ABSOLUTE AND RELATIVE MEASURES OF DIMENSIONAL CONTRAST

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Two sets of experiments examined the discriminative performance of pigeons on a visual flicker-rate continuum using a maintained generalization procedure. In the first experiment, responses during the intermediate stimulus value were not reinforced, whereas responses during all other stimuli were reinforced periodically. In the second experiment, training was similar to the first, with the exception of one condition in which stimuli adjacent to the negative stimulus border were eliminated from the discrimination set. Results from both experiments show that positive dimensional contrast seems to represent a relative enhancement of discrimination gradient form, rather than an absolute increase in responding with respect to prior baseline. Further, the form and magnitude of positive dimensional contrast are not predictable from the form and magnitude of baseline response rates. Results from the second experiment indicate that eliminating border stimuli increased response-rate differences between positive and negative stimuli, but did not necessarily diminish the magnitude of positive dimensional contrast.

Key words: dimensional contrast, maintained generalization, flicker rate, key peck, pigeons

One of the most historically important methods in the study of dimensional stimulus control is the transient generalization testing technique pioneered by Guttman and Kalish (e.g., Guttman & Kalish, 1956; see also Honig & Urcuioli, 1981). This method determines stimulus control by a transient test of probe stimulus values during extinction. Although the method is called a generalization testing technique, it has been used more often to measure discrimination after pretraining with various conditions of reinforcement. For instance, one of the first uses of the transient technique was to test the Hull-Spence model of discrimination (e.g., Kalish & Guttman, 1957, 1959). Studies using this method have revealed interesting and counterintuitive findings in the postdiscrimination gradient, such as peak shift (e.g., Guttman, 1965; Hanson, 1959).

More recently, workers in the area of stimulus control have tried to make discrimination an explicit, rather than implicit, feature of their methods. In particular, use of the Guttman and Kalish technique has been supplemented

with a continual training procedure called the maintained generalization technique (e.g., Malone & Staddon, 1973; Pierrel, 1958). Although this procedure is also called a generalization technique, it really involves nothing more than the continual, successive presentation of stimulus values to be discriminated. Because the schedules of reinforcement associated with stimuli are held constant across many sessions, acquisition and maintenance of discrimination can be more readily observed (D. S. Blough, 1975; Hinson & Malone, 1980), and like the Guttman and Kalish technique, the maintained generalization technique has produced some robust and unexpected findings, including dimensional contrast (D. S. Blough, 1975; Reynolds, 1961b).

Dimensional contrast refers to enhancement or depression of response rates in certain regions of stimulus control gradients, despite equivalent conditions of reinforcement. For example, consider a maintained generalization procedure that employs several adjacent positive (S+) and negative (S-) stimuli, represented in Figure 1. Positive dimensional contrast occurs when response rate is higher during S+ values at an intermediate, rather than the most extreme, distance from S- along the stimulus continuum (i.e., at Stimulus 19). Similarly, negative dimensional contrast occurs when response rate is lower during S- values at an intermediate distance from S+

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Fig. 1. Hypothetical maintained generalization gradient showing dimensional contrast. Stimulus values to the left of the vertical line are S $-$, and stimulus values to the right of the line are S $+$.

along the continuum (i.e., at Stimulus 7) (for additional examples see D. S. Blough, 1975, 1983).

Previous research has noted points of similarity between dimensional contrast and peak shift (e.g., D. S. Blough, 1975). For example, both effects may represent large shifts in responding as a result of discrimination training (D. S. Blough, 1975; Hanson, 1959). These effects are limited neither to a single stimulus continuum nor to certain types of reinforcement schedules (P. M. Blough, 1980; Catania & Gill, 1964; Malone, 1975). Moreover, both effects appear in positive and negative form (Guttman, 1965; Hinson & Malone, 1980). Finally, an important fact that is sometimes overlooked is that both effects occur in cases in which S $+$ and S $-$ are defined in terms of relative rates of reinforcement, rather than the absolute presence or absence of reinforcement (e.g., D. S. Blough, 1975; Guttman, 1965).

