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A PEAK SHIFT ON A LINE-TILT CONTINUUM[1]

T. M. BLOOMFIELD

UNIVERSITY OF SUSSEX, ENGLAND

Pigeons were trained to discriminate the presence or absence of a vertical line, and their performance on a subsequent generalization test was compared with that of other pigeons trained to discriminate a vertical from a 45° line. On the generalization gradient after discrimination training, the presence/absence discrimination group showed a peak at 0° (vertical) while the peak for the 0°/45° discrimination group shifted from 0° in a direction away from the 45° line. The results, discussed in connection with a recent suggestion about the role of color in the peak-shift effect, are interpreted as supporting the generality of the phenomenon.

The "peak shift" is identified as a displacement of the maximum point of the generalization gradient from the positive, reinforcement-correlated stimulus (S+) in a direction away from the negative, extinction-correlated stimulus (S−) after discrimination training. A number of experimenters have demonstrated this effect (Guttman, 1959, 1965; Hanson, 1959; Honig, Thomas, and Guttman, 1959; Honig, 1962; Pierrel and Sherman, 1960, 1962; Thomas, 1962; Terrace, 1964, 1966; Friedman and Guttman, 1965; Stevenson, 1966). All, except Pierrel and Sherman (1960, 1962), used a color dimension only, and Guttman (1965) has suggested that the peak shift may be specific to this dimension. He seems to take as evidence against the generality of the peak shift the fact that this phenomenon was not obtained in a study (Jenkins and Harrison, 1960) using an auditory continuum.

The Jenkins and Harrison (1960) procedure was to reinforce responses in the presence of a tone of a certain frequency and not to reinforce responses in its absence. Under these conditions, it is difficult to see how a shift of the peak on the generalization gradient away from the negative stimulus could be obtained, since all points on the continuum of tone frequency can be considered as equidistant from the absence of a tone. Such an assumption was used by Honig, Boneau, Burstein, and Pennypacker (1963) in measuring gradients of inhibition, as it was by Jenkins and Harrison. Hence, it appears that the lack of a peak shift after training with presence/absence of a given stimulus dimension need not preclude the development of a peak shift when differential training to two values of a stimulus continuum is given. The present experiment examined this hypothesis using orientation of a line as the dimension (Bloomfield, 1966, 1967).

METHOD

Subjects

Ten homing pigeons, locally obtained and experimentally naive at the outset, were maintained at 80 to 85% of their free-feeding body weights throughout the experiment.

Apparatus

A standard (Grason-Stadler) three-key chamber was used, with the outer keys covered and invisible to the bird. Reinforcement consisted of 4-sec access to a grain mixture through an aperture below the response key. Stimuli were projected on the reverse side of a translucent response key by In-Line Digital Display Units, and consisted of a 1/16th in.-wide dark line on an illuminated background. The lines were 1-in. long and at 12 different orientations to the vertical (0°), in 15° steps. Experimental sessions were programmed by relays, timers and steppers, and recordings were taken on

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counters and printing-counters. All controlling equipment was located in a separate room.

Procedure

The pigeons were adapted to the box and trained to eat from the feeder over the first four days. Next, with the 0° stimulus projected on the key, one day was spent shaping the key-peck, followed by one day of reinforcement for each response (60 reinforcements). Following this training, responses were reinforced on a variable-interval schedule. The mean interreinforcement interval was 1 min (VI 1-min) and the intervals were arranged according to the progression given by Hoffman and Fleshler (1962). This type of VI schedule ensures that the probability of reinforcement is roughly constant as a function of the time elapsed since reinforcement. Each VI session lasted 1 hr, during which a vertical (0°) line was projected on the key. Training on VI 1-min continued for 14 daily sessions; the last five sessions revealed no consistent increases or decreases in response rates. Then, the 10 birds were divided into two groups of five, matched for mean rate of responding at this point in the experiment.

One group received 14 days of training on a schedule which alternated 2-min periods of VI 1-min reinforcement with 2-min periods of an extinction schedule in which no responses were reinforced (*mult* VI 1-min EXT). 0° (S+) was correlated with VI 1-min and a blank, illuminated key (S−) with EXT. Then, one day of generalization testing was given, where eight blocks, each containing the 12 possible stimuli, were presented in succession. The order of stimuli in each block was randomized, and 1 sec elapsed during stimulus change. Each stimulus was present for 30 sec, and responses to each were cumulated over the session.

