ADVENTITIOUS CONTROL BY THE LOCATION OF COMPARISON STIMULI IN CONDITIONAL DISCRIMINATIONS

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In a conditional discrimination procedure, samples appeared in a center key, and comparisons appeared in two of four outer keys. The location of comparison keys varied from trial to trial. Separate learning curves for each of the six possible pairs of comparison keys were plotted in a signal-detection space, revealing different patterns of progress on each pair. Also, when learned conditional discriminations were disrupted, pairs of keys differed in their patterns of disruption. Varying the location of comparison stimuli among six different pairs of keys had not eliminated key position as a controlling aspect of the stimuli. The variations simply increased the number of stimulus compounds—key position and experimental stimuli—that the subject learned. Plotting conditional-discrimination learning curves in a signal-detection space reveals relations among hits, false alarms, accuracy, and comparison preference that help to define a subject's progress.
   Key words: stimulus control, conditional discrimination, equivalence relations, signal-detection analyses, stimulus location, key press, monkeys

Sidman et al. (1982) suggested that the actual controlling stimuli in the standard conditional discrimination procedure (e.g., Cumming & Berryman, 1965) may include both the experimenter-specified stimuli and the locations in which those stimuli appear. Constantine (1981), with harbor seals as subjects, found that characteristic scanning patterns gave special status to particular stimulus locations. Also, with monkeys as subjects, Iversen, Sidman, and Carrigan (1986) showed that interchanging the locations of sample and comparison keys could disrupt ongoing conditional discriminations.

A seemingly reasonable way to prevent comparison-key location from becoming a controlling aspect of the stimuli would be to present comparison stimuli in varying locations, not just on the single pair of keys that are customarily used. With more comparison-key pairs involved in conjunction with each sample, perhaps the difficulty of learning many key positions would shift the balance of control to the experimenter-specified stimuli rather than to their positions. For example, in a sys-

tem for investigating conditional discrimination learning by monkeys (Sidman et al., 1982), a sample and two comparison stimuli were presented on every trial, but instead of the usual three-key arrangement, a five-key display was used (Figure 1). The sample was always presented in the center, but the two outer keys on which comparisons were presented varied from trial to trial. A pair of comparison stimuli appeared equally often on each of the six possible key pairs, and each member of a stimulus pair appeared equally often on each key. With comparison stimuli presented on six different pairs of keys, key position was expected to become an irrelevant aspect of the stimuli. Then, perhaps, the monkeys would quickly learn the particular conditional discriminations that the experimenters wanted them to learn.

This expectation proved unfounded. One reason was that pairs of key positions appeared to have become units unto themselves. The experimenters had not yet come to appreciate fully that persisting position preferences, far from *causing* subjects' failures to learn (Harlow, 1959), are usually *produced by* their failures to learn (e.g., Sidman & Stoddard, 1967; Stoddard & Sidman, 1967). Perhaps it should not have been surprising to find that even as many as six spatial arrangements of a pair of comparisons might not prevent location from becoming a defining feature of the stimuli.

The first purpose of this report is to present some of the data that led to this conclusion.
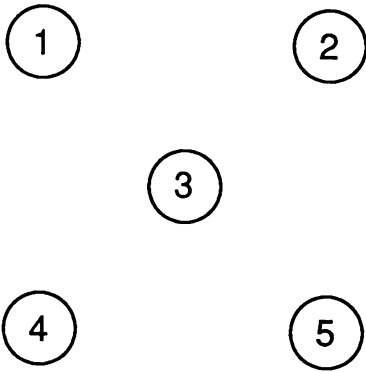
Fig. 1. Schematic representation of the keys (not to scale).

Fig. 2. A signal-detection matrix.

The second purpose is to illustrate a data-analysis technique that reveals features of a subject's conditional discrimination performance that might otherwise be missed. A final purpose is to outline some implications of control by key position for experiments that seek to demonstrate generalized identity matching.

METHOD

The Conditional Discrimination

Conditional-discrimination learning curves were obtained from an adult rhesus monkey (*Macaca mulatta*). The apparatus and procedures have been described elsewhere (Sidman et al., 1982), and only a few details need be repeated here. Specific procedural details will be given as necessary along with the results. Figure 1 is a diagram of the keys that served to present stimuli and record responses. At the start of a trial, a sample was presented on Key 3. When the subject touched Key 3, two comparison stimuli, a horizontal line and a vertical line, were presented. When the sample was a horizontal line, the subject could produce a food pellet by touching the horizontal comparison; when the sample was vertical, a food pellet was forthcoming when the animal touched the vertical comparison. Comparison stimuli could appear on any of six possible combinations of two keys: 1-2, 1-4, 1-5, 2-4, 2-5, or 4-5.