Theories which have been adapted to explain peak shift (e.g., the interacting gradient model of Spence [1937], or the signal-detection model of Boneau & Cole [1967]), fare less well in explaining dimensional contrast. For example, positive dimensional contrast can be observed when a single S $-$ value, along a unidimensional continuum, is bordered on both

sides by S $+$ values. The interacting gradient model predicts a monotonically increasing discrimination gradient as a function of distance from S $-$ along the continuum. In a similar fashion, the detection model predicts that judgment criteria should be placed somewhere in the region of overlap between S $-$ and S $+$. Depending on the stringency of the criterion, judgment preference should be displaced away from S $-$ in both directions, again monotonically increasing with distance from S $-$ along the continuum. For both accounts, responding should be highest for S $+$ maximally dissimilar from S $-$. In fact, actual response rate is usually highest during S $+$ values at an intermediate distance from S $-$ (D. S. Blough, 1983).

As an alternative to traditional theories of stimulus control, D. S. Blough (1975, 1983) has proposed a model called the incremental model, which is designed specifically to account for dimensional contrast, and which also predicts peak shift. This model should be taken seriously, because it has been the only serious attempt to provide a formal account of dimensional contrast. The incremental model combines in a novel fashion aspects of previous behavioral theories. For example, the model assumes that presentations of stimuli activate sets of elements that are shared by stimuli lying close to one another on the stimulus continuum, a time-honored explanation of similarity (e.g., Konorski, 1948). And the model incorporates an incremental growth function comparable to that of Rescorla and Wagner's (1972) model of Pavlovian conditioning, which describes changes in response strength for each set of elements with variations in reinforcement.

Part of the problem in explaining dimensional contrast lies in properly defining the effect. Before evaluating or adopting any model of discrimination performance, the defining properties of dimensional contrast need to be better understood. The description of dimensional contrast offered earlier (viz., enhancements or depressions in stimulus discrimination gradients) is convenient, but inadequate for theoretical purposes. Perhaps the most generally accurate definition is that dimensional contrast is a violation of the expected monotonic relationship between stimulus difference and stimulus discrimination measures.

Taking this definition as a first approximation, it is reasonable to ask if outcomes usu-

ally observed during dimensional discrimination are necessarily related to the occurrence of dimensional contrast. For example, does positive dimensional contrast always represent an absolute response increase over prior baseline responding? Must a decrease in S- responding, below prior baseline, occur concomitantly with S+ response-rate increases? Do factors that increase the overall difference between S- and S+ response rates affect the form or magnitude of positive dimensional contrast effects? The present experiments address these questions by examining absolute and relative measures of positive dimensional contrast. Absolute measures consider the form of the discrimination gradient with respect to prior baseline responding, whereas relative measures consider gradient form with respect to total responding within a discrimination condition. The first experiment examined changes in the form and magnitude of positive dimensional contrast with changes in the form and magnitude of baseline responding across replications. In the second experiment, variation in the form and magnitude of dimensional contrast was assessed when the separation between S+ and S- along the stimulus continuum differed.

EXPERIMENT 1

METHOD

Subjects

Four male homing pigeons served as subjects. All subjects had previously served in experiments using concurrent variable-interval schedules, although none had had previous experience with successive discrimination procedures. The subjects were maintained at 80% of their laboratory free-feeding weights. Because 1 subject was unable to discriminate S- from S+, its data are excluded.

Apparatus

Experiments were carried out in a standard Plexiglas and aluminum operant conditioning chamber. The internal dimensions of the chamber were 30 cm by 30 cm by 32 cm. A Gerbrands translucent pecking key, 2 cm in diameter, was affixed to the center of the front wall about 27 cm above the floor. A 6-W houselight provided diffuse illumination throughout the chamber during experimental

sessions. A 5 cm by 4 cm aperture, 15 cm below the key, provided access to a food magazine. Mixed grain presented for 3 s was used as a reinforcer. The experimental chamber was housed in a larger sound-attenuating box that contained a fan for ventilation and masking of extraneous noise. Experimental events and data collection were controlled by a microcomputer in an adjacent room.

Procedure

Subjects were exposed to a 13-stimulus maintained generalization procedure. The stimuli were rates of flicker of a yellow flashing light-emitting diode (LED), with peak wavelength of 580 nm. The luminance of the steady LED was 10 cd/m². Duty cycle of the flickering LED was equal on and off. The frequencies of the 13 stimulus values were 6.3, 6.7, 7.1, 7.7, 8.3, 9.1, 10, 11.1, 12.5, 14.3, 16.7, 20, and 25 Hz.

