F < 1$, $df = 2, 12$). A measure of the steepness of the generalization gradient is the percentage of total responses given to the modal stimulus. These percentages are: Group 1, 33.4; Group 2, 28.6; and Group 3, 33.6. These differences are not significant ($F < 1$, $df = 2, 12$).

Perhaps a better way to indicate the reliability of the results would be to present the stimulus-generalization gradients of all *S*s in the study. Figures 2, 3, and 4 present the individual curves from Groups 1, 2, and 3, respectively. The peak shift is strikingly displayed with all *S*s. Note that not a single *S* showed peak responding to the S^D.

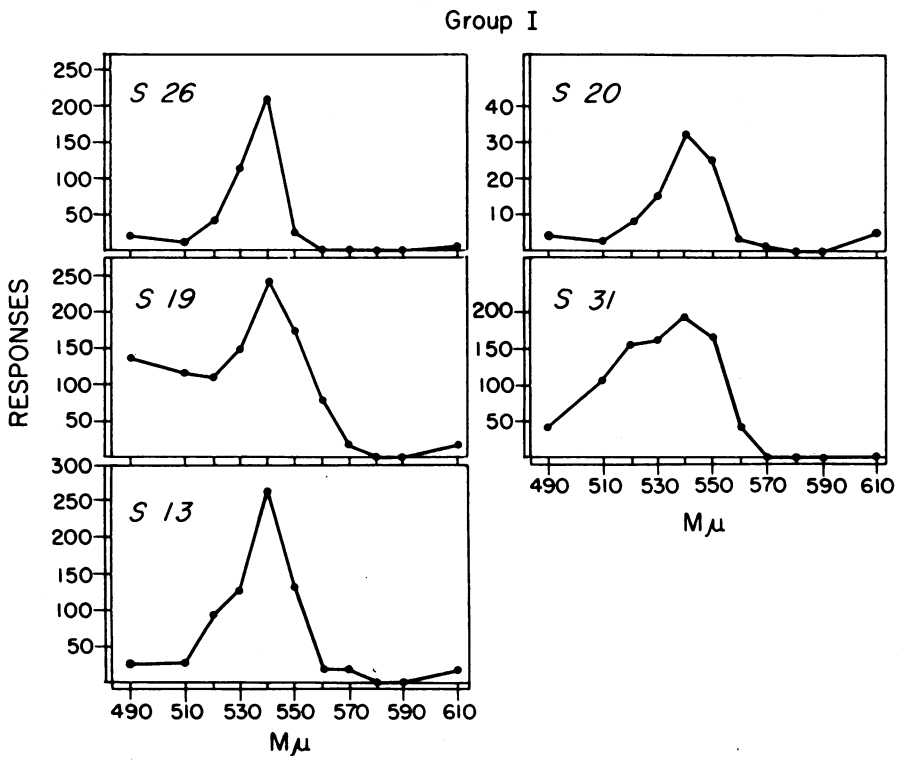

Figure 2. The generalization gradients of individual *S*s in Group 1.

The apparent stability of the generalization gradient over a period of 21 days suggests that the conditioned discrimination is well retained by the *S*s. Some corroborating evidence is presented in Table 1. All *S*s show considerable savings in the relearning of the discrimination. The fact that some retraining is necessary for the criterion to be reachieved should not be considered definite evidence for forgetting. Quite possibly, this is partly due to the generalization testing procedure, which necessarily involves some extinction. There is no reliable difference between the retention scores of Groups 2 and 3 on either of the two ob-

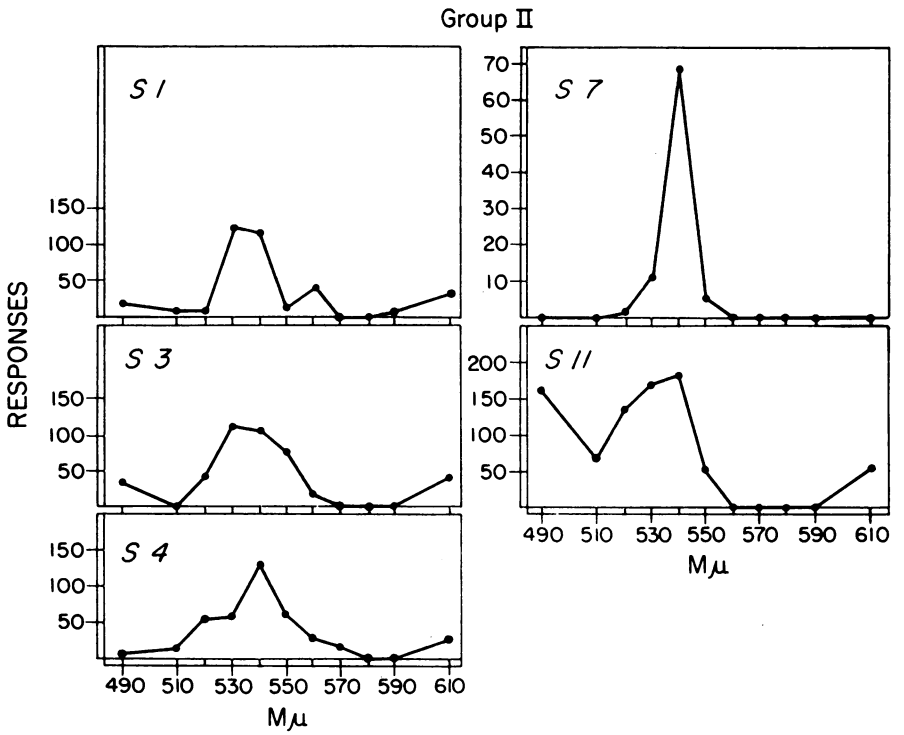

Figure 3. The generalization gradients of individual *S*s in Group 2.

