STEADY STATE RESPONDING BASED UPON SIMPLE AND COMPOUND STIMULI¹

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Two pigeons were trained to perform discrimination tasks along two dimensions, wavelength of a circular spot of light and orientation of a white line. Discriminability among stimuli along these dimensions was established for both subjects by means of a steady state testing procedure. The two dimensions were then combined by superimposing the white line upon the colored background. Subjects were given a series of tests in which a correct response could be made on the basis of either of the two components of the stimulus compounds. Discriminability among these redundant compound stimuli was found to be better than that among wavelength and tilt stimuli alone. A second series of tests was administered using both redundant and conflicting compound stimuli. The results of this test series are consistent with a response strategy in which subjects first examine both elements of a compound and then emit a choice response on the basis of the element that best predicts reinforcement.

In the animal behavior literature, one of the most frequently used indices of stimulus control has been the generalization gradient. Following a training period during which subjects earn reinforcement for responding in the presence of one stimulus, test sessions are administered with an array of novel stimuli in the absence of reinforcement. When orderly functions relating rates of response to some aspect of the stimulus are obtained, then it is said that the subject's behavior is under stimulus control. A wide variety of phenomena have been explored using gradients-in-extinction, ranging from Guttman and Kalish's (1965) evaluation of wavelength discriminability to Reynolds' (1961) demonstration of attentional processes in discrimination learning.

For certain purposes, however, the rate-of-response measure is not a wholly adequate

dependent variable. Quantitative models of information processing, for example, are difficult to evaluate on the basis of rate data. Perhaps the clearest reason for this is the problem of relating rate-of-response measures to the predictions of various information processing models, which are typically expressed as proportions of discrete choice responses. Thus, the analyses of stimulus combination offered by Butter (1963) and Johnson (1970) carry the assumption that the data to which they are applied are in a form already compatible with the models used in the analyses.

A further problem in both free-operant and discrete trial methods is that the data are typically collected in extinction. Thus, a limited amount of information can be obtained from individual subjects, and this information is subject to a high degree of variability.

Because of the above-mentioned factors, a steady state, discrete trial procedure (Blough, 1969) may provide measurements preferable to rates obtained in extinction. This paper describes a steady state procedure designed to produce highly stable discriminative behavior in the presence of simple and compound stimuli, and treats the data obtained through this procedure in light of some current theories of the processing of redundant information.

METHOD

Subjects

Two male Silver King pigeons, about 5 yr old and experimentally naive at the outset of

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this study, were maintained at 80% of their free-feeding weights.

Apparatus

A standard Lehigh Valley pigeon chamber (model 1519) was used. One wall of the chamber contained a magazine for delivering reinforcers, three circular translucent keys of 1-in. (2.54 cm) diameter arranged in a horizontal line at about eye level of the subject, a speaker that supplied white noise at an intensity of 80 dB and a houselight, fitted with a GE1822 bulb and aimed at the ceiling, that provided dim illumination during experimental sessions. All inputs and outputs of the apparatus were connected with a LINC computer, which monitored experimental sessions and printed out daily results for each subject on a teletype. The two side keys could each be illuminated by a GE1822 bulb, and an optical system adjacent to the chamber produced stimuli that transilluminated the center key through a hole in the side of the pigeon box that was behind the manipulanda panel.

The optical system produced stimuli of three types:

- (1) a white line of variable orientation 0.64 cm long and 0.16 cm wide.
- (2) a circular disc of monochromatic light of variable wavelength 0.64 cm in diameter with a white line of the above specifications passing through its center.
- (3) a circular disc of monochromatic light of variable wavelength 0.64 cm in diameter.

Eight stimulus values were generated along both the wavelength and tilt dimensions. Wavelength stimuli were provided by a Bausch & Lomb 250-mm grating monochromator, whose nominal half-band width was 6.6 nm. Wavelength values were chosen such that four of the wavelengths were shorter than 580 nm, whereas the remaining four were longer. The shorter wavelengths are referred to as W1, W2, W3, and W4, whereas longer wavelengths are called W5, W6, W7, and W8. The luminance of the wavelength corresponding to W8 was calibrated at 3.202 cd/m² and was not adjusted when different wavelengths were presented. It is unlikely that this would result in control by brightness, since the spectral sensitivity function for the pigeon is more or less flat in the region of 580 nm (Blough, 1957)

and the output of the monochromator is relatively flat at these wavelengths (Blough, 1957). At the outset of discrimination training, W1 was set at 569.5 nm, and successive stimuli were 3 nm apart.