Measurement of the Conditional Discrimination

The extent to which specified sample stimuli control a desired comparison discrimination is usually measured by the percentage of "correct" responses, or *accuracy*. To the extent that unspecified, competing, or unwanted (by the experimenter) features of the stimuli control a subject's performance, the performance is considered deficient. It has been argued, however, that failures to specify the actual controlling stimuli may lead to serious errors when describing and interpreting conditional discrimination data (Ray & Sidman, 1970; Sidman et al., 1982).

The signal-detection matrix. A useful way to analyze control by the experimenter-specified stimuli is to organize the response probabilities in a format similar to the signal-detection matrix (e.g., Goldiamond, 1964; Green & Swets, 1966). Figure 2 illustrates the matrix and the application of signal-detection terminology to conditional discriminations.

If we arbitrarily define vertical samples as signals plus noise, horizontal samples as noise, selections of vertical comparisons as "yes," and horizontal comparisons as "no," the four cells represent the usual signal-detection categories (definitions of vertical and horizontal could, of course, be interchanged): Given vertical samples, selections of vertical comparisons are hits (V/V) and selections of horizontal are misses (H/V); given horizontal samples, selections of vertical are false alarms (V/H) and selections of horizontal are correct rejections (H/H). Both hits and correct rejections denote correct choices; their sum divided by the total number of trials is accuracy.

Signal-detection analysis makes explicit use only of the probabilities of hits and false alarms; given these, and equal probabilities of sample presentation (row margins), all other cell (and column) probabilities are determined. Without invoking signal-detection theory, one may locate any given matrix within the signal-detection space to analyze empirically the relations among hits, false alarms, accuracy, and comparison preference (column margins), and to show how these relations can illuminate features that one might otherwise miss when evaluating how subjects learn conditional discriminations.

The signal-detection space. In Figure 3, the vertical axis denotes the probability of hits—the percentage of times the animal selected the vertical comparison when given a vertical sample. The horizontal axis at the bottom indicates the probability of false alarms—the percentage of times the animal selected vertical when given a horizontal sample. Each point in the space represents a particular matrix of the form of Figure 2. For example, points falling along the major diagonal (CB and its extension to the lower left corner) represent combinations of hits and false alarms that yield 50% accuracy—no evidence of control by the samples. Parallel to the major diagonal are constant-accuracy lines, with accuracy increasing as the lines approach the upper left corner. The accuracy scale is at the top; the point marked A indicates perfect accuracy, a signal-detection matrix in which the hit rate is 1 and the false-alarm rate is 0.

Points above the minor diagonal (AB) represent various degrees of preference for the vertical comparison, and points below the minor diagonal represent preferences for horizontal. For example, C indicates a complete preference for vertical—perfect control by a comparison stimulus and no evidence of control by the samples; in a matrix located at C, hit and false-alarm rates both equal 1, and accuracy equals .50.

Matrices that fall along the minor diagonal indicate an absence of comparison preference. For example, Point B indicates no line preference—in fact, no indication of control by any of the experimenter-specified stimuli; in a matrix located at B, hit rate, false-alarm rate, and accuracy all equal .50.

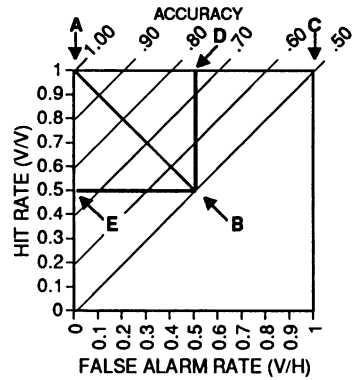In a signal-detection matrix located at D, the hit rate is 1, the false-alarm rate is .50,

Fig. 3. The signal-detection space (hits and false alarms), with an added scale for accuracy. Arrows A, B, C, D, and E indicate the location of particular signal-detection matrices (see text).

and the accuracy is .75. Even though this accuracy is greater than would be expected by chance, D indicates a conditional discrimination that is completely different from one based solely on the lines (Sidman, 1980). With a vertical sample, the subject always selects the vertical comparison, but with a horizontal sample, the subject disregards the comparison lines and always selects some other stimulus, perhaps a particular key. Point D denotes a perfect conditional discrimination, but one that differs from the discrimination desired by the experimenter. A matrix located at D, therefore, signifies as extreme a form of control as Points A, B, and C. (A similar analysis would lead to the same conclusion with respect to Point E.)

