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CONDITIONAL DISCRIMINATION IN MENTALLY RETARDED ADULTS: THE DEVELOPMENT OF GENERALIZED SKILLS

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The development of generalized conditional discrimination skills was examined in adults with retardation. Two subjects with histories of failure to acquire arbitrary matching under trial-and-error procedures were successful under procedures that trained one or more prerequisite skills. The successive discrimination between the sample stimuli was established by training the subjects to name the stimuli. The simultaneous discrimination between the comparison stimuli was established using either (a) standard simple discrimination training with reversals or (b) a procedure in which each of the two sample-comparison relations in the conditional discrimination was presented in blocks of trials, with the size of the blocks decreasing gradually until sample presentation was randomized. The amount of prerequisite training required varied across subjects and across successive conditional discriminations. After acquiring either two or three conditional discriminations with component training, both subjects learned new conditional discriminations under trial-and-error procedures. In general, each successive conditional discrimination was acquired more rapidly. Tests showed that conditional responding had become a generalized skill. Symmetry was shown for almost all trained relations. Symmetry trial samples were ultimately named the same as the stimuli to which they were related in training.

Key words: conditional discrimination, matching to sample, differential sample responses, naming, symmetry, learning set, button press, mentally retarded adults

This study is the second of a series focusing on the acquisition of conditional discriminations by retarded adults with laboratory histories of failure under matching-to-sample procedures. The working hypothesis has been that failure is due to deficits in prerequisite component skills, making these excellent subjects for evaluating the effects of explicitly training potentially critical skill components. For analytic purposes, the use of retarded adult subjects has advantages over the use of normally developing young children (who also have difficulty acquiring conditional discriminations) because eventual acquisition is unlikely to be due to developmental changes or to training experiences outside the laboratory.

By definition, arbitrary matching involves control by a sample stimulus over the selection of a specific comparison stimulus. Although this performance depends on a successive discrimination between the sample stimuli and a simultaneous discrimination between the comparison stimuli, our previous study (K. Saunders & Spradlin, 1989) showed that establishing these two component discriminations may not be sufficient to establish the conditional discrimination. In that study, the discrimination between the samples was established by programming a different schedule of reinforcement in the presence of each, but this did not result in the acquisition of the conditional discrimination by either of 2 subjects. To train the comparison discrimination, 1 subject was then exposed to a series of simple discrimination reversals; he subsequently failed to acquire the conditional discrimination with maintenance of differential sample responses. Both subjects acquired the conditional discrimination when the sample schedule procedure was combined with a procedure in which each of the two sample-comparison relations in the conditional discrimination occurred in blocks of trials within the session, with the size of the blocks decreasing gradually across sessions until sample presentation was randomized. The blocked-trial procedure served to maintain the comparison discrimination within arbitrary matching sessions. In addition, features inher-

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ent to the blocked-trial procedure actively promoted sample control of comparison selection (see K. Saunders & Spradlin, 1989, p. 7). Although successful, the training was lengthy: Approximately 40 sessions were required under the blocked-trial procedure alone.

A major goal of the present study was to determine whether the amount of training required for acquisition would decrease across successive conditional discriminations. The design permitted periodic assessment of learning under trial-and-error conditions or after a reduced number of training components. Increasingly rapid acquisition defines the development of generalized arbitrary matching skills. An additional question was whether unreinforced conditional selection (R. Saunders, Saunders, Kirby, & Spradlin, 1988) would eventually be demonstrated by initially unskilled learners.

A second goal was to replicate systematically the procedure used in K. Saunders and Spradlin (1989). In the present study, 1 subject was exposed to the training components in the same order as a previous subject, but vocal names (rather than button presses) served as differential sample responses. A third goal was to clarify the effects of differential sample responses. In the previous study, acquisition occurred only after the addition of the blocked-trial procedure, leaving the role of the differential sample responses in question. The 2nd subject in the present study was exposed to the blocked-trial procedure first, allowing assessment of the effects of the addition of differential sample responses.

GENERAL METHOD

Subjects

Two adult residents of Parsons State Hospital and Training Center served as subjects. CS was a 37-year-old female with a measured IQ of 58 (Weschler Adult Intelligence Scale), and KR was a 32-year-old male with a measured IQ of 44 (Lieter International Performance Scale). Both exhibited functional speech and participated in vocational training programs.