The second group of pigeons also received training for 14 days on the *mult* VI 1-min EXT schedule after training on VI 1-min. However, while 0° was still correlated with VI 1-min, 45° (S−) was now present during extinction periods. This stimulus was chosen in preference to an S− of 90° (horizontal), which would have made the discrimination easier; in a 0°/90° discrimination, any shift of the peak obtained in generalization testing could be interpreted as a shift toward S−. Line-tilt dimensions present problems of this sort since the same stimulus is at both ends of the dimension. The birds in the 0°/45° discrimination group received similar generalization testing to those in the 0°/absence group.

RESULTS

Two features of performance before generalization testing are worth noting. First, responding to S+ increased for both groups of birds when S− was introduced. This is the usual contrast effect (Reynolds, 1961). There were no apparent differences between the two groups in the size of the increase shown. Second, little or no responding was observed in the fixed 2-min interval when S− was present. It appeared that the fixed-interval return of S+ had not established any superstitious behavior.

Figure 1 shows the generalization performance of each of the five birds given differential training with respect to presence/absence of the 0° line. The group mean is given in the top, left-hand panel. None of the pigeons in this group shows a peak-shift effect, since in each case most responses in testing occurred to the training stimulus, 0°. This finding agrees with the results from Jenkins and Harrison (1960) on an auditory dimension.

Figure 2 gives the results from the second group of birds. Here, differential training had been given with 0° as S+ and 45° as S−. Mean performance is shown in the top, left-hand panel. In all cases, there is a shift of the maximum point of the curve from the previous S+ in a direction away from S−. For birds 08, 11, and 12 the new peak is at 15°, while for birds 07 and 10 it lies at 30°.

Figure 3 compares the total responses of both groups on one graph. The peak number of responses of the 0°/45° group is higher than that of the 0°/absence group, and the shift of the peak after differential training on 0°/45° is shown clearly.

DISCUSSION

The results support the hypothesis advanced in the introduction. Lack of a peak shift with presence/absence training does not appear to be incompatible with the appearance of a shift after training with two stimuli from the continuum. Thus, a failure to produce a peak shift after presence/absence training on a

