emergence-from-cage test. Among males there was no difference between the non-cross-fostered handled (N = 7) and control (N = 10) groups, whereas both cross-fostered groups of prenatally handled animals (N = 11 and 20) emerged significantly sooner than controls (N = 10 and 12). Among females it was the cross-fostered groups (N = 13 and 11 for handled and 10 and 9 for control animals) which did not differ significantly, but the non-cross-fostered offspring of handled mothers (N = 12) emerged significantly sooner than controls (N = 13). These data are presented in Fig. 1.

In contrast to the greater offspring emotionality effected by prenatal maternal "anxiety," prenatally handled animals appear to be less emotional than controls. To the extent that high emotionality may be considered maladaptive, such results serve to contradict any orientation or expectation that only deleterious effects can result from prenatal manipulation.

It has been hypothesized by Thompson (*1*) that the behavioral effects of prenatal maternal manipulations are brought about by the hormonal changes which occur in the mother in response to the anxiety-provoking stimulation. Presumably, these changes are transmitted to the fetus via the maternal-fetal blood exchange. If such are the mediating mechanisms, it would follow from the present data that the response of the pregnant (or for that matter, the nonpregnant) animal to handling is qualitatively and/or quantitatively different from the response to some if not all other forms of "stressful" stimulation of the kind commonly used in studies of environmental influences on behavior. Such a hypothesis has implications for the design of research on the effects of "early" as well as prenatal experiences since it would appear that one cannot necessarily generalize from the effects of one type of manipulation to another. Unfortunately, little is known at this time about the psychophysiological responses concomitant with handling or other behavioral manipulations (*3*).

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Prediction of Discrimination from Generalization after Variations in Schedule of Reinforcement

Abstract. *The relationship between generalization and discrimination is explored in the present study by utilizing the results of systematic changes in the generalization gradient to predict changes in discrimination behavior. In the first of two experiments, differing groups of pigeons were trained to respond to a wavelength of 550 mμ under conditions of varying schedules of reinforcement. Generalization gradients were then obtained and the ratios of the responses to selected discriminative stimuli calculated. These were used to predict discrimination behavior in a second experiment using the same stimuli. Both the number of trials to a discrimination criterion and the ratio of response indicate the plausibilty of an inverse hypothesis, and the applicability of the generalization model to related behavior such as discrimination.*

Several investigators (*1–3*) have explored the relationship between generalization and discrimination. In one such study, Guttman and Kalish (*1*) hypothesized an inverse relationship between generalization and the discrimination function for wavelength of light in pigeons (delta lambda function). Gradients obtained after training, however, did not show the anticipated changes corresponding to variations in the delta lamdba function. Kalish (*2*), on the other hand, obtained the expected relationship between generalization and the discrimination function for human subjects.

Other studies have also attempted to demonstrate the extent to which variables commonly associated with generalization testing procedures have produced changes in the generalization gradient. Such changes may involve the elimination of cues which maximize discrimination during generalization testing.

Kalish and Haber (*3*), for example, compared gradients from generalization testing to single and multiple stimuli. The gradient obtained with the single stimulus procedure was flatter than that from the multiple stimulus method. The concave form of the mutliple stimulus gradient compared to the linear form of single stimulus gradient suggested the presence of a discrimination process during generalization testing.

An alternative method of testing the inverse hypothesis would involve generating systematic changes in generalization and using the obtained generalization gradients as models to predict discrimination behavior. If systematic changes corresponding to steepening of the gradient for one level of a variable and flattening for the other could be obtained, the gradients thus generated could be used as models for predicting subsequent behavior in a discrimination task. Varying the number of reinforcements during training suggests one possible way to achieve these changes in the gradient.

Two separate experiments were conducted following the preceding plan. The first one explored changes in generalization along the wavelength continuum as a function of schedules of reinforcement. Subjects were trained to respond to 550 mμ under different schedules of variable-interval reinforcement. Predictions concerning discrimination between certain selected points on the wavelength continuum were made from the subsequent generalization gradient. A new group of birds was then trained to 550 mμ under precisely the same schedules of reinforcement employed in the first experiment, and, after 10 days of training, these birds were required to form a discrimination between 550 to 540 or 540 to 530 mμ.

The subjects were 54 experimentally naive, white, Carneau pigeons reduced to 80 percent of their free-feeding weight. Eighteen birds were used for the first experiment, and 36 for the second.

After the 18 birds in the first experiment were reduced to 80 percent of their free-feeding weight they were trained by the method of successive approximations to peck at a plastic disk illuminated by a wavelength of 550 mμ. They were then placed in one of three reinforcement groups (mean intervals 15 seconds, 1 minute, and 4 minutes) and given 30 minutes of variable-interval training each day for a period of 10

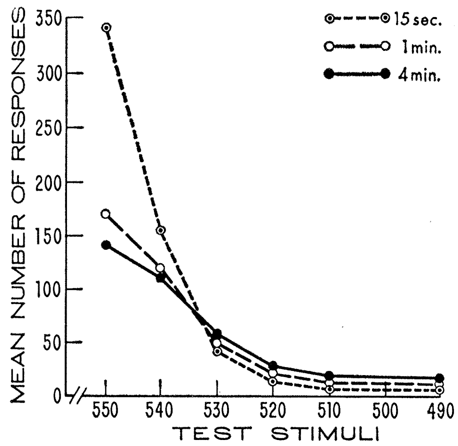

Fig. 1. Mean generalization gradients for three reinforcement groups.

days. During this period 60-second "stimulus-on" trials were alternated with 10-second "blackouts." On the day after the last session of variable-interval training, each of the 18 birds received a generalization test under extinction conditions, consisting of 72 30-second periods of stimulus presentation alternating with 10 seconds of blackout. Six different test stimuli (550, 540, 530, 520, 510, and 490 mμ) were presented in random series and 11 different random series were used.