Apparatus

The subjects sat at a table that supported a stimulus display box that housed an Apple IIE® microcomputer, an interface device, and a DSI tray feeder. Three windows (5 cm by 5 cm), spaced 2.5 cm apart, were mounted in the front wall of the box 105 cm from the floor. During sessions, the computer's monochrome monitor was positioned behind the windows such that stimuli displayed on the monitor screen were centered in the display windows. Under each window was mounted a spring-loaded button with an exposed diameter of 2.5 cm. To the subject's lower left was a container into which pennies were dispensed by the feeder (see Figure 1 in R. Saunders, Wachter, & Spradlin, 1988).

General Procedure and Baseline Training Conditions

Baseline conditional discrimination training sessions used a trial-and-error procedure (i.e., presentation of the terminal task under differential reinforcement). Each trial began with the presentation of one of the two sample stimuli in the center display window. Sample stimuli occurred equally often in a session and were presented quasi-randomly, with the restriction that the same stimulus appear no more than three times in a row. A press on the center button produced the two comparison stimuli in the outer windows; each comparison stimulus occurred an equal number of times in each position and was never in the same position more than three consecutive trials. Additional responses on the sample button had no consequences. Pressing the button under the correct comparison produced a 1-s computer-generated jingle and the delivery of a penny, removed the stimulus display, and initiated an intertrial interval (ITI) that was reset contingent upon sample or comparison button presses. The ITI was 2 s for Subject CS and 5 s for Subject KR. For Subject CS, pressing the incorrect comparison button produced a buzzer and initiated the ITI. For Subject KR, a correction procedure was used; an incorrect selection produced a buzzer but did not result in the removal of the stimulus display. A subsequent correct selection initiated the ITI but had no other consequences. All sessions contained 32 trials. Two or three sessions were conducted each weekday.

Preexperimental History

Using the apparatus and procedures described above, Subject CS did not acquire an arbitrary matching problem involving line drawings of insects and fish in ten 32-trial sessions. Next, a blocked-trial procedure (see Method for Phase 1) was used in an attempt to teach arbitrary matching of letter-like shapes. The final two sessions of the 26-session series contained four blocks of eight trials; mean accuracy was 56%. However, identity matching of 12 letter-like shapes was 100% correct.

Subject KR exhibited chance performance in two sessions of identity matching involving 12 letter-like shapes. When the number of shapes was reduced to two and a blank screen replaced the incorrect comparison stimulus, accuracy reached 100% in seven sessions. However, reintroduction of the incorrect comparison stimulus resulted in two sessions of chance performance. The correction procedure was not used in these sessions.

Pretraining for Subject KR

Subject KR did not exhibit several prerequisite laboratory skills shown by previous subjects (K. Saunders & Spradlin, 1989). A 65-session teaching sequence (a) taught Subject KR to press buttons only when a stimulus was present; (b) taught one simple simultaneous discrimination using a stimulus fading procedure; (c) exposed the subject to several reversals of the simple discrimination (without fading) and ultimately demonstrated changes in selections after no more than three errors; and (d) taught identity matching between letter-like drawings for two different sets of 12 stimuli. The stimuli used in the identity matching sessions were used in later conditional discriminations; the stimuli used in the simple discrimination were not.

PHASE 1: CONDITIONAL DISCRIMINATION TRAINING

METHOD

The stimuli used in each conditional discrimination are shown in Figure 1. The order in which these conditional discriminations were presented is indicated in the first column of Figure 2. Each conditional discrimination was presented first under baseline training conditions (trial and error). If acquisition did not occur, component training was implemented; each subject's component training protocol is described separately below. The top rows in Figure 2 show the order of conditions for each subject. Acquisition could be demonstrated in any baseline training condition (note that the final step of the blocked-trial procedure is the same as baseline training). Upon acquisition (100% accuracy), the experimenter discontinued presession or within-session prompts for naming (which were given only if naming had been trained). This was done in preparation for symmetry tests, which were conducted after each conditional discrimination was acquired.

Training Procedure for Subject CS

The order in which training components were to be presented was (a) sample-naming training, (b) baseline training with sample naming, (c) comparison discrimination training, (d) baseline training with sample naming, and (e) the blocked-trial procedure with sample naming. Subject CS always acquired the conditional discrimination prior to presentation of the blocked-trial procedure, so the blocked-trial procedure will be described with procedures for Subject KR.

Sample naming. The experimenter was seated next to the subject at the apparatus. Sample stimuli were presented randomly in the center window and the comparison keys were inoperative. At the beginning of the first sample-naming session for each conditional discrimination the subject was told, "Today you're going to name the picture and then press the button, and I'll give you a penny when you're right. I'll help you with the names at first." The experimenter named each stimulus the first time it appeared and delivered a penny and praise contingent upon imitation (specific sample names will be presented with the results). For the remainder of the sample-naming phase, pennies were delivered for correct naming. After naming correctly, the subject was allowed to press the sample key, which removed the stimulus and presented the next trial after the ITI. When the sample was named incorrectly, or when the subject had not named the sample within approximately 5 s of its presentation, the experimenter named the stimulus and the subject was required to repeat the name; pennies were not delivered for prompted naming. Criterion for advancement to the next phase was two consecutive sessions in which naming was 97% correct.