We are concerned here with the situation in which the desired performance is located at A. If the subject always selects one particular key, thereby locating the performance at B, then the desired conditional discrimination is nonexistent. Although a complete key preference might facilitate the subject's eventual acquisition of the desired performance (Ray, 1967), no evidence of Performance A can be detected while Performance B prevails. Similarly, even though a performance located at C involves a comparison-line discrimination that constitutes one component of the desired conditional discrimination and may facilitate the eventual movement of the performance toward A (Cumming & Berryman, 1965), no evidence of Performance A can be detected while Performance C prevails. By extension from these examples, a matrix located at D,
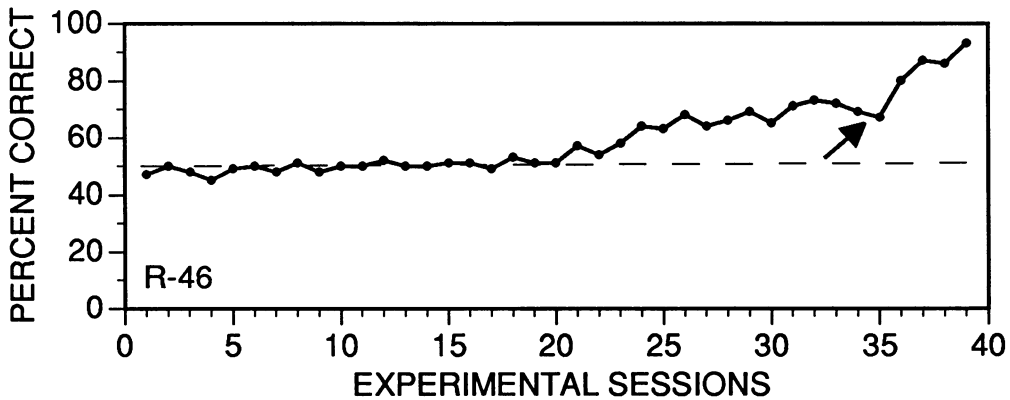
Fig. 4. Acquisition of a line–line conditional discrimination by 1 monkey. Each session contained about 300 trials. The arrow denotes where differential sample responding (FR and DRL) was carried out.

which also contains a component of the desired performance, nevertheless represents a conditional discrimination other than that denoted by A (Sidman, 1980).

Therefore, B, C, and D (and their counterparts below the minor axis) represent uniquely significant points in the signal-detection space; all signify that the desired conditional discrimination is absent. Movements away from those points in any direction within the space denote lessening degrees of the type of control they represent.

Any performances that fall between D and B represent a mixture of both; none of these provide evidence of the desired conditional discrimination. Similarly, the lines DC and BC also indicate the absence of the desired performance. Therefore, all points located on or within the triangle DBC represent performances in which conditional discrimination A plays no part. (This holds true also for the corresponding triangle in the lower left corner of the space.)

On the other hand, as performances shift from D and B along lines DA and BA (or from E along EA), conditional discrimination A becomes involved. The types of control exemplified by D (or E) and B decrease as the performances converge on A. All points located within the square ADBE, unless they fall directly on line DB or EB, represent performances in which conditional discrimination A does play a part.

The lines DB and EB, then, form an important boundary within the signal-detection space. They divide an area (ADBE), in which

the desired performance is involved to a lesser or greater extent, from the remaining areas in which the desired performance is nonexistent. It is possible, therefore, for a learning curve to approach Point A along an infinite number of paths within the signal-detection space, and for the desired conditional control to emerge out of any of the other types of control that one can recognize within the space.