Preliminary work with other pigeons in this apparatus and other assessments (Graf, 1973) were used to select stimulus values. Like people, pigeons are probably most sensitive to flicker rates within the 10 to 30 Hz range. Although sensitivity seems to drop off at the extremes, pigeons seem to have a much higher critical fusion frequency than people over conventional photopic luminance levels (e.g., Emmerton, 1983). Stimulus values used in this experiment were intended to provide one set of more highly discriminable S+ stimuli, those above S-, and one set of less discriminable S+ stimuli, those below S-. Exact knowledge of the discriminability function for this stimulus continuum is not available. Because the interpretation of dimensional contrast relies only on the assumption of ordinality of stimulus and response scales, no attempt was made to equalize discriminability steps between stimulus values.

During baseline conditions, responses during all stimuli were reinforced according to constant probability variable-interval 60-s schedules (VI 60 s). During other conditions, the intermediate stimulus value (10 Hz) was designated S-, and responses during its presentations were never reinforced (EXT). All other stimulus values were designated S+, and responses during these stimuli were reinforced according to a VI 60-s schedule.

A single session consisted of 170 30-s stimulus presentations. The stimulus sequence was

changed every day, but the stimuli were ordered such that after the first stimulus component, each stimulus preceded and followed every other stimulus, including itself, equally often. The order of conditions and number of sessions in each condition was as follows: Baseline 1, VI 60 s all stimuli, 28 sessions; Condition 1, EXT during Stimulus 7, 32 sessions; Baseline 2, VI 60 s all stimuli, 29 sessions; and Condition 2, EXT during Stimulus 7, 30 sessions.

RESULTS

Figure 2 shows maintained generalization gradients for Birds 51, 52, and 38. The empirical gradients are three-session averages for the last sessions of Baseline 1 and representative periods of Condition 1. These representative sessions are included to show the progressive development of discrimination during the course of learning. The gradient for Baseline 1 appears in each panel as a solid line, and the gradient for the sample period of Condition 1 is represented by open circles. All gradients are plotted in terms of responses per minute.

Mean response rate during the early period of Condition 1 is considerably higher than the Baseline 1 rate for Birds 38 and 51, whereas response rate for Bird 52 shows little change. The elevation in response rate for Birds 38 and 51 occurred before the appearance of dimensional contrast. For example, gradients for Birds 38 and 51 look more or less like a V-shaped gradient about S-. Responding is more erratic, and not clearly different from Baseline 1, for Bird 52. This period was selected because the gradient form was as close to a V-shape as occurred during Condition 1.

The middle period panel in Figure 2 shows gradients at a later stage of training in which positive dimensional contrast is more clearly evident. That is, response rates during S+ do not increase uniformly with distance from S-. Instead, peaks appear toward the high end of the continuum at Stimulus 11 or 12. On the low end of the continuum, gradient form is less consistent across subjects, but peaks appear at

Stimulus 2 for Bird 51, Stimuli 1 and 4 for Bird 52, and Stimulus 3 for Bird 38. In general, the gradient form is more nearly an M-shape instead of a V-shape.

By the late period shown in Figure 2, an M-shaped gradient around S- is more evident in both form and magnitude. The peak on the high frequency side of the gradient is larger for Bird 51, whereas high and low peaks are closer to equal in size for Birds 52 and 38. In all cases, response rates during the late period of Condition 1 were equal to, or greater than, response rates during Baseline 1.

The usual result of discrimination procedures like the one in Condition 1 is to reduce responding during EXT stimuli and to increase responding during unchanged VI stimuli, that is, positive behavioral contrast (Reynolds, 1961a). Because Condition 1 was the first exposure of the birds to successive discrimination procedures, it may be that the original baseline does not accurately reflect actual baseline response levels after a change in reinforcement context. This fluctuation may have masked the assessment of behavioral contrast.

To check this possibility, birds were exposed to Baseline 2 and then to Condition 2, which was simply a replication of the prior baseline and experimental conditions. Figure 3 shows the results from Baseline 2 and Condition 2. Maintained gradients for individual birds representing three-session averages are shown for the final sessions of Baseline 2 and for three representative periods during training for Condition 2.