Since the paradigm used in this study defines correct responses on the basis of whether the wavelength presented on a trial is longer or shorter than 580 nm, it is possible to reduce the range of stimuli (and, hence, increase the difficulty of the discrimination) without changing the reinforcement rule. This was accomplished by increasing the wavelengths of stimuli W1 through W4 and reducing those of W5 through W8 in such a manner that the wavelength differences between successive stimuli are equal for a given set of stimuli, in keeping with the restriction that half of the wavelengths be shorter than 580 nm, and the rest longer.

Line orientation stimuli were classified in a similar manner to wavelengths. Four orientations, T1 through T4, were greater than 112.5°, whereas T5 through T8 were less than 112.5°. All tilt stimuli were obtained by counter-clockwise rotation of a horizontal line that represented zero degrees. At the outset of tilt training, T1 was set at 135°, and the difference between successive steps was 6.4°. As with the wavelength dimension, the range of tilt stimuli may be decreased by making T1 through T4 closer to the vertical and T5 through T8 closer to the horizontal, keeping the number of degrees between successive stimuli equal and defining correct responses on the basis of whether the stimulus in question is more vertical or horizontal than 112.5°.

Two types of compound stimuli were constructed. In the first of these, eight redundant compound stimuli could be produced by simultaneously adjusting line orientation and wavelength such that both tilt and wavelength stimulus numbers are identical. These have been labelled T1W1, T2W2, . . . T8W8. Alternatively, 64 compounds could be generated by pairing the eight tilts and wavelengths in all possible combinations.

Procedure

Subjects were first magazine trained and shaped to peck at the illuminated side keys by the method of successive approximations. Following this procedure, the center key was transilluminated by a 580-nm patch of light

at random intervals. Approximations to pecking the center key were reinforced by the illumination of both side keys, and food reinforcers were then delivered for pecks on one of the side keys, according to a random schedule. When 20 reinforcers had been delivered for completed two-peck chains, discrimination training was begun.

Discrimination Training and Testing

The training and testing procedure was divided into the following four phases:

- (1) Subjects were first trained and tested for discriminability along the tilt and wavelength dimensions.
- (2) Sessions of either wavelength or tilt were presented according to a random schedule to ensure that the subjects' behavior could be readily controlled by either dimension.
- (3) The two dimensions were combined so as to give redundant information, and discriminability of the compound dimension was compared to that of the individual component dimensions.
- (4) The two dimensions were combined so that on some trials information was redundant, but on others it was conflicting.

Phase 1—Single Dimension Training

Subjects were run for one session daily. Each subject was placed in the experimental chamber, and the beginning of a session was signalled by the illumination of the houselight. The outset of an individual trial was marked by the appearance of a stimulus on the center key. After the stimulus had been turned on, a peck on the center key caused both side keys to be illuminated. For Subject 20, if a stimulus numbered 1, 2, 3, or 4 was projected on the center key, then a response to the illuminated left key turned off the stimulus and side-key lights, and the food magazine was raised for 2.5 sec. A right-key response by this subject in the presence of stimuli numbered 5, 6, 7, or 8 had exactly the same effect. After an intertrial interval of randomly chosen duration averaging 3.0 sec and ranging from 2 to 4 sec in steps of 0.25 sec, a new trial began. During the intertrial interval, responses to the dark center key had the effect of resetting the interval timer, thus delaying the onset of the next trial. Stimuli were selected at random

without replacement from the block of eight possible values until all had been presented. This process was then repeated until the number of blocks defining the session was completed. When an incorrect response was made, the stimulus and keylights were turned off, but no reinforcer was delivered, and the subsequent intertrial interval was 10 sec longer than that following a correct response. In addition, the same stimulus to which the subject had just responded incorrectly was presented again, and a new stimulus was not chosen until a correct response to this stimulus was made. For Subject 22, reinforcement contingencies were the reverse of those applying to Subject 20. That is, left-key responses to stimulus values 5 through 8 and right-key responses to values 1 through 4 were reinforced, whereas all others were extinguished. Most sessions were terminated after 80 reinforcers had been delivered. If the subjects' weight exceeded 80% of its free-feeding weight by at least 20 g, however, the session length was reduced to 70 correct responses.

