STUDIES ON DRIVE AND INCENTIVE IN PERCEPTION VIII

Stimulus Generalization as a Function of Drive Shift

Technical Report

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by

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A number of recent experiments examined the hypothesis that the perceived stimulus intensity ($S'$) is an increasing function of the physical stimulus intensity ($S$) and momentary drive ($D$) level (Carter & Zajonc, 1962; Dorfman, 1961; Karp, 1961; Platz & Zajonc, 1961).

This hypothesis together with the assumption that response strength is not a function of $S_H$ but $S_N$, led to implications concerning the effects of drive on stimulus generalization. It predicts, namely, that when drive level is shifted from training to testing, the resulting change in the perceived stimulus intensity ($S'$) will result in a lateral shift of the stimulus generalization gradient (Dorfman, 1961). Increased drive level was predicted to yield displacement of the gradient toward smaller stimulus intensities, and decreased drive toward greater intensities. The predicted shifts in generalization gradients along the dimension of tactual stimulation were first obtained for human $S$s (Dorfman, 1961; Karp, 1961). Tones of high and low amplitude presented contiguously with the tactual cues served to manipulate drive level. Dorfman (1961) employed a differential training procedure involving one positive and two negative stimuli. One response was reinforced to a shock stimulus of $-0.20 \log ma$ and another response to one of lower ($-0.38 \log ma$) and one of higher ($-0.02 \log ma$) intensity. In testing, drive level was increased for one group of $S$s and decreased for another, and responses to the three training stimuli and four others, of intermediate intensities, were observed. The predicted shifts were obtained. Karp (1961), using the same stimuli and the same drive manipulation, but training $S$s only to the middle stimulus ($-0.20 \log ma$),
obtained substantially the same results. Platz and Zajonc (1961) observed
the predicted shifts in generalization gradients along the loudness
dimension using conditioned fear to manipulate drive, and Carter and Zajonc
(1962), along the loudness dimension using shock to manipulate drive. In
the latter experiments, which employed animal Ss (pigeons), generalization
shifts were observed only for the first trial.

The present experiment also utilizes pigeons to test the above
implication of the drive-stimulus interaction hypothesis. However, a
primary drive whose $S_D$ is more diffuse, namely hunger, is employed
and responses to differing sizes of circles are observed.

Method

Subjects

Twelve male, White Carneaux pigeons were used as subjects. They were
deprived of food until their body weights were 80% of their free-feeding
level.

Apparatus

A conventional experimental chamber for pigeons (Grayson-Stadler,
Elll00PB) was used. It was modified by mounting a small strip-film
projector on its side so that the stimulus (the only source of light in
the chamber) could be focused on the pecking key. Seven stimuli were
employed during the course of the experiment. These consisted of white
circular spots on black backgrounds photographed and copied on 35 mm high
contrast copy film. The stimuli, as projected onto the back of the pecking
key, ranged in size (in two-millimeter steps) from four to 16 mm in
diameter.
Procedure

All Ss were magazine trained and conditioned to key peck with the key continuously illuminated by a 10 mm diameter spot of light. After one session during which 50 continuous reinforcements were provided, the pigeons were divided equally into two groups: Group I Ss were raised to 90% of their free-feeding body weight and Group II Ss were dropped to 70% of their free-feeding level. Controlled feeding, during all of the training sessions that followed, maintained the body weight of each S within 5 grams of that established. All Ss received 60 minutes of FI 15-second training to the same stimulus (S^D: 10 mm spot) consisting of 100 15-second work periods separated by 15-second blackouts. Reinforcement consisted of access to the food magazine for 5 seconds. All Ss were then given nine daily sessions of discrimination training during which each of three stimuli, (the initial S^D and two S^A's: 4 and 16 mm spots) were presented 16 times in random sequence for 15-second periods separated by 15-second blackouts. S^D responding was reinforced at the end of each presentation period with 15 seconds access to the food magazine, and S^A responding was extinguished. The Ss were run in matched pairs: one S from each group. Each pair was run at the same time every alternate day. Following the last day of discrimination training each S was shifted in body weight; Group I Ss were shifted to 70% of their free-feeding level and Group II Ss were shifted to 90% of their free-feeding level. Three to four weeks were permitted to elapse between training and testing for each pair until the new levels were stabilized. Generalization testing consisted of repeated presentation of five stimuli (6, 8, 10, 12, and 14 mm spots) under extinction conditions. The initial S^A's were omitted. Each stimulus was presented 10 times for 15 seconds according to a predetermined schedule of random permutations of the five stimuli.
Fifteen-second blackouts separated each presentation. Each S of a given pair received the same random sequence of trials but different random sequences were used for different pairs. Three daily test sessions were given. At the end of each session $S^D$ was presented briefly (5 secs.) and responding was reinforced. Following these testing sessions, body weights were again shifted to the level previously established for discrimination training and one additional session of generalization testing was given. Thus Group I received training under low drive conditions and generalization testing under high drive conditions, followed by further testing under low drive. Group II received identical treatment under high drive, low drive, and again high drive.