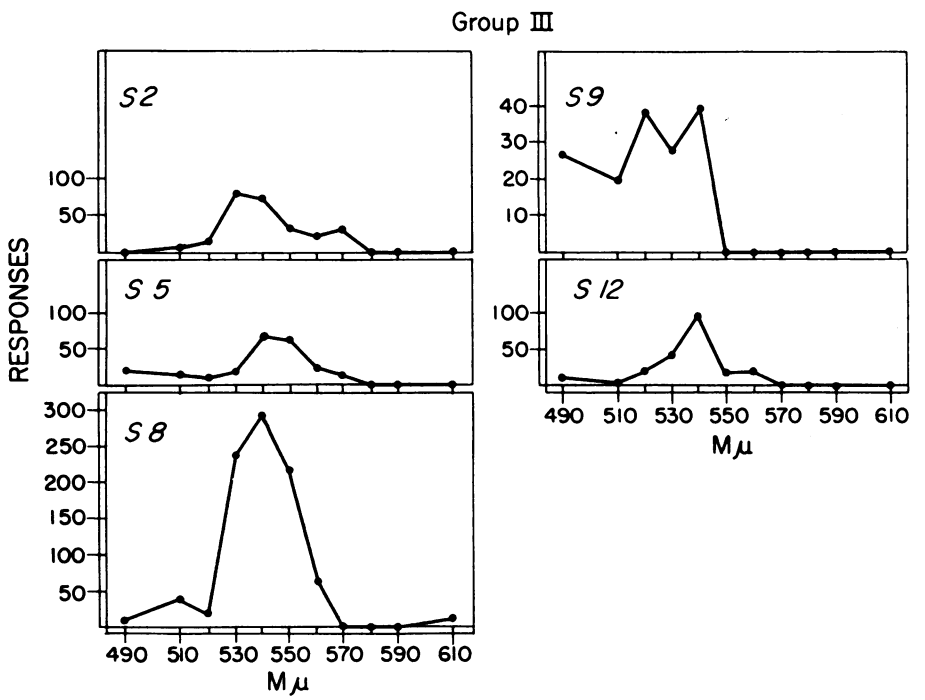

Figure 4. The generalization gradients of individual *S*s in Group 3.

Table 1
Retention Scores of Groups 2 and 3

	Minutes to Criterion		% R's to S^{Δ} in Retraining
Group 2 Subjects	Original Training	Re-training	
S 1	98	19	1.12
S 3	110	32	5.45
S 4	81	14	7.37
S 7	90	10	0.00
S 11	85	42	6.52
Group 3 Subjects			
S 2	116	29	3.11
S 5	90	35	9.33
S 8	103	29	1.86
S 9	87	38	4.82
S 12	105	41	4.27
		$t = 1.72$ $df = 8$	$t < 1$ $df = 8$

tained measures, time to criterion ($t = 1.72$, $df = 8$) and percentage of responses to S^{Δ} during retraining ($t < 1$, $df = 8$).

In view of the considerable agreement among the various measures, it appears safe to conclude that a conditioned discrimination in the pigeon may be maintained without intervening practice for a period at least as long as 21 days without any noticeable decrement in strength. The present study was not designed to test the limit of time over which a discrimination may be maintained. However, these results do add confirmation to Skinner's observation (Skinner, 1950) of learned discriminations maintained for long periods. Whether or not the generalization gradient, or any other measure, would reflect a significant weakening of a conditioned discrimination after a *very extended* period of time remains an open question.

The fact that the generalization gradient remained unchanged over a period as long as 21 days is in disagreement with a recent finding (Perkins & Weyant, 1958). In this study, a different species, different delay intervals, and an entirely different procedure are used. In addition, the present study involved generalization gradients obtained after discrimination training. It is reasonable to assume that in addition to making the generalization gradient more consistent at the time of the test, discrimination training increases the stability of the gradient over a time interval. Whether generalization gradients obtained after the usual single-stimulus training procedure would prove so invulnerable to the effects of time remains to be determined.

SUMMARY

An experiment was performed to study the retention of a conditioned discrimination as indicated by changes in the stimulus-generalization gradient. It had been hypothesized that any forgetting that took place during the interval between training and testing would be

reflected by a progressive flattening of the gradient and a shift of the peak of responding toward the negative stimulus. Gradients obtained after 7 and 21 days were similar to those obtained 1 day after training. This fact suggests that little or no forgetting had taken place during the interpolated time interval. Two other retention measures, time to relearn the discrimination and the percentage of responses to S^{Δ} during relearning, also showed negligible forgetting, thus adding confirmation to the generalization measure.

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