The first few training sessions differed from the above procedure in that only stimuli numbered 1 and 8, the two most extreme values along both dimensions, were presented. These were chosen at random from trial to trial, rather than in blocks. When nearly 100% correct responding was achieved by both subjects, stimuli numbered 2 through 7 were added to the discrimination task.

The percentage of left-key responses as a function of each stimulus was determined for each individual session. Whenever a discrepancy of at least 50% appeared between left-key responses to stimuli numbered 4 and 5, the range of equally spaced stimuli was decreased until performance appeared not to improve with further practice. The correction procedure (including the 10-sec penalty for incorrect responses) was then discontinued and, over the next few sessions, reinforcement density was decreased from a 1.0 probability of reinforcement for a correct response to a probability of 0.25. This permitted sessions of 60-block (480 trial) duration. For the final set of tilt stimuli, T1 was equal to 128.8°, with 4.8° between successive stimuli. For wavelengths, W1 was equal to 574.75 nm with 1.5 nm between successive values.

When subjects showed no trend of decreasing errors over six consecutive days for a given

set of stimuli, as determined by Daniel's Test for Trend (Bradley, 1968), the above procedure was halted and the data combined over these six sessions. Both subjects followed the above procedure for wavelength and then for tilt. An apparatus failure that occurred after the data for the wavelength discrimination had already been collected made it impossible to reproduce exactly the stimulus intensities under which wavelength training had taken place. Thus, a second series of wavelength sessions had to be given after tilt training in order to determine the wavelength discrimination function. Subjects were run for a total of 88 sessions with wavelength stimuli and 77 sessions with tilt.

Phase 2—Alternating Tilt and Wavelength Sessions

For the next nine sessions it was equally probable that, for a given session, only tilt or wavelength would be presented. For wavelength sessions, only W1 and W8 were presented and, similarly for tilt sessions, only T1 and T8 were presented. The probability of reinforcement for any correct response was always 0.25. Each of these sessions was 400 trials in length. This procedure ensured that subjects' behavior could be readily controlled by either dimension and minimized any effects of order of training.

Phase 3—Redundant Compound Testing

Subjects were run on a series of sessions, each of which consisted of 60 blocks of eight redundant, compound stimuli, T1W1 through T8W8. Correct responses in the presence of any compound were defined identically to those in the presence of the components during single-stimulus training. The probability of reinforcement for any correct response was 0.25. These sessions were continued until subjects appeared to show no improvement over six consecutive days, as determined by Daniel's Test for Trend (Bradley, 1968). The last six days' performance was combined to determine the discrimination functions for compound stimuli.

Phase 4—Non-Redundant Testing

During the next series of sessions, each of the 64 possible combinations of tilt and wavelength were presented 15 times per session, according to the randomization-within-blocks

method described previously. Responses in the presence of conflicting compounds were never reinforced. Correct responses in the presence of compounds for which both components required identical choices, however, were reinforced with probability 0.375. Because of slight weight increases, this value was reduced to 0.25 on the fifth session for Subject 20 and the fourth session for Subject 22. Subject 20 was run for 10 sessions whereas Subject 22 was run for eight sessions.

RESULTS

Figure 1a shows the percentage of left-key responses in the presence of the eight tilted line stimuli for Subjects 20 and 22. Each function represents the combined data of six sessions, for a total of 360 observations per stimulus. Analogous functions for wavelength are presented in Figure 1b, and the data for redundant compounds are given in Figure 1c. The results of non-redundant compound testing are given in Figures 3a and 3b. Each panel shows the percentage of left-key responses as a function of the eight wavelength stimuli paired with one tilted line stimulus. The same data are given in Figures 4a and 4b, with the modification that each panel shows left-key responding as a function of the eight tilt stimuli paired with one wavelength. The lines drawn through or near the data points are theoretical fits, which are discussed below. Each point in Figures 3 and 4 represents 110 observations obtained over seven sessions.