RESULTS

The first suspicion that varying the location of the comparison stimuli might have made learning not easier but more difficult came when the animal took thousands of trials to learn what was then thought of as "identity matching." Figure 4 is a traditional type of acquisition curve for the conditional discrimination. Each session contained about 300 trials. After Session 20, some learning appeared to take place, but even by Session 34 (about 9,000 trials) the animal's performance was still quite poor, with accuracy hovering around 70%. After Session 34 (indicated by the arrow), a training procedure that had been reported by Cohen, Looney, Brady, and Aucella (1976) was instituted. The animal was taught to react differentially to each sample line: It had to touch the sample key five times to produce the comparisons when the sample was vertical; it had to touch the sample key twice, spacing the touches at least 2 s apart, when the sample was horizontal. As expected, these differential sample response requirements brought the performance up to a high level.
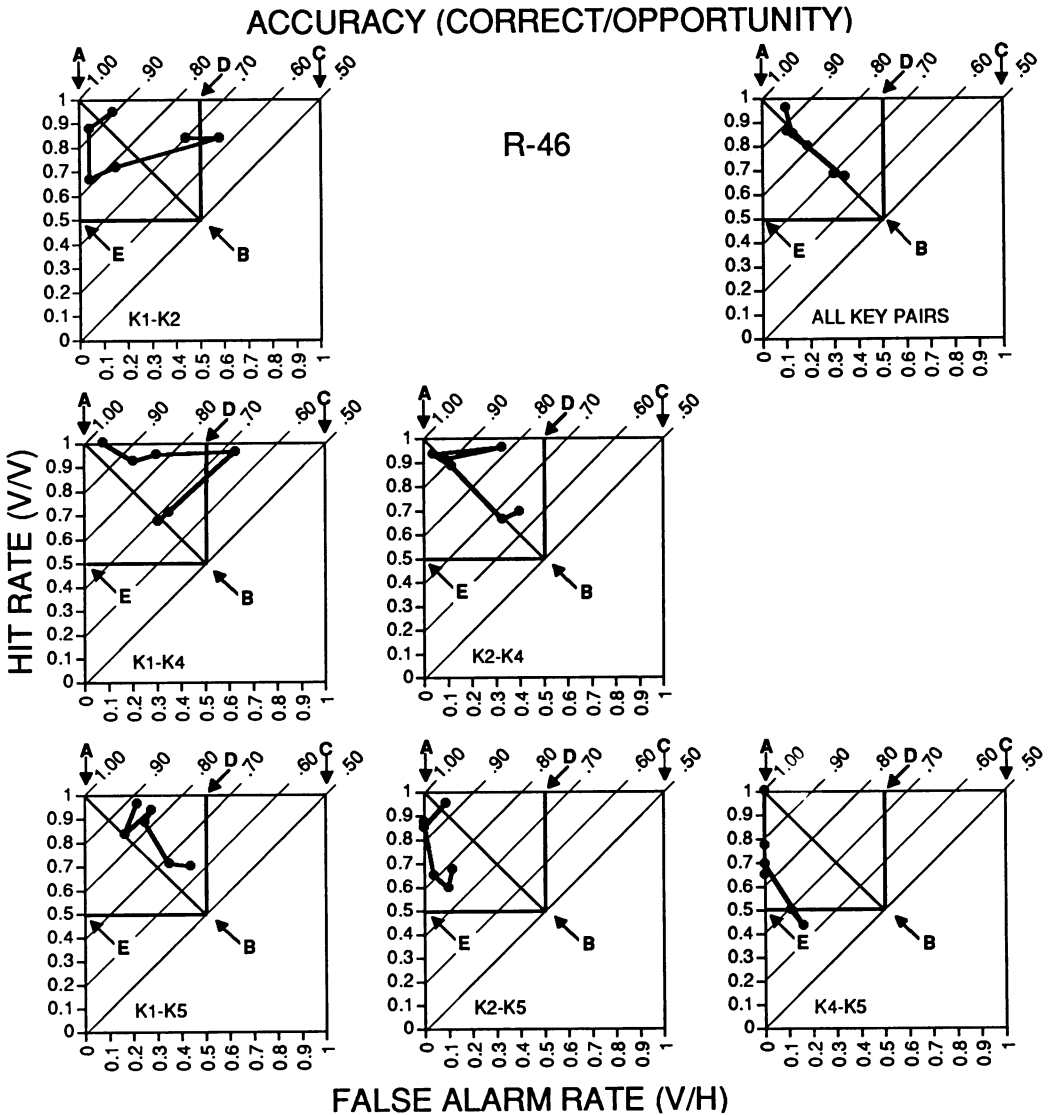
ACCURACY (CORRECT/OPPORTUNITY)

Fig. 5. Signal-detection plots of acquisition on all key pairs combined and on separate key pairs (K1-K2, etc.). All curves begin with Session 34 (see Figure 4) at or near the point most distant from A, and then proceed toward A.