Baseline training with sample naming. These were identical to baseline conditional discrim-

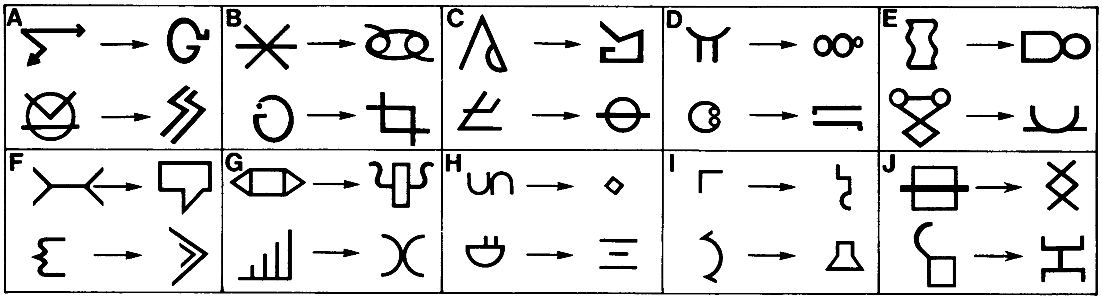

Fig. 1. The stimuli used in each conditional discrimination. The arrows point from sample stimuli to the corresponding correct comparison stimuli.

ination training sessions, except that procedures to maintain sample naming were in effect. Before sessions, subjects were told, "Remember to name." If the subject did not name the sample stimulus correctly within approximately 5 s, the name was provided by the experimenter and repeated by the subject. After correctly naming the sample stimulus, the subject was allowed to press the sample button; there were no other consequences for correct naming. If the percentage of unprompted correct naming responses fell below 90 for two consecutive sessions, conditional discrimination training was interrupted to reestablish criterion performance on sample naming.

Comparison discrimination training. Trials began with the presentation of two comparison stimuli in the outer display windows. The middle display window was always blank and the middle button was inoperative during trials. Consequences for selections were as previously described. One comparison stimulus was designated correct for an entire session. When accuracy reached 94%, the other comparison stimulus was designated correct for the next session (reversal). Training ended when accuracy was 94% or better for two consecutive sessions (one or two errors at the beginning of sessions were expected after reversals).

Training Procedure for Subject KR

For Subject KR, the blocked-trial procedure was presented first and was continued until acquisition occurred or until criterion performance for a given step was not achieved in 35 sessions. If this occurred, the blocked-trial procedure was interrupted, sample naming was trained, and the blocked-trial procedure was reinitiated with maintenance of sample naming.

Blocked-trial procedure. Initially, sessions composed entirely of one trial type were conducted (i.e., the same sample stimulus was presented on all trials). Thus, as in comparison discrimination training, one comparison stimulus was correct for an entire session. The criterion was the same as for comparison discrimination training. Next, sessions containing two blocks of trials were presented (i.e., one sample appeared for the first 16 trials and the other appeared for the second 16 trials). When errors occurred only in the first two trials of each block (demonstrating maintenance of the simple comparison discrimination with a single mid-session reversal), sessions containing blocks of eight trials were presented. Subsequent increases in the number of reversals (blocks) per session were made when accuracy was 100%. The number of trials per block was next decreased to four, and then sessions with irregularly sized blocks of three, four, and five trials were presented. Finally, sessions with randomized presentation of trial types were presented (identical to baseline trial-and-error training conditions).

Sample-naming training. As described for Subject CS.

Blocked trials with sample naming. The procedures for maintaining sample naming within blocked-trial sessions were as described for "Baseline training with sample naming" above.

Symmetry Tests for Both Subjects

Symmetry tests were conducted after each conditional discrimination was acquired. At least one baseline session with no trial-by-trial consequences was conducted before each symmetry test session, and 90% accuracy was required to proceed. Prior to these baseline sessions and symmetry test sessions (also without feedback), subjects were told that the computer would not make sounds or give pennies during the session and that they would be paid at the end of the session. A test session included a mixture of 10 symmetry test trials and 22 baseline trials. On symmetry test trials, baseline sample stimuli were presented as comparisons and vice versa. For example, if the sample–comparison relation A1-B1 had been trained, selecting A1 in the presence of a B1 sample was considered correct. At the end of sessions without feedback, subjects received 1 cent for each correct baseline trial and 1 cent for each test trial regardless of performance, with no comment as to number or type of errors.