DISCUSSION

One frequently observed property of psychophysical functions is that, when stimuli are spaced according to equal subjective intervals, these functions take the form of an s-shaped, cumulative normal curve. It would appear from examination of Figure 1 that this holds true for the present data as well. Though psychophysical data for orientation detection have not been reported for the pigeon, the obtained functions for wavelength discrimination are consistent with recent work (D. Blough, 1972; P. Blough, 1972, Wright, 1972) indicating that equal wavelength differences are about equally discriminable in that portion of the visual spectrum used here. A more precise determination of the form of

Fig. 1. (a) Proportions of left-key responses as a function of tilted line stimuli; (b) Proportions of left-key responses as a function of wavelength stimuli; (c) Proportions of left-key responses as a function of redundant compound stimuli.

these functions may be obtained by replotting the points on probability axes. If the data do describe a cumulative normal function, then the points should all lie upon a straight line. Figure 2 reveals that this is the case.

Given the cumulative normal form of the present data, it may be seen that as a subject commits progressively fewer errors the discrimination function becomes progressively steeper, its cumulative normal transform approaching the vertical that would represent perfect performance. A question that has been of interest to several researchers (Warren, 1953; Warren, 1954; Eriksen and Hake, 1955; Hara and Warren, 1961) concerns the relative

discriminability of simple *versus* compound stimuli, and this question may now be approached in the present data by comparing the slopes of the transformed discrimination functions as determined by a least-squares procedure. The slopes given in each panel of Figure 2 show that functions for stimuli having both a color and tilt component are steeper than for color or tilt alone. A Wilcoxon's Rank-Sum test (Bradley, 1968) performed upon error rates under the three conditions reveals that significantly fewer errors ($p < 0.05$) were committed in the presence of compound than simple stimuli.

The relative discriminability of simple *ver-*

Fig. 2. (a) Cumulative normal transform of Figure 1a; (b) Cumulative normal transform of Figure 1b; (c) Cumulative normal transform of Figure 1c.

sus compound stimuli allows one to narrow the range of possible combination rules employed by the subjects. The obtained data are, for example, inconsistent with any rule according to which subjects base individual decisions upon information from only one of the two available dimensions; such a strategy can at best result in equivalent discriminability among compound stimuli and the more discriminable of the two sets of components. Though a "one-look" rule can be reconciled with the obtained results, if one assumes improved discriminability among components due to practice during Phase 3 testing, such an explanation is unlikely to be correct. Both subjects had over 70 sessions experience with each component dimension and had reached criteria of stability before compound testing was begun, while evidence of improved performance with redundant information was seen for both subjects after only nine sessions.

Thus, the improved discriminability of com-

pound *versus* simple stimuli appears to be consistent only with a response strategy by which information is combined from both stimulus dimensions on individual trials. The results of Phase 4 testing (Figures 3 and 4) shed further light upon how this combination is carried out. These data have been fit by functions consistent with the following combination rule based upon the theory of Signal Detection (Green and Swets, 1966).

Assume that, corresponding to the physical dimensions of tilt and wavelength, there exist two perceptual dimensions, which will here be called angle and color, and that the repeated presentation of each of the eight tilt and wavelength stimuli gives rise to a normal distribution of angles and colors. The variances of all angle distributions are assumed to be equal, as are those for color. Examples of these are given in Figure 5. The upper panel represents the angle dimension, and the distribution at the left is assumed to arise from many presen-

Fig. 3. Proportions of left-key responses as a function of the eight wavelength stimuli paired with one tilted line stimulus for (a) Subject 20; (b) Subject 22.

Fig. 4. Proportions of left-key responses as a function of the eight tilt stimuli paired with one wavelength stimulus for (a) Subject 20; (b) Subject 22.

tations of one of the tilted lines, T1. The lower panel shows the color dimension, and includes the distribution arising from repeated exposure to W4. It is assumed that these continua are scaled in units of the standard deviation, σ , and that the reinforcement contingencies used in single-stimulus training result in the establishment of criteria along these continua, such that when an event falls to the left of the criterion the subject emits response A, whereas events falling to the right elicit response B. Arbitrarily, the criterion points along these dimensions will be given σ values of zero, with events falling to the right having positive values, and those to the left being negative. According to the response rule proposed here, a subject performs the following operations on each trial: (1) *look at both tilt and wavelength*; (2) *identify the most discriminable stimulus component (i.e., decide whether the perceived value of tilt or wave-*

length is most distant from the criterion line); (3) *emit the response appropriate to this stimulus component*.