Results

Figure 1 shows the effects of stimulus size and drive level on response frequency during each of three consecutive days of generalization testing. The Group I curves represent total responding to each stimulus value for all of six birds trained under low drive and tested under high drive conditions. Although all birds in Group II (trained under high and tested under low drive) were given three days of testing, some failed to perform after the first or second day. Thus, the Group II curves represent response totals for six, three, and two Ss for Days 1, 2, and 3 respectively. It can be seen that the shape of the generalization curves for each group remained stable over test sessions. It can be seen that for birds for whom drive was increased during testing, stimuli 12 and $\frac{14}{2}$ mm in diameter are associated with a higher response rate than stimuli 6 and 8 mm in diameter. For birds trained under high and tested under low drive, the converse is true.

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1 We wish to express our gratitude to Mr. David Carter who assisted with the tabulation and analysis of the results.
Fig. 1: Stimulus generalization gradients in terms of absolute response rate for three consecutive days following the first drive level shift.
An analysis of variance of these response measures showed that both main effects, stimulus size (F = 30.342, p < .001 for 5 and 50 df) and drive level (F = 58.048, p < .001 for 1 and 50 df), were significant as was the effect due to their interaction (F = 4.511, p < .01 for 4 and 50 df). These results are reported primarily to establish the fact that drive had a significant effect on overall rate of responding. Our chief interest, however, is in the interaction effect as manifested in the between group differences in generalization functions.

Normalizing the above response measures relative to total responding for each S removes the effect of the drive on the overall response rate and minimizes the contribution to the interaction effect of between group differences in symmetric components of trend. The generalization functions relating proportion of total responses to stimulus size for the two groups are shown in Figure 2. Analysis based on these proportions provides a better test of our hypothesis which was concerned with drive-produced directional asymmetries in the generalization functions. An orthogonal polynomial trend analysis was performed. The results are summarized in Table 1. A significant interaction effect was obtained (F = 6.302, p < .001) owing to differences in the asymmetric (linear and cubic) components of the two generalization functions. These differences are exhibited in Figure 2 in the relative displacement to the right in the Group I gradients and to the left in the Group II gradients.

The results for individual Ss are shown in Figure 3. The generalization curve obtained from each S is compared with that of the S with which it was paired in the experimental treatment. The response measures were normalized relative to the total number of responses emitted by each S.
Table 1
Summary of Analysis of Variance for Data in Figure 2

<table>
<thead>
<tr>
<th>Source</th>
<th>d.f.</th>
<th>M.S.</th>
<th>Error Term (Row)</th>
<th>F</th>
</tr>
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<tr>
<td>A. Stimulus Effect</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Linear</td>
<td>1</td>
<td>1,197.01</td>
<td>E.1</td>
<td>.46</td>
</tr>
<tr>
<td>2. Quadratic</td>
<td>1</td>
<td>781,053.65</td>
<td>E.2</td>
<td>41.77***</td>
</tr>
<tr>
<td>3. Cubic</td>
<td>1</td>
<td>6,931.20</td>
<td>E.3</td>
<td>2.55</td>
</tr>
<tr>
<td>4. Quartic</td>
<td>1</td>
<td>17,281.07</td>
<td>E.4</td>
<td>6.58*</td>
</tr>
<tr>
<td>B. Between Group Means (Drive Effect)</td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Between Group Trends (Drive Effect x Stimulus Effect)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Linear</td>
<td>1</td>
<td>18,775.00</td>
<td>E.1</td>
<td>7.27*</td>
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<tr>
<td>2. Quadratic</td>
<td>1</td>
<td>3,146.05</td>
<td>E.2</td>
<td>1.68</td>
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<td>34,408.50</td>
<td>E.3</td>
<td>12.65**</td>
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<td>1</td>
<td>2,786.70</td>
<td>E.4</td>
<td>1.06</td>
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<td>D. Between Individual Means (Response Rate)</td>
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<td></td>
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<tr>
<td>E. Between Individual Trends</td>
<td>(40)</td>
<td>(2,449.97)</td>
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<td></td>
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<td>10</td>
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</tr>
<tr>
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<td>1,869.76</td>
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<td>3. Cubic</td>
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</tr>
<tr>
<td>4. Quartic</td>
<td>10</td>
<td>2,626.43</td>
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</table>

* Significant at the .05 level
** Significant at the .01 level
*** Significant at the .001 level
Fig. 2: Stimulus generalization gradients in terms of percentage of total responses following the first drive level shift.
The interaction effect is exhibited in the generalization behavior of all pairs of Ss. There is a modal shift for one bird trained under low and tested under high drive and for two birds, in the opposite direction, which were trained under high and tested under low drive. The gradients of birds tested under low drive are somewhat steeper than those for birds tested under high drive, a finding consistent with the results obtained by Thomas and King (1959).