Results

Figure 2 shows, for both subjects, the point in the training sequence at which 100% accuracy was achieved under baseline conditions for each conditional discrimination.

Conditional Discrimination: Subject CS

Figure 3 shows the accuracy of sample naming and of comparison selections for all conditional discrimination training sessions for Subject CS. For the first conditional discrimination, the experimenter sometimes pointed to the sample and the correct comparison for a few trials at the beginning of sessions. Circled numerals adjacent to data points for these sessions indicate the number of prompted trials. Because of the subject's history of failure to acquire arbitrary matching, the initial baseline was brief. Accuracy was at chance levels for four sessions. Sample naming was taught in three sessions (the names, "clock" and "feet," were assigned by the experimenter), but poor maintenance of naming in subsequent conditional discrimination sessions dictated retraining. After retraining, comparison selections were 100% accurate.

Accuracy across eight baseline sessions for the second conditional discrimination ranged from 38% to 50%. Spontaneous naming occurred on many trials in the first session; this behavior did not result in consequences and did not recur during baseline. The names assigned by the subject, "star" and "sun," were used in sample-naming training. Sample naming did not promote acquisition, but rapid acquisition of the conditional discrimination occurred after comparison discrimination training

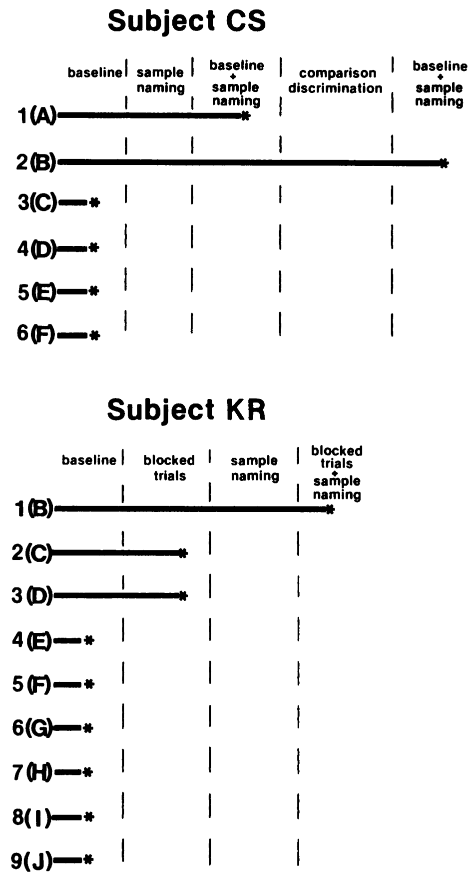

Fig. 2. The order of training components for each subject appears across the top of each schematic. The solid lines show the point in the training sequence at which 100% correct selections occurred under baseline (trial-and-error) conditions for each conditional discrimination. (The final step in the blocked-trial procedure is the same as baseline conditions.) The letters refer to the stimulus arrays shown in Figure 1.

(the penny delivery mechanism failed during Session 33 and performance was at chance levels). Interestingly, after naming instructions and prompts were discontinued in preparation for symmetry tests, samples were often named incorrectly. However, in four subsequent sessions without feedback on selections or naming, naming again became accurate and stable (data not shown).

The next four conditional discriminations were acquired under baseline conditions. The subject spontaneously named the sample stimulus either "star" or "sun" on all trials across the four new conditional discriminations. Naming was ultimately differential with respect to the samples, so the percentage of sam-