A simple example may aid understanding of the possible outcomes of such a rule. Consider a hypothetical trial on which a subject is presented with the stimulus compound T1W4. Further suppose that events a_1 and c_1 (see Figure 5) occur on the trial in question. It can be seen that these events provide the subject with conflicting information. The angle a_1 falls to the left of the angle criterion and thus elicits response A, whereas the color c_1 falls to the right of the color criterion, and thus elicits response B. If we assume that equivalent distance along both color and angle axes is scaled in equivalent values of σ , then by the proposed rule a subject would first look at both angle and color and determine that a_1 is farther from criterion than c_1 . It would then ignore c_1 and emit response A,

which is associated with a_1 . Quantitatively, the rule may be expressed as follows: *if $a + c$ is less than zero, respond A; if it is greater than zero, respond B*. This strategy is a reasonable method of optimizing the number of reinforcers delivered over many trials, since choices based upon events falling close to a criterion are more likely to be erroneous than those based upon events falling farther away. The above example is a case in point; the correct response to both T1 and W4 is A, but stimulus W4 resulted in an event that would have led to response B. Since choices are always based upon the better of two pieces of information, overall discrimination performance among redundant compound stimuli would be expected to be superior than that among stimuli that are varied along only one of the component dimensions. This is consistent with the results seen in Figure 2.

The proposed rule makes some specific predictions about the form of the data resulting from Phase 4, non-redundant testing. Consider the effects of pairing stimulus T1 with each of the eight wavelength stimuli, W1 through W8. Most of the angles that arise as a result of the presentation of T1 will tend to fall far to the left of the angle criterion; *i.e.*, they will be highly negative. This is also true of colors produced by W1. Thus, the quantity $a + c$, which results from the repeated combination of these two stimuli, will tend to be highly negative as well, leading to the response A on almost every trial. As one moves progressively from W1 through W8, however, the values of color stimuli change from highly

negative to highly positive. The quantity $a + c$ should become positive on a substantial percentage of trials only when T1 is paired with longer wavelengths, *i.e.*, W7 and W8. Thus, when T1 is combined with each of the eight wavelengths, subjects would be expected to emit response A consistently for pairs containing shorter wavelengths such as W1 and W2, but begin to emit a large number of B responses when T1 is paired with longer wavelengths (the exact proportions of choice responses predicted for any set of compound stimuli are, of course, dependent upon the relative discriminability of the set of stimuli along the two dimensions. For purposes of simplifying the present example, equal discriminability has been assumed here, though this assumption will later be discarded in dealing with the obtained data).

The same line of reasoning may now be used to predict the outcomes of trials on which each of the remaining seven tilts is paired with the eight wavelengths. Specifically, a family of response curves should be generated, each of which is shifted to one side or the next by an amount equal to the difference between the means of the successive angle distributions in units of the standard deviation of these distributions. This follows from the fact that when two events are each sampled repeatedly from different normal populations, the expected mean of the sum of these sampled pairs is equal to the sum of the means of the two original populations (Hays, 1963). Since the variances of all angle distributions are assumed to be equal to one another (as are those for color), however, the variance of the distribution of sums $a_1 + c_1$ should all be equal (Hays, 1963). Thus, each of the expected response curves should be of identical variance, but of different mean. A close approximation to this model is easily applied to the results of Phase 4, non-redundant testing. For each set of eight panels in Figures 3 and 4, the best-fitting cumulative normal curve was determined for the points in the upper-right-hand panel by replottting them on probability paper and fitting these points with a straight line by the method of least squares. This line was then replotted on standard axes and applied to the original data points. To test the predictions of the proposed model, functions used to describe the data in each upper right-hand panel were shifted either to the right or

Fig. 5. Hypothetical distributions of angle and color events caused by the repeated presentation of T1 and W4, respectively.

left in an attempt to fit the rest of the points in each set. In all cases, the fit appears to be very good. A more rigorous evaluation of the data (requiring the aid of a digital computer) involves determining those functions that simultaneously provide the best fit for wavelength as tilt varies and for tilt as wavelength varies. Theoretical functions determined in this manner account for 89.3% of the variance in the data of Subject 22 and 97.7% of that of Subject 20.