Could the extended period of learning have come about because each of the six key pairs posed a different problem for the subject? Did the animal learn the experimenter-specified conditional discrimination separately for each pair of keys? If key location, along with the horizontal and vertical lines, was a controlling aspect of the comparison stimuli, then the six comparison key pairs might be expected to have generated different learning curves.

Figure 5 displays acquisition patterns in ses-sion-by-session plots of hit versus false alarm probabilities. To avoid cluttering the graphs, only the final session before the introduction of differential sample schedules (Session 34) and the first five sessions in the final stage of acquisition (Sessions 35 through 39) are shown for each pair of keys and for all key pairs combined.

In the combined curve for all key pairs (up-per right graph), accuracy began, as Figure 4 had indicated, at about 69%, and decreased

slightly during the first session after the subject had learned the differential sample schedules. The performance then progressed relatively consistently along the minor diagonal toward A. Learning seemed to occur with little preference being revealed for either comparison line. This idealized learning curve, however, turned out to be an artifact of averaging. The course of the subject's progress depended on the keys that contained the comparisons. The remaining curves in Figure 5 reveal different patterns of acquisition on various key pairs, almost as though each key pair were a different subject.

As acquisition proceeded, all of the curves in Figure 5 moved, with occasional reversals, toward the upper left corner of the signal-detection space. On Keys 4 and 5 (lower right corner of Figure 5), the curve began at about 62% accuracy; the location of the first two points on or below the line EB indicated a preference for the horizontal comparison and the absence of the desired conditional discrimination. Then, however, we see the rapid development and maintenance of a maximal preference for horizontal as acquisition proceeded. Keys 2 and 5 (bottom center) followed a similar course, although the accuracy at the start was considerably higher than it was for Keys 4 and 5.

Keys 1 and 4 (center left), however, show a quite different course of learning. Starting with an accuracy slightly below 70% and no significant comparison preference, the performance moved along the 70% accuracy line almost to D, and the final state eventually developed along the route of an extreme preference for the vertical comparison.

Keys 1 and 2 (upper left) showed an early increase in accuracy, accompanied by a shift from a strong vertical to a marked horizontal preference, out of which the final performance developed.

In contrast to these strong comparison-line preferences and extreme shifts in preference, acquisition on Keys 2 and 4 (center) proceeded (except for one session) along the zero preference line, AB. On Keys 1 and 5 also (lower left corner), the final performance developed more or less along AB, with a relatively small but consistent preference for vertical.

Thus, during learning, stimuli on different key pairs controlled the animal's behavior differently. To the experimenter, a horizontal line was a horizontal line no matter where it was

located, and so was a vertical line; not so to the subject. The different acquisition patterns indicated that location was a controlling aspect of the stimuli.

How about later, after the animal's behavior had come to conform almost perfectly to the procedural requirements? Had the comparison lines acquired complete control, or was the animal still performing six different conditional discriminations? We were fortunate to gather some data on this point. While gradually reducing the reinforcement probability for the animal's correct choices from 1.00 to .20 in preparation for other experiments (Sidman et al., 1982), we noted frequent performance deteriorations. But the breakdown was often different on the various key pairs. What had seemed a learned congruence between the relevant stimuli for subject and experimenter turned out to be more apparent than real. Figure 6 illustrates three examples, two for Monkey R-46 and one for a second animal, Monkey R-47. Each panel represents data from a single session.

Before these sessions, the animals had almost invariably selected correct comparisons, regardless of the key pair on which they were located. It looked as though they were responding consistently to the lines alone. But here, when the overall performance declined, the change in accuracy was not the same on all key pairs. For example, in the graph at the upper left, Monkey R-47 maintained almost 100% accuracy on one key pair (2-4), but dropped to about 70% on another (1-2). In the graph at the lower left, three key pairs remained at nearly 90% accuracy, whereas the other three dropped to about 70%. Also, two key pairs (2-4 and 2-5) showed no comparison-line preference, but the other four showed strong preferences for horizontal, with two (1-2 and 1-5) showing no evidence of Type A control. Other such examples are easily seen in Figure 6.