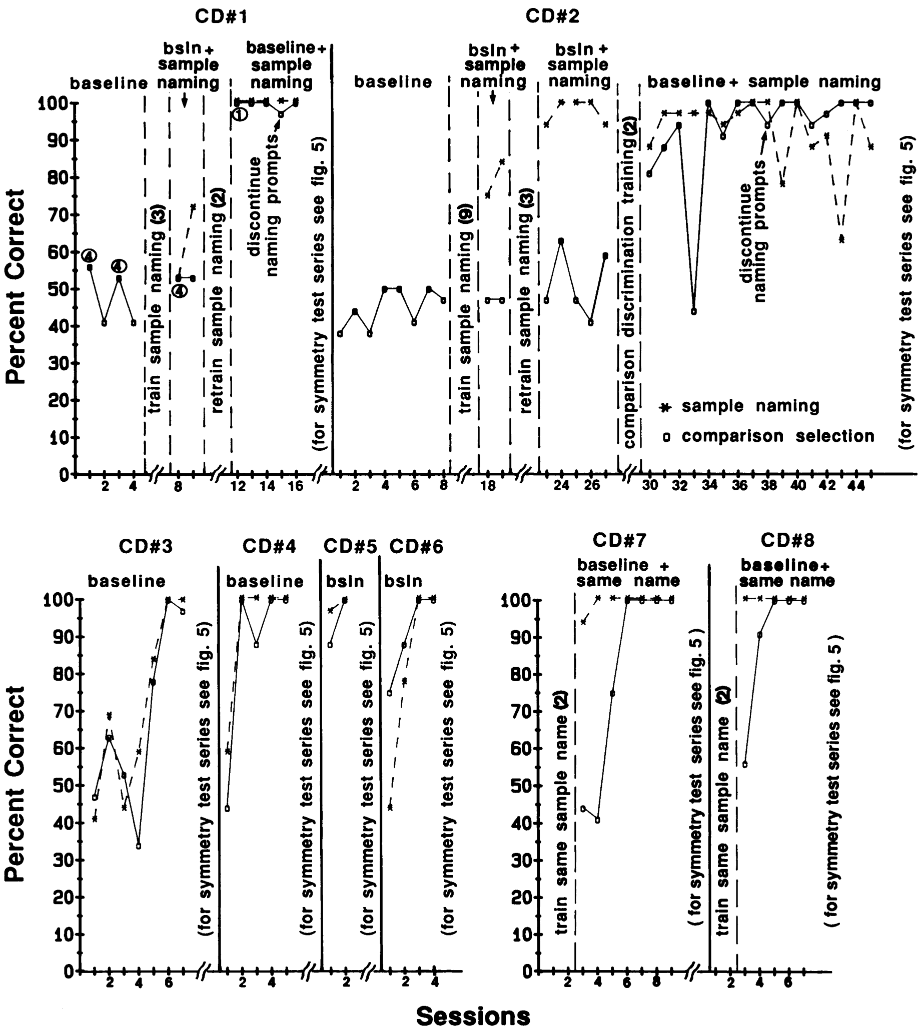

Fig. 3. Percentage of correct comparison selections in the conditional discriminations (circles) and the percentage of correctly named sample stimuli (asterisks) for all conditional discrimination training sessions for Subject CS. Circled numerals next to some data points indicate the number of trials on which selections were physically prompted at the beginning of sessions.

ples named correctly was calculated by scoring retroactively in accord with terminal performance. Increasingly consistent differential naming was associated with increasingly accurate conditional discrimination performance.

Further investigation of sample naming for Subject CS. The spontaneous sample naming of Subject CS raised the question of whether differential sample naming would be necessary for the acquisition of additional conditional discriminations. Before exposure to baseline training conditions for the next two conditional discriminations (#7 and #8), the procedures described previously were used to teach Subject CS to say the *same* name ("chair") in the presence of both sample stimuli. Figure 3 displays sample-naming and comparison selection accuracy for these two conditional discriminations. Acquisition of the first required four sessions and began with two sessions of chance performance. Accuracy on the second conditional discrimination reached 90% in the second session.

Conditional Discrimination: Subject KR

The data for Subject KR are shown in Figure 4. Baseline phases lasted at least 10 sessions. The first three conditional discriminations were not acquired under baseline training conditions, and the blocked-trial procedure was implemented. For the first conditional discrimination, training progressed to blocks of eight trials, but criterion was not met in 35 sessions under this condition (to save space, only the first five and last five sessions are shown). Most errors occurred in the first two trials of a block, indicating successful comparison discrimination but with shifts in comparison selection controlled by the consequences for an error rather than the sample stimulus. Sample-naming training required three sessions; the names "star" and "sun" were assigned by the experimenter. Reinitiation of Block 8, now with maintenance of sample naming, resulted in 100% accuracy of comparison selections by the 15th session. The remaining steps were completed in 11 sessions. The second and third conditional discriminations were acquired under the blocked-trial procedure with few errors. Six subsequent conditional discriminations were acquired increasingly rapidly under baseline conditions.

No-Feedback and Symmetry Test Sessions: Both Subjects

Baseline sessions without feedback and symmetry test sessions occurred following criterion performance on each conditional discrimination. Comparison selection accuracy in baseline sessions rarely fell below 100% (data not shown). An exception occurred with Subject CS's third conditional discrimination: Comparison selections completely reversed for two consecutive sessions, although sample naming was 100% correct. Two training sessions reestablished criterion performance. Selection accuracy on baseline trials within symmetry test sessions was virtually perfect for Subject KR and fell below 95% only twice for Subject CS.