One aspect of the data obtained from non-redundant testing which has thus far remained unaccounted for is the steepness of the best-fitting functions. In the preceding analysis, the slopes of functions obtained in the presence of compound stimuli were discussed relative to those obtained during single-stimulus testing. Similarly, from the discrimination functions obtained for tilt and wavelength during Phase 1 testing, it is possible to make some predictions as to the relative slopes of functions obtained during Phase 4 testing. Specifically, since both subjects discriminated better among tilted line stimuli than among wavelengths, choice functions for compounds of a given wavelength plus the eight tilted lines (Figure 4) should be steeper than those for a given tilt plus the eight wavelengths (Figure 3). In fact, the opposite effect occurred. The most likely explanation of the obtained result is that the white line is not as clearly visible to the subject when it is presented on a background of colored light as when it is surrounded by darkness. That is to say, the values of the discrimination index d' among tilt stimuli may have been reduced by compounding them with the wavelength stimuli. This explanation seems reasonable, since there is better contrast between the line and darkness than there is between the line and colored surround.

The model proposed here deals with performance on a steady state task and makes no statement about the acquisition of control by redundant stimuli. The present set of results does, however, appear to have some implications for the assumptions made by learning theorists concerning that aspect of information processing commonly referred to as "selective attention". In the behavioral literature, this concept is invoked when certain classes of stimuli acquire control over an organism's behavior while others do not, despite the fact

that stimuli belonging to both of these classes are equally good predictors of reinforcement. In the theories of Zeaman and House (1963) and Lovejoy (1968), for example, attention is treated as a mediating response. For these theorists, the occurrence of any given attention state is determined by the relative strengths of all possible attention states; the role of stimulus factors in determining attention on individual trials is not treated. In the additive rule discussed here, however, the values of the stimulus components present on a given trial determine which component will be selected as a basis for choice responding. Similar mechanisms have been suggested in dealing with the outcomes of studies on dichotic listening (Treisman, 1964, Norman, 1968, Moray, 1970). A model that postulates the prior selection of one dimension on each trial results in a different set of predictions as to the results of Phase 4, non-redundant testing. Specifically, it is expected that the difference between the asymptotes of the functions relating choice responding in the presence of a single value along one dimension with the eight stimuli along the other should reveal the proportion of trials on which attention is directed toward that dimension (Heinemann, Avin, Sullivan, and Chase, 1969). The only way in which the eight panels of each set in Figures 3 and 4 should differ from one another is by the addition or subtraction of a constant percentage of left-key responses, which would be determined by the subject's choice responding on those trials for which it was attending to the alternate dimension. One should therefore be able to find a best-fitting function for any one of the panels in a set of figures and then fit all the rest of the data in that set by merely sliding that function up and down. That such a formulation does not describe the data as well as the proposed rule may be seen by taking any one of the panels for each set of choice curves in Figures 3 and 4 and attempting to fit the remaining panels by following this procedure.

It is interesting to note that some of the human psychophysical data using multiple observations can be treated with an "integration model" of the Theory of Signal Detection (Green and Swets, 1966) which is essentially the same as that offered here. Whereas the integration model combines information from several observations of the same signal, the response rule discussed here combines informa-

tion from the simultaneous observation of two separate classes of stimuli. More closely related to the present research is the work of Chase and Heinemann (1972), who reported data which, despite considerable differences in procedure and stimulus material, are quite similar to those given here. These authors, too, have chosen to incorporate the Theory of Signal Detection into a model of choice behavior. Though their model can accommodate the performance of subjects that completely ignore the information along one of the redundant dimensions on a certain proportion of trials (*i.e.*, violate the first stage of the rule proposed here), Chase and Heinemann reported no significant attention effects in their data. While they have not discussed their theory in terms of a sequence of decision stages, it is easily demonstrated that, disregarding their concept of attention, the model that they offer is equivalent to the one described here. According to Chase and Heinemann, the angle and color continua seen in Figure 5 are treated as the orthogonal axes defining a two-dimensional space, any point in which represents the joint occurrence of a particular angle and color. The subject is assumed to establish a criterion line that divides this space into two regions such that events falling to one side of the line elicit one response, whereas those falling to the other side of the line result in an alternative choice. By following Chase and Heinemann's procedure for calculating the equation for this criterion line, one obtains the formula $a + c = 0$. A point for which the quantity $a + c$ is negative will thus fall below the line, while positive values appear above. Thus, the behavior predicted by that model is identical to that of the rule described here, and there seems at this time to be no reason to prefer one manner of expressing these formulations over the other.

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