Figure 3 shows that Baseline 2 response rates varied over a range of approximately 10 responses per minute for Birds 52 and 38, whereas response rates for Bird 51 reflected experience with the prior discrimination condition by being lower in the region of the former S- value. Mean Baseline 2 response rate during all stimuli increased from about 10 to 20 responses per minute for all birds, compared with Baseline 1 rates. Nevertheless, the general pattern of results in Condition 2 was similar to that obtained in Condition 1. During the early period of Condition 2, response rates

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Fig. 2. Maintained generalization gradients for Birds 51, 52, and 38 averaged over three sessions from Experiment 1. The solid curve represents the last three sessions of Baseline 1. The curve with open circles represents three-session averages from different periods during Condition 1 (Early, Sessions 6 through 8; Middle, Sessions 17 through 19; and Late, Sessions 30 through 32).

Fig. 4. Maintained generalization gradients for Birds 51, 52, and 38 averaged over three sessions of Conditions 1 and 2 from Experiment 1. The solid curve represents the last three sessions of Condition 1. The curve with open circles represents the last three sessions from Condition 2.

during all stimuli were evaluated above Baseline 2 for all birds. Figure 3 also shows that after the appearance of the M-shaped gradient form during the middle period, response rates during all stimuli were still elevated above Baseline 2 response rates. This was true even for Bird 51, which had the least uniform baseline gradient. Finally, during the late period of Condition 2, mean response rates declined somewhat for all birds. The M-shaped gradient form persisted during this period.

Changes in baseline responding between Conditions 1 and 2, and changes in the mean response rate during Conditions 1 and 2, had little impact on overall gradient form. Figure 4 provides a comparison of final empirical gradients in Conditions 1 and 2. Gradients are plotted in terms of relative response rate, with respect to maximum rate during each condition. Although the exact shape of the empirical gradient varied from session to session, Figure 4 shows good agreement in the overall M-shaped form. The greatest differences appear in the low-end peak for Bird 52 and the middle region for Bird 51. In general, during

discrimination conditions the relative response profile was largely independent of the form of prior baseline responding or absolute response rate.

DISCUSSION

The results from Experiment 1 show that reliable positive dimensional contrast effects can be produced with a flicker-rate discrimination procedure. This adds to reports of dimensional contrast using other continua (cf. P. M. Blough, 1980). In addition, two important findings emerged. First, positive dimensional contrast did not seem to be related in any important way to the pattern of previous baseline responding. That is, despite impressive differences in baseline profiles among individual subjects and changes in these profiles across conditions, the form and magnitude of dimensional contrast (as shown in the relative plots of Figure 4) were remarkably consistent. Second, there were no important changes in discrimination gradient form across replication conditions, even though absolute response rates fluctuated dramatically in some cases. In

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Fig. 3. Maintained generalization gradients for Birds 51, 52, and 38 averaged over three sessions from Experiment 1. The solid curve represents the last three sessions of Baseline 2. The curve with open circles represents three-session averages from different periods during Condition 2 (Early, Sessions 4 through 6; Middle, Sessions 16 through 18; and Late, Sessions 28 through 30).

general, these findings indicate that dimensional contrast may be best defined in terms of *relative* changes in discrimination gradient form, rather than in terms of *absolute* deviations from baseline.

Ordinarily, changes in relative reinforcement frequency would be expected to produce negative baseline deviations for S- and positive baseline deviations for S+ (i.e., positive behavioral contrast; Reynolds, 1961a). Nonetheless, this pattern did not occur consistently in Experiment 1, even though positive dimensional contrast was evident throughout. In Experiment 2 we attempted to produce more consistent positive and negative deviations from baseline responding during discrimination conditions and to assess the effects of these changes on the form and magnitude of positive dimensional contrast. Specifically, a comparison was made between conditions with and without S+ stimuli adjacent to S-. Removal of adjacent S+ stimuli was intended to increase overall discrimination between S+ and S- and thereby produce more characteristic deviations from baseline response rate during S+ and S-.

EXPERIMENT 2

METHOD

Subjects and Apparatus

Four male homing pigeons served as subjects. All subjects were experimentally naive prior to the present experiment and were maintained at 80% of their laboratory free-feeding weights. Experiments were conducted in the apparatus described for Experiment 1.

Procedure

Subjects were exposed to a 25-stimulus maintained generalization procedure, using the stimulus display described in Experiment 1. The frequencies of the 25 stimulus values were 5.6, 5.8, 6, 6.3, 6.5, 6.8, 7.1, 7.4, 7.7, 8.1, 8.5, 8.9, 9.4, 10, 10.6, 11.4, 12.2, 13.2, 14.3, 15.6, 17.2, 19.2, 21.7, 25, and 29.4 Hz. As in Experiment 1, the values used were designed to provide one set of more highly discriminable S+ stimuli, those above S-, and one set of less discriminable S+ stimuli, those below S-.