DISCUSSION

The data were consistent with our suspicion that the subject had learned and was maintaining not one but several conditional discriminations. Even after accuracy had become nearly perfect, the relevant stimuli for the animals were not simply horizontal and vertical, but horizontal and vertical on particular keys.
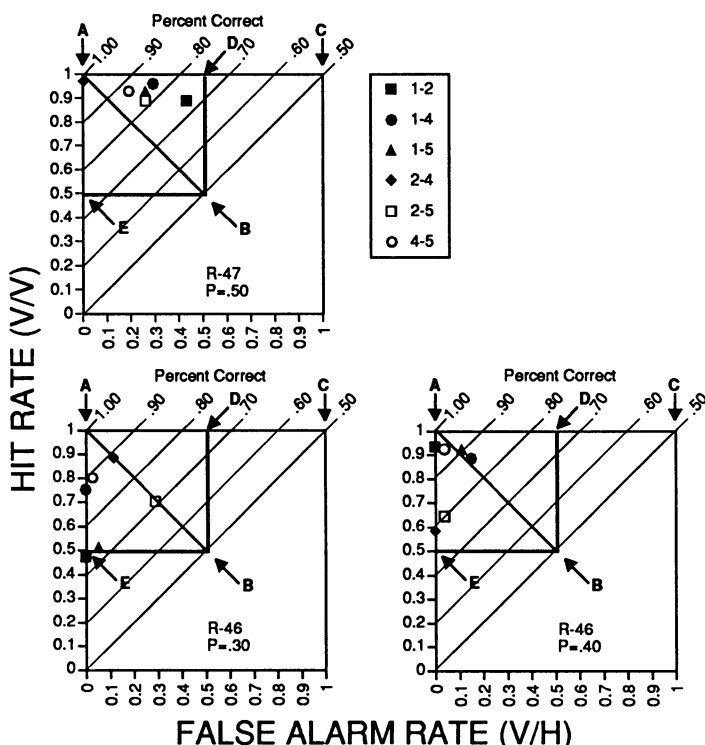
Fig. 6. Differential deterioration of the conditional discrimination on various key pairs (identified in the legend) for 2 animals (R-46 and R-47) at various reinforcement probabilities (P).

Key location was still a controlling stimulus. Instead of simply learning one set of conditional relations between experimenter-specified sample and comparison stimuli, the subjects apparently learned six sets, one for each pair of comparison-key locations.

Relevant to these data is the observation that pigeons and monkeys have not yet been unequivocally shown to be capable of generalized identity matching (Cohen, 1969; Cumming & Berryman, 1965; Davenport & Rogers, 1970; Eckerman, 1970; Farthing & Opuda, 1974; Ginsburg, 1957; Mackay & Brown, 1971; Urcuioli & Nevin, 1975; Weinstein, 1941, 1945). It is possible that failures of nonhumans to show generalized identity matching have been caused by a basically irrelevant feature of the standard conditional discrimination procedure. Because sample stimuli are typically presented on only one key in the display, and comparison stimuli on two other keys, subjects may come to identify stimuli not only by their physical characteristics but also by their locations.

If the fixed locations become defining features of sample and comparison stimuli, then it cannot be correct to call a subject's performance *identity* matching. For example, if the sample stimulus is not just a *vertical* (or *horizontal*) line, but rather, *vertical* (or *horizontal*) *in the center key*, and if the comparison stimuli are *vertical* (or *horizontal*) *in the left* (or *right*) *key*, then what looks to the experimenter like an identical sample and comparison are not identical for the subject. Such a subject would not be learning to match on the basis of identity, and any subsequent test that assumed an experimental history of generalized identity matching by the subject would be invalid. If nonhuman subjects are to learn to separate stimulus features (and functions) from stimulus locations, they may have to be taught explicitly to do so.

It is not clear why selection patterns on some key combinations differed during acquisition and during later deteriorations of the conditional discrimination with lower reinforcement densities (Figures 5 and 6). Informal observations suggested that the reduced reinforcement schedules did not assign reinforce-

ments with equal probability to each key pair. When subsequent experiments in this laboratory corrected that aspect of the reinforcement schedules, breakdowns in conditional discriminations at low reinforcement densities seemed to become less frequent, but hard confirmatory data were not gathered.