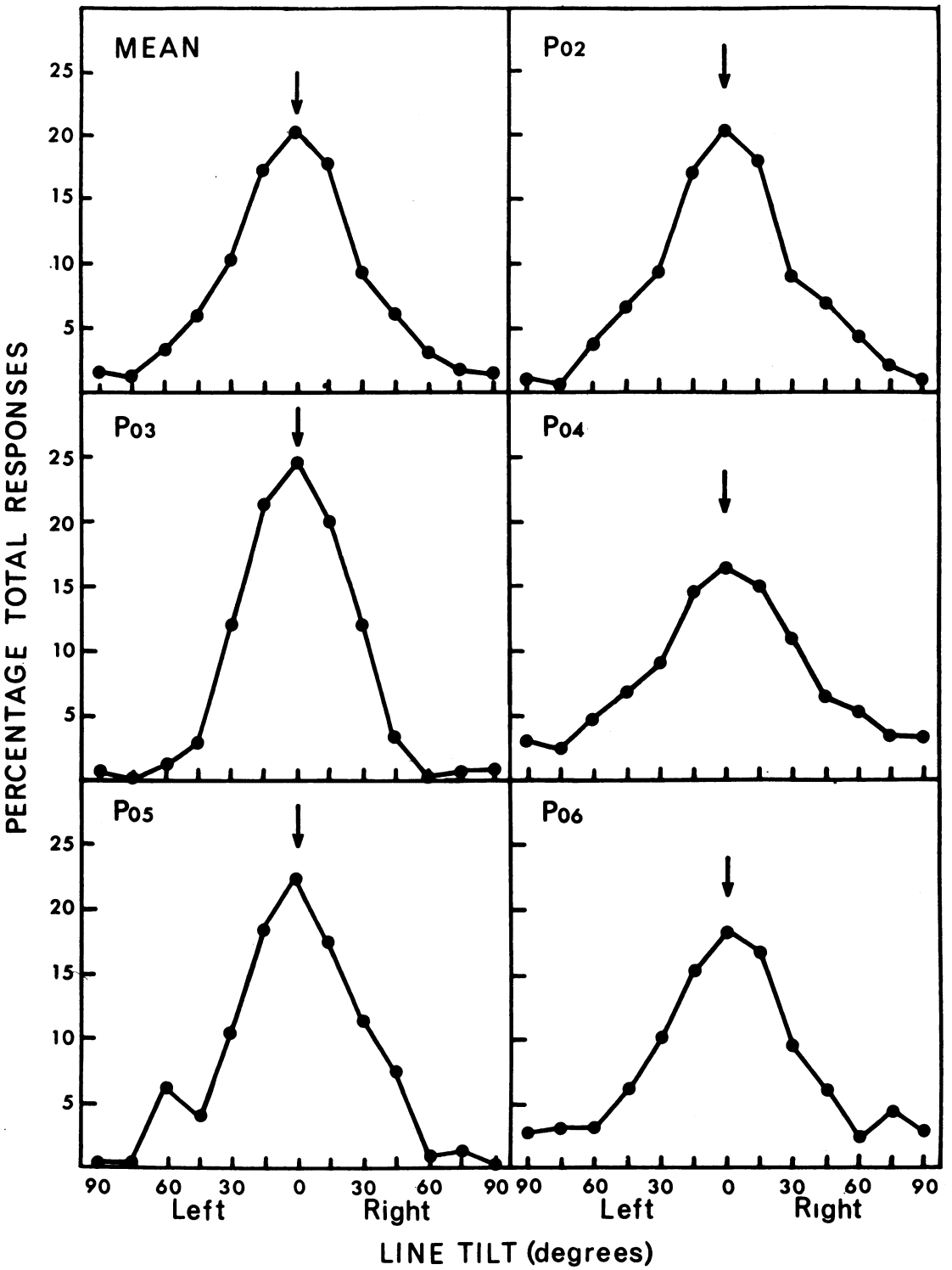

Fig. 1. Generalization gradients from five birds after discrimination training with 0° as S+ and absence of any line orientation as S−. The group mean is shown at the top left. Points are plotted as a percentage of total responses during testing. The arrow indicates the S+ point on the continuum.