After initial magazine training and auto-shaping in the chamber, subjects were exposed to five consecutive sessions in which the VI

reinforcement rate for responses during flickering stimuli increased from an initial value of VI 15 s to VI 60 s. The experiment proper began after this training. During baseline, responses under all stimuli were reinforced according to a VI 60-s schedule. During Condition 1, the intermediate stimulus value (9.4 Hz) was designated S- and EXT was its associated schedule. All other stimuli were designated S+ and VI 60 s was their associated schedule. Condition 2 was similar to Condition 1 except that the two S+ values on either side of S- (Stimuli 11, 12, 14, and 15) were eliminated from the discrimination task. Thus, compared with Condition 1, during Condition 2 total session time decreased, and the amount of exposure to each stimulus remained constant. To control for order of the discrimination conditions, Birds 55 and 56 received exposure to Condition 1 followed by Condition 2; Birds 57 and 58 were exposed to the opposite order.

A single session consisted of 125 30-s stimulus presentations in Condition 1 and 105 30-s stimulus presentations in Condition 2. The stimulus sequence was based on a pseudo-random sequence and changed every day. The order of conditions and number of sessions in each condition were as follows:

(a) Birds 55 and 56: Baseline 1, VI 60 s all stimuli, 28 sessions; Condition 1, EXT during Stimulus 13, 28 sessions; Condition 2, EXT during Stimulus 13, 28 sessions (Stimuli 11, 12, 14, 15 were omitted).

(b) Birds 57 and 58: Baseline 1, VI 60 s all stimuli, 28 sessions; Condition 2, EXT during Stimulus 13, 28 sessions (Stimuli 11, 12, 14, 15 were omitted); Condition 1, EXT during Stimulus 13, 28 sessions.

RESULTS

Figure 5 illustrates the maintained generalization gradients averaged across the last four sessions of each condition for individual subjects. The profile for baseline differed among subjects. For 3 of 4 birds, there was a tendency to respond at a higher rate during higher frequency stimuli. For Bird 55 response rate was fairly uniform except for a decrease during the highest frequency stimulus.

For all subjects, overall response rates were higher during the discrimination condition to which they were initially exposed. That is, response rate was higher in Condition 1 for

Fig. 5. Maintained generalization gradients for Birds 55, 56, 57, and 58 averaged over the last four sessions (Sessions 25 through 28) of baseline, Condition 1, and Condition 2 from Experiment 2. The solid curve represents baseline, the curve with open circles represents Condition 1, and the curve with asterisks represents Condition 2.

Birds 55 and 56, whereas it was higher in Condition 2 for Birds 57 and 58. During Condition 1, all subjects showed a prominent peak on the high end of the gradient (in the region of Stimulus 20 to Stimulus 22). Small but consistent peaks appeared on the low end of the gradient (in the region of Stimulus 5 to Stimulus 7). Apart from the differences in magnitude of dimensional contrast on the two sides of S^- , the pattern clearly does not monotonically increase away from S^- .

Removal of $S+$ adjacent to S^- did not eliminate dimensional contrast. In fact, for 3 of 4 subjects the symmetry of the M-shaped gradient seems to be increased. For Birds 55 and

56, responding during Condition 2 was near or lower than baseline, while at the same time prominent peaks are visible on either side of S^- . Bird 57 showed peaks in $S+$ responding on either side of S^- , even though total responding was higher than baseline. The pattern for Bird 58 is similar to that for Bird 57, but not quite as clear. One complicating factor is the large upturn in response rate seen at the low end of the continuum. This may be a more extreme form of the upturn observed in Condition 2 for Bird 55.