Although the plotting of acquisition data in the signal-detection space is neutral with respect to signal-detection theory, sophisticated application of that theory (e.g., Davison & Tustin, 1978; McCarthy & Davison, 1991) might still permit the key-pair data of Figure 5 to be derived from simpler individual key-position biases or preferences. To expedite such analyses, an appendix presents the raw data that underlie Figure 5, along with additional data on individual key preferences. Such simplification, however, would not alter the need to eliminate key position as an unintended controlling aspect of the stimuli whenever one attempts to assess the generality or transfer of stimulus control.

It should be noted that plotting conditional-discrimination learning curves in a signal-detection space does not serve the same function for stimulus-control as for signal-detection theory. The basic concern of signal-detection theory is to measure discriminability—in a conditional discrimination situation, to measure control by the sample stimuli. A matrix located at D (Figure 3), for example, represents perfect control by the samples, and is in this respect as good an indicator of discriminability as is a matrix located at A. Suppose a subject followed the instructions, "When you see a vertical sample, ignore key position and always select the vertical comparison line; when you see a horizontal sample, ignore the comparison lines and always select the key on the left." The resulting matrix, with a hit rate of 1.00, a false-alarm rate of .50, and an accuracy of .75, would fall at Point D in Figure 3, and would represent perfect conditional control over two discriminations—a line discrimination and a position discrimination. (In our laboratory, we have seen many such instances.) The substantial response bias that signal-detection analysis would derive from the difference between the two error probabilities in a matrix located at B would actually be an artifact of the experimenter's incorrect assumptions about the controlling stimuli (Sidman, 1980).

The basic concern of a stimulus-control analysis is with the measurement not simply of sample discriminability, but of the extent to which the samples control the desired comparison discriminations. Although Point D represents perfect sample control (in signal-detection theory, a high d'), the samples do not control the two desired comparison discriminations. Compared to signal detection, then, the present analysis is considerably restricted in scope. It is concerned not with the measurement of sample control as such, but with the measurement of the particular form of sample control that the experimenter has defined as the goal of the experiment.

The analysis does, however, delineate a critical area of the signal-detection space—the square, ADBE. Only if a performance falls within that area can one consider the desired conditional discrimination to be involved. All matrices located within the borders of the square, ADBE, represent performances in which the desired conditional discrimination plays a part. All matrices located on or outside the borders of the square represent performances in which the desired conditional discrimination plays no part.

The path followed by a learning curve as it approaches the critical area, and then as it proceeds within that area toward A, may be a critical property of the learning process. The extent to which this is true will be shown by experiments in which that path is explicitly controlled, by studies of the ways that various paths may influence subsequent performances, and by the development of new conditional discrimination indices that specify the extent to which a subject's performance actually fulfills the requirements of the experimenter-specified contingencies.

REFERENCES

Cohen, L. R. (1969). Generalization during acquisition, extinction, and transfer of matching with an adjustable comparison. *Journal of the Experimental Analysis of Behavior, 12,* 463–474.

Cohen, L. R., Looney, T. A., Brady, J. H., & Aucella, A. F. (1976). Differential sample-response schedules in the acquisition of conditional discriminations by pigeons. *Journal of the Experimental Analysis of Behavior, 26,* 301–314.

Constantine, B. (1981). *An experimental analysis of stimulus control in simple conditional discriminations.* Unpublished doctoral dissertation, Northeastern University, Boston.

Cumming, W. W., & Berryman, R. (1965). The com-

plex discriminated operant: Studies of matching-to-sample and related problems. In D. I. Mostofsky (Ed.), *Stimulus generalization* (pp. 284–330). Stanford, CA: Stanford University Press.

Davenport, R. K., & Rogers, C. M. (1970). Intermodal equivalence of stimuli in apes. *Science, 168,* 279–280.

Davison, M. C., & Tustin, R. D. (1978). On the relation between the generalized matching law and signal-detection theory. *Journal of the Experimental Analysis of Behavior, 29,* 331–336.

Eckerman, D. A. (1970). Generalization and response mediation of a conditional discrimination. *Journal of the Experimental Analysis of Behavior, 13,* 301–316.

Farthing, G. W., & Opuda, M. J. (1974). Transfer of matching-to-sample in pigeons. *Journal of the Experimental Analysis of Behavior, 21,* 199–213.

Ginsburg, N. (1957). Matching in pigeons. *Journal of Comparative and Physiological Psychology, 50,* 261–263.

Goldiamond, I. (1964). Response bias in perceptual communication. In D. M. Rioch & E. A. Weinstein (Eds.), *Disorders of communication* (pp. 334–363). Baltimore: Williams & Wilkins.