An additional aspect of Subject KR's performance is noted. During no-feedback sessions for each conditional discrimination, KR began to say the names "star" and "sun" in the presence of the sample stimuli. Differential sample naming was perfectly consistent by the first or second no-feedback session.

Data from the symmetry test series for each conditional discrimination are presented in Figure 5. The wide bars show the number of correct selections on the 10 test trials in each session. In early test series, 100% accuracy took two or more sessions to develop; the second test series of Subject KR was discontinued when accuracy was 50% for two consecutive sessions. Both subjects showed perfect accuracy beginning with the second or third test series, except that Subject CS made one error across symmetry tests conducted for conditional discriminations learned with nondifferential sample naming (#7 and #8).

Although instructions to name had been discontinued, both subjects named the sample stimuli on almost all symmetry test trials. Ultimately, the names given to symmetry test samples (former comparisons) were those of the stimuli to which they were related in baseline training sessions; this performance was considered correct. The relation of sample naming and comparison selection on symmetry test trials is shown in Figure 5. For both subjects, naming the sample correctly was usually followed by selecting the correct comparison. Naming the sample incorrectly or not naming was usually followed by an incorrect selection for Subject CS, but there was no consistent pattern of selections after sample-naming errors for Subject KR. On symmetry tests conducted after nondifferential sample naming was trained for Subject CS, sample naming was nondifferential (#7 and #8).

PHASE 2: TEST FOR UNREINFORCED CONDITIONAL SELECTION

Subjects who acquire conditional discriminations rapidly under trial-and-error procedures may have learned something more general than specific sample–comparison relations. For example, they may have learned that, within each problem, comparisons go with samples on a one-to-one basis (this description is not meant to imply control by verbal rules). Thus, when exposed to a new two-choice conditional discrimination *in the absence of feedback,* such subjects may consistently select one comparison stimulus in the presence of one sample and the other comparison in the presence of the other sample (R. Saunders, Saun-