When the Ss were shifted back to the body weight at which they were initially trained and then retested for generalization, a tendency to reverse the initial pattern of behavior was observed. The dashed curves in Figure 4 represent the results for four Ss in Group I and 5 Ss in Group II. Three Ss failed to perform to a criterion of the total omission of at least 500 responses during the session, thus were not included. The curves shown represent an average total number of responses for each S of 1512 for Group I and 1830 for Group II. The solid curves are the same as those in Figure 2. They are presented again for comparison. The trends are clearly reversed for Group II. The results for Group I are less clear. Considering that two months time elapsed since the last day of training and that these birds were tested under low drive conditions subsequent to three days of extinction under high drive, it is understandable that their behavior would exhibit noticeable variability. In fact, the generalization functions were displaced to the left for two Ss and to the right for the other two. The displacement of the gradients as a result of drive shift is clearly seen when we compare normalized response rates to stimuli 6 and 8 mm in diameter with those to stimuli 12 and 14 mm in diameter. The percentage of total responses (excluding those emitted to the middle stimulus, 10 mm) is shown in Table 2. It is seen that whenever drive
Fig. 3: Stimulus generalization gradients in terms of percentage of total responses following the first drive level shift for individual matched Ss pairs.
Fig. 4: Stimulus generalization gradients in terms of percentage of total responses following the first and second drive shifts.
is increased the response rate to the two smallest stimuli is less than that to the two largest stimuli. This is true for the first test in Group I and retest in Group II. A decrease in drive, on the other hand,

Table 2
Mean Percent of Response to the Left and Right Wings of Generalization Gradients

<table>
<thead>
<tr>
<th></th>
<th>Group I</th>
<th>Group II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Test High</td>
<td>Test Low</td>
</tr>
<tr>
<td></td>
<td>Drive</td>
<td>Drive</td>
</tr>
<tr>
<td>Left</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Stimuli 6 &amp; 8 mm)</td>
<td>41.5</td>
<td>44.1</td>
</tr>
<tr>
<td>Right</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Stimuli 12 &amp; 14 mm)</td>
<td>58.5</td>
<td>55.9</td>
</tr>
</tbody>
</table>

leads to an increased response rate to the two smallest and decreased response rate to the two largest stimuli (Group II). In Group I, however, while the response rate to the smallest stimuli is higher and to the largest is lower on retest than it was on the first test, the second shift is quite weak.

Discussion

It is clear from the results that a displacement of the gradients occurred as a consequence of drive shift. However, in contrast to previous studies, increase in drive level produced shifts of the generalization gradients toward stimuli of greater intensities, and decrease in drive toward stimuli of smaller intensities. Thus, on the one hand the obtained shifts support the hypothesis that drive influences the perceived intensities of stimuli, but on the other that the function relating $S'$ to $D$ and $S$ may not be an increasing one for all drives and all stimuli. While the exact
nature of this function may be questioned on the basis of the present experiment alone, the hypothesis cannot be arbitrarily rejected or modified. The major difference between the present experiment and those cited in the introduction lies in the time interval between training and testing. In the present experiment at least three weeks separated training from testing, in the former tests were run immediately after the completion of the training. It is not clear what happens to the habits of the organism under a prolonged state of drive. If there is a gradual adaptation to the gradually changing perceived stimulus intensities, a possibility may exist that the birds overcompensate upon repeated contact with the original stimuli.

It is of interest to compare the present results to those obtained by Thomas and King (1959). These authors also examined the effect of drive shift on stimulus generalization. As in the present experiment, hunger served to manipulate drive level, and pigeons served as Ss. However, the stimulus dimension used was wavelength. While Thomas and King found vertical displacement of the gradients as a function of drive shift, the examination of their results does not suggest that a lateral displacement occurred. The hypothesis examined here relates drive to stimulus intensity. If one coordinates stimulus intensity to the amount of neural firing and stimulus quality to the localization of the firing, it is possible to interpret the drive-stimulus interaction hypothesis to mean that increased firing in some assemblies may interact with the activity in others such that the activity of other assemblies is heightened. Such an interaction might lead to distortions in perceived stimulus magnitudes, but would be less likely to produce distortions in perceived qualities, unless the two are highly correlated. In an experiment by Matlin (1960) in which dynamometer tension served to manipulate drive and generalization to pitch was observed, also no shift in the gradients occurred as a result of change in drive level.
References


Thomas, D. R., & King, R. A. Stimulus generalization as a function of level of motivation. J. exp. Psychol., 1959, 57, 323-328.