A direct comparison of gradients for all birds in Conditions 1 and 2 is made in Figure 6, which illustrates mean relative response-rate

Fig. 6. Maintained generalization gradients for Birds 55, 56, 57, and 58 averaged over the last four sessions (Sessions 25 through 28) of baseline, Condition 1, and Condition 2 from Experiment 2. The curve with open circles represents Condition 1, and the curve with asterisks represents Condition 2.

gradients for the last four sessions of each condition for each bird (i.e., the same gradients seen in absolute terms in Figure 5). In 3 of 4 subjects, the relative difference between maximum S+ and S- response rates was greatest in Condition 2. For all birds, the relative difference between S- and nearest S+ values was also greatest in Condition 2. Positive dimensional contrast on the lower frequency side of S- seems to be enhanced for Birds 55, 56, and 57; for Bird 58 the difference between relative gradient forms is not as clear. The only obvious diminution in dimensional contrast appears on the higher side of the gradient for Bird 57. In general, Figure 6 shows that the

symmetry of positive dimensional contrast was increased in Condition 2.

GENERAL DISCUSSION

These studies show that bimodal positive dimensional contrast effects can be obtained with a visual flicker-rate discrimination task. This result, combined with evidence from other studies of stimulus continua, increases the likelihood that dimensional contrast is a general property of unidimensional successive discrimination performance (cf. D. S. Blough, 1983).

An important finding of the present experiments is that dimensional contrast can be dis-

sociated from baseline response rate. Results from Conditions 1 and 2 of Experiment 1 showed dimensional contrast effects when S- response rate was equivalent or greater than prior baseline rate. Also, the bimodal gradient form was obtained when response rate during all stimulus values was higher than prior baseline rate. For Bird 51, baseline responding varied dramatically without producing noticeable changes in the gradients during discrimination conditions. In general, relative gradients were stable despite changes in absolute responding. Therefore, dimensional contrast should probably be defined in terms of relative changes in discrimination gradient form, rather than in terms of absolute increases or decreases from baseline.

The results from Experiment 2 show that there was a general tendency for response rate to decrease over discrimination training. However, this tendency did not affect the occurrence of positive dimensional contrast. Dimensional contrast appeared whether adjacent S+ stimuli were present or absent. In most cases, the magnitude of the effect was not diminished by the absence of adjacent stimuli, although the symmetry of the effect seemed to be somewhat improved. Finally, the characteristic M-shaped gradient could be observed in cases in which all response rates were higher, or all response rates were lower, than prior baseline response rates.

Some of the facts outlined above seem to be consistent with one interpretation of D. S. Blough's (1975) incremental model of discrimination learning. For example, the model is able to account for the findings of Experiment 1. The form of dimensional contrast predicted by the incremental model is determined in part by a variable that represents the asymptotic level of conditioning. The variable need not have the same *absolute* value in all conditions. Rather, its value can vary depending on the context of reinforcement (see D. S. Blough, 1975). This feature allows the incremental model to predict dimensional contrast effects that do not represent absolute positive or negative deviations from baseline.

The only problem arises in the results of Experiment 2. According to the incremental model, elimination of stimuli along the S+/S- border should reduce the magnitude of both positive and negative dimensional contrast. This prediction derives from the model's

assumption that stimulus elements shared between S+ and S- are ultimately responsible for the enhancements and depressions away from the border (see D. S. Blough, 1975, 1983; P. M. Blough, 1980). However, Figures 5 and 6 show that eliminating border stimuli may have actually increased the magnitude and symmetry of positive dimensional contrast, at least on the lower end of the continuum.

An explanation of the results of Experiment 2 may be that dimensional contrast depends on the level of discrimination between S+ and S-. If it is too difficult to distinguish S- from S+, dimensional contrast may not appear at all or may appear in a reduced form. At the other extreme, if the discrimination is too easy, dimensional contrast may be a transitory phenomenon, or the dependent measure may not be sensitive enough to reveal it. For example, because of the stimulus spacings chosen in Experiment 2, the level of discrimination between S- and S+ should have been relatively lower on the low end of the continuum (e.g., Graf, 1973). And, in fact, overall discrimination of S+ values was quite low on this end of the continuum until removal of the S+ adjacent to S-. As overall discrimination improved in Condition 2, so too did dimensional contrast increase in magnitude.

This interpretation is consistent with the fact that dimensional contrast is a time-dependent phenomenon (see Hinson & Malone, 1980). That is, depending on the discrimination task, dimensional contrast may appear at an earlier or later stage of learning. If this explanation is correct, it provides a tentative proposal for accounting for these results within Blough's model. If the separation between S+ and S- changes either the model's learning rate parameter or the underlying similarity function that describes the overlap of stimulus elements, the model can be adapted to these results. Not enough is known at present to offer more than tentative proposals, but serious attention is due dimensional contrast effects and any theory that can explain them.

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