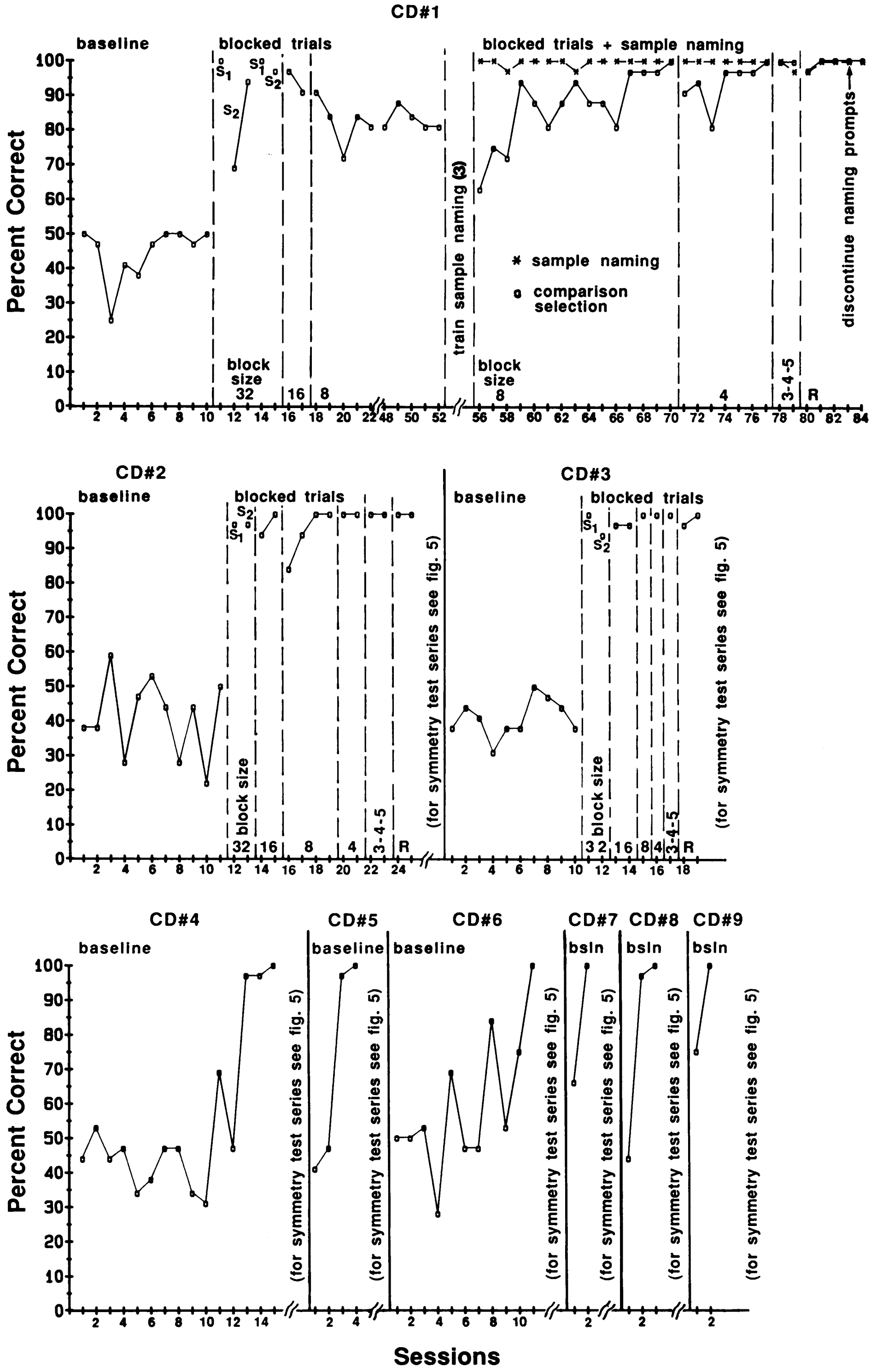

Fig. 4. Percentage of correct comparison selections in the conditional discriminations (circles) and the percentage of correctly named sample stimuli (asterisks) for conditional discrimination training sessions for Subject KR. Sessions 23 through 47 in the first panel are omitted. Block 32 sessions are labeled "S1" (Sample 1) or "S2" to indicate the sample stimulus that was presented. When the blocked-trial procedure is in effect, the size of the blocks of similar trials is indicated by the numerals just above the *x* axis; "R" refers to randomized presentation of trial types.