The 36 subjects assigned to the second experiment received 10 days of training to 550 mμ under differing schedules of reinforcement identical to those for the birds in the first experiment. On the day after variable-interval training, each of the subjects was assigned to one of two groups for discrimination training with successive presentation of stimuli. For one group the discriminative stimuli were 550 mμ (S+) and 540 mμ (S−); for the other, 540 mμ (S+) and 530 mμ (S−). Since these birds had already been divided into three reinforcement groups during training, a total of six experimental groups resulted. Each bird received 30 one-minute periods of stimulus presentation alternating with 10 seconds of blackout in which the positive stimulus was reinforced on a variable-interval schedule with a mean of 1 minute.

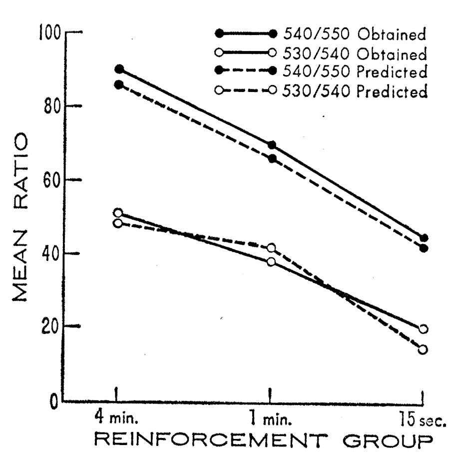

Fig. 2. Predicted and obtained ratio values.

In order to eliminate any differences between subjects during discrimination training, all the birds received discrimination training on a 1-minute schedule regardless of the reinforcement schedule previously employed during acquisition training.

The Gellerman series employed by Honig (*4*) was used to determine the order of presentation of negative and positive stimuli. The criterion for discrimination was also that established by Honig (*4*).

The mean generalization gradients for the three reinforcement groups in the first experiment are presented in Fig. 1. The differential effects of various schedules of reinforcement are most evident in the differences between the gradients which enabled predictions to be made concerning the behavior to be expected as a result of discrimination training. The gradient for the 15-second group has a steeper slope between 550 to 540 and 540 to 530 mμ than the gradient for the other two groups. This suggests that subjects trained on a 15-second acquisition schedule of reinforcement should reach the discrimination criterion more rapidly for both the 550 to 540 and 540 to 530 mμ stimuli than the other two groups. Moreover, since the slope, in terms of difference in absolute number of responses, is also greater between 550 to 540 than 540 to 530 mμ for the 15-second group, discrimination should proceed more rapidly for the group given discrimination training on 550 to 540 mμ as compared to 540 to 530 mμ.

This prediction is reversed for the 1-minute and 4-minute groups, since the slope of the gradient for these groups is steeper between 540 to 530 mμ.

An additional measure was derived from the first experiment in order to facilitate the prediction of discrimination behavior in the second experiment and provide a basis for direct statistical comparison. This consisted of the ratios of rates of responding to 540/550 mμ and 530/540 mμ ($\times$ 100) over the entire test period for the three reinforcement groups (solid curves, Fig. 2). Except for 540 to 530 mμ, 15-second group, these ratios correspond to the results suggested by the mean generalization gradient in Fig. 1.

In the second experiment, the mean number of trials required to reach the established criterion of discrimination for each group indicates that, as predicted, ease in learning the discrimination is a joint function of reinforcement schedule and the discriminative stimuli (F for interaction = 36.63, 2/30, $p <$ .01).

In addition, the analysis of simple effects indicated that for each of the reinforcement groups the 550 to 540 mμ discrimination condition took longer to learn than the 540 to 530. This finding, as well as the interaction, demonstrates that the number of trials required to reach the discrimination criterion corresponded almost exactly to the order predicted from an analysis of the mean generalization gradients in Fig. 1. The 540 to 530 mμ discrimination for the 15-second group represents the only exception to the predicted results. Discrimination learning for this group should have required a greater number of trials to reach the criterion than the 550 to 540 mμ group which has a steeper slope.

The ratios for rates of responding (540/550 and 530/540) derived from the discrimination experiment (experiment 2) were also compared to the similar ratios obtained from the generalization data. This comparison, shown in Fig. 2, indicates that the predicted results from generalization (dashed lines) correspond quite closely to those obtained from discrimination, since the F for goodness of fit (1.52, 2/30, $p >$ .20) failed to attain the expected significance level.

The results of these experiments present rather striking evidence that, at least in certain instances, the relationship between generalization and discrimination may be regarded as inverse. It also indicates the extent to which generalization can be used as a variable to predict related behavior (*5*).

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