Green, D. M., & Swets, J. A. (1966). *Signal detection theory and psychophysics.* New York: Wiley.

Harlow, H. F. (1959). Learning set and error factor theory. In S. Koch (Ed.), *Psychology: A study of a science* (Vol. 2, pp. 492–537). New York: McGraw-Hill.

Iversen, I. H., Sidman, M., & Carrigan, P. (1986). Stimulus definition in conditional discriminations. *Journal of the Experimental Analysis of Behavior, 45,* 297–304.

Mackay, H. A., & Brown, S. M. (1971). Teaching serial position sequences to monkeys with a delayed matching-to-sample procedure. *Journal of the Experimental Analysis of Behavior, 15,* 335–345.

McCarthy, D. C., & Davison, M. (1991). The interaction between stimulus and reinforcer control on remembering. *Journal of the Experimental Analysis of Behavior, 56,* 51–66.

Ray, B. A. (1967). The course of acquisition of a line-tilt discrimination by rhesus monkeys. *Journal of the Experimental Analysis of Behavior, 10,* 17–33.

Ray, B. A., & Sidman, M. (1970). Reinforcement schedules and stimulus control. In W. N. Schoenfeld (Ed.), *The theory of reinforcement schedules* (pp. 187–214). New York: Appleton-Century-Crofts.

Sidman, M. (1980). A note on the measurement of conditional discrimination. *Journal of the Experimental Analysis of Behavior, 33,* 285–289.

Sidman, M., Rauzin, R., Lazar, R., Cunningham, S., Tailby, W., & Carrigan, P. (1982). A search for symmetry in the conditional discriminations of rhesus monkeys, baboons, and children. *Journal of the Experimental Analysis of Behavior, 37,* 23–44.

Sidman, M., & Stoddard, L. T. (1967). The effectiveness of fading in programming a simultaneous form discrimination for retarded children. *Journal of the Experimental Analysis of Behavior, 10,* 3–15.

Stoddard, L. T., & Sidman, M. (1967). The effects of errors in children's performance on a circle-ellipse discrimination. *Journal of the Experimental Analysis of Behavior, 10,* 261–270.

Urcuioli, P. J., & Nevin, J. A. (1975). Transfer of hue matching in pigeons. *Journal of the Experimental Analysis of Behavior, 24,* 149–155.

Weinstein, B. (1941). Matching-from-sample by rhesus monkeys and by children. *Journal of Comparative Psychology, 31,* 195–213.

Weinstein, B. (1945). The evolution of intelligent behavior in rhesus monkeys. *Genetic Psychology Monographs, 31,* 3–48.

APPENDIX

Absolute values for each data point in Figure 5. Hits (H) and false alarms (FA) are shown as instances per opportunity. The number of selections per opportunity is also shown for the first member of each key pair. Values not listed can be determined by simple subtraction.

	Sessions					
	34	35	36	37	38	39
Keys 1 and 2						
H	21/25	26/31	18/25	16/24	22/25	21/22
FA	12/27	18/31	4/26	1/24	1/23	3/21
Key 1	22/52	19/62	22/51	24/48	22/48	21/43
Keys 1 and 4						
H	18/27	25/31	25/26	21/22	23/25	21/21
FA	8/26	15/31	15/24	7/23	5/24	2/24
Key 1	25/53	41/62	19/50	27/45	29/49	25/45
Keys 1 and 5						
H	19/27	22/31	23/26	25/27	19/23	23/24
FA	12/27	11/31	7/28	7/25	4/24	5/23
Key 1	15/54	21/62	20/54	17/52	16/47	17/47
Keys 2 and 4						
H	18/26	21/32	23/26	25/27	23/24	21/23
FA	10/25	11/33	3/25	1/24	8/24	2/22
Key 2	34/51	43/65	26/51	24/51	23/48	24/45
Keys 2 and 5						
H	18/27	19/32	17/26	20/23	22/26	21/22
FA	3/26	3/30	1/26	0/22	0/25	2/23
Key 2	29/53	36/62	26/52	23/45	28/51	20/45
Keys 4 and 5						
H	13/26	13/30	18/26	17/22	15/23	22/22
FA	3/27	5/31	0/27	0/24	0/24	0/22
Key 4	25/53	29/61	29/53	24/46	22/47	24/44