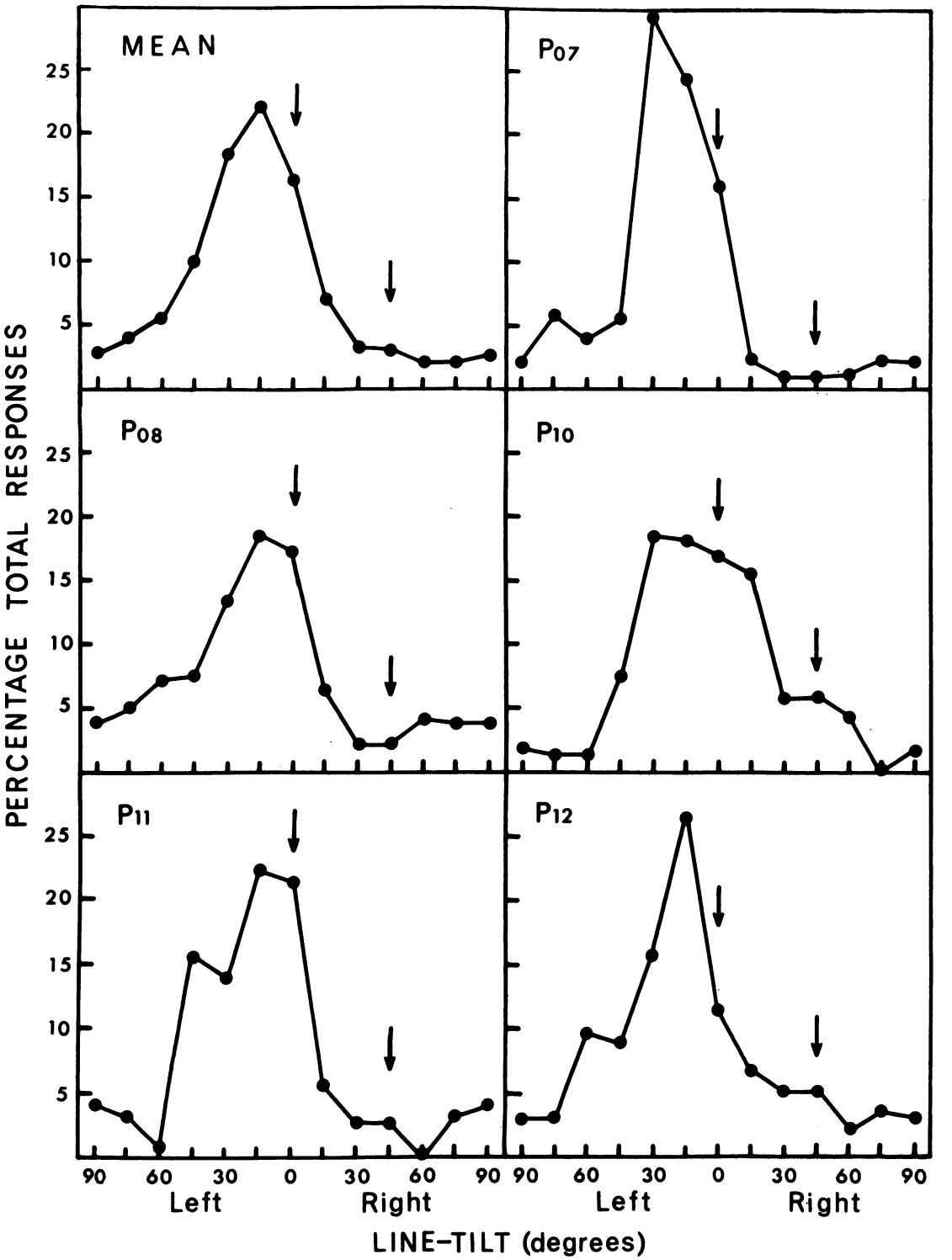

Fig. 2. Generalization gradients from five birds after discrimination training with 0° as S+ and 45° as S—. The group mean is shown at the top left. Points are plotted as in Fig. 1: as a percentage of total test responses. Arrows indicate the S+ and S— points.

given continuum does not imply that the peak-shift phenomenon cannot be demonstrated on that continuum. Further, the present results disagree with Guttman's (1965) suggestion that the peak-shift effect is restricted to a dimension of color.

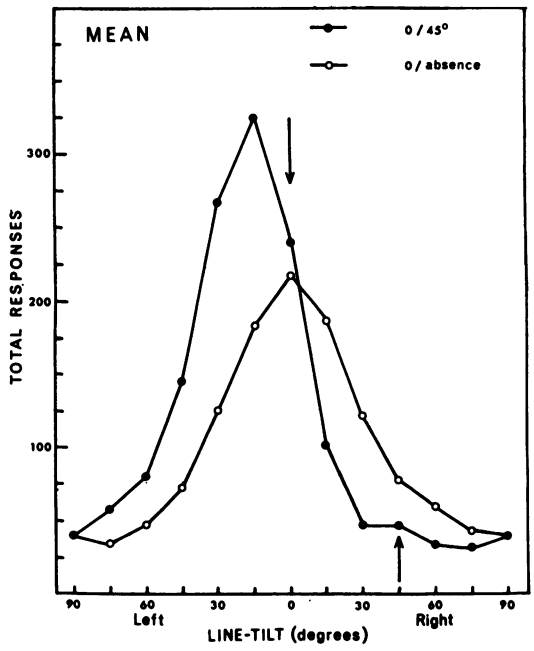

Fig. 3. Mean generalization gradients from Fig. 1 and Fig. 2 plotted for total responses to each stimulus in testing. Arrows indicate the S+ and S− points for the 0°/45° group.

Further work is needed to investigate the generality of the peak shift across sensory modalities. The present experiment, taken together with Hanson's work and the other work noted in the introduction, seems to indicate that the peak shift may occur on any visual continuum. Thus, it is difficult to accept Guttman's suggestion that complementary colors, for instance, play any specific role in peak-shift effects.

Friedman and Guttman (1965) have argued that it is possible to separate behavioral contrast from the peak shift as general and specific effects, respectively, of discrimination training. This claim seems to rest on the assumption that the peak shift, but not contrast, is dependent upon the separation of the stimuli used. The authors quote in this context Jenkins and Harrison (1960), who obtained a contrast effect but no peak shift in their experiment with a pitch continuum. However, it is possible to view the data another way. It may be argued that two variables are involved in the peak shift: the height of the peak and the extent of the shift from the S+ used in training. When no shift from S+ occurs in subsequent generalization testing, the height of the peak will be identical with the contrast effect. Under conditions where no shift in the maximum point on the gradient occurs, as in the present experiment and that of Jenkins and Harrison, a contrast effect still appears. Such conditions of presence/absence training make it impossible to specify what would constitute a shift away from S−, since S− does not lie on the stimulus dimension. The available results could thus be interpreted as showing that where a shift away from S− is possible, it occurs, together with an increase in the height of the gradient; but when such a shift is not possible, the effect of discrimination training is restricted to elevation of the gradient.

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