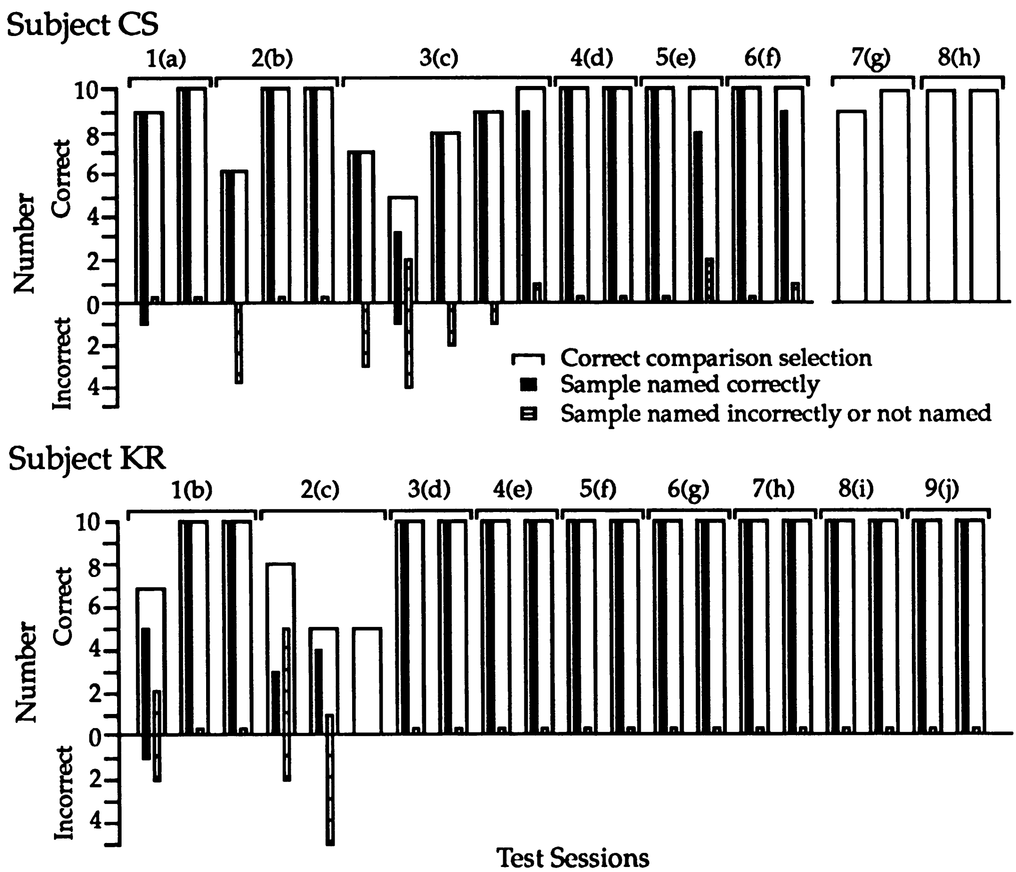

Fig. 5. The wide bars show the number of correct comparison selections in the 10 symmetry test trials of each test session. The solid inner bars show the number of correct (above the zero line) and incorrect (below the zero line) comparison selections on test trials on which the sample was named correctly. The hatched inner bars show the number of correct and incorrect comparison selections on test trials in which the sample was named incorrectly or not named. For example, in his first test session, Subject KR named a total of six test trial samples correctly; of these, five were accompanied by correct comparison selections and one was accompanied by an incorrect selection. Four test trial samples were not named correctly; two of these were followed by correct selections and two were followed by incorrect selections. Naming data were lost for the final session of the second test series for Subject KR. Naming data are not shown for Test Series 7 and 8 for Subject CS, reflecting nondifferential sample naming.

ders, Kirby, & Spradlin, 1988; Stromer, 1986). Would such unreinforced conditional selection be demonstrated by the present initially unskilled learners?

Method and Results

The procedure for these sessions was like that of baseline sessions, except that there was no feedback and subjects were paid 32 cents *before* each session. To familiarize the subjects with this payment procedure, it was first used for two sessions with a previously learned conditional discrimination. The comment, "I'm paying you before the session this time," accompanied payment. No instructions were given.

Test session results are shown in Figure 6. The arrows point from each sample stimulus to the comparison stimulus that was selected most consistently in its presence. The selections of Subject CS were 100% consistent across two test sessions. In his first test session, Subject KR selected consistently across the first five trials, showed the opposite selection pattern on 17 of the next 19 trials, and then returned to the initial selection pattern on the last eight trials. This final selection pattern was exhibited on all trials for two additional sessions.

DISCUSSION

Two retarded adults acquired two or three conditional discriminations only after one or

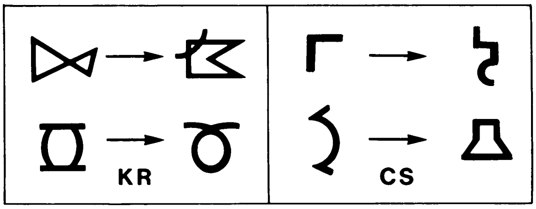

Fig. 6. The sample stimuli (left) and comparison stimuli (right) to which subjects were exposed in generalized conditional selection test sessions. The arrows point from a sample stimulus to the comparison stimulus selected in its presence.

more components of the skill were trained. Subsequently both subjects learned new conditional discriminations increasingly rapidly under trial-and-error procedures. Although learning-set outcomes involving simple discrimination have been well described (e.g., Harlow, 1949; Kaufman & Prehm, 1966), the effects of learning multiple conditional discriminations have received little attention. What generalized skills might such a training history engender? Clearly, experienced subjects can acquire the component simple discriminations in the context of the arbitrary matching task. In addition, the demonstration of unreinforced conditional selection (Phase 2) suggests that conditional responding is a generalized skill. That is, subjects with a history of reinforcement for responding conditionally tend to respond conditionally. There is evidence that this generalized skill may have been in Subject CS's repertoire prior to the present experiment: After training one or both of the component simple discriminations, acquisition of her first two conditional discriminations was extremely rapid. Based on this line of reasoning, it seems possible that generalized conditional responding could be established within a series of problems using highly discriminable stimuli. Once acquisition of such problems occurred reliably with few errors under trial-and-error conditions, training the component simple discriminations might be sufficient for the acquisition of problems involving more complex stimuli (such as those used here).

The present study continues a component analysis of arbitrary matching begun by K. Saunders and Spradlin (1989). Three component skills have been identified: sample discrimination, comparison discrimination, and sample control of comparison selection. Either or both of the simple discriminations may be demonstrated without sample control of comparison selection (K. Saunders & Spradlin, 1989), but sample control is dependent on the two simple discriminations. Although all three skills are necessary, training a single skill component can promote acquisition, as was shown when sample discrimination training alone promoted acquisition of Subject CS's first conditional discrimination. Because the need for explicit component training was shown to decrease over successive new conditional discriminations, one can infer that Subject CS's initial success was because she had a more extensive task-relevant learning history than other subjects did. Thus, acquisition after the training of only one component skill can be taken as evidence that the training has established a necessary skill component, but not as evidence that other skill components are not necessary for the task.

Taken together, the results of the present study and the previous one establish the basis for an arbitrary matching training procedure that combines differential sample responses and the blocked-trial procedure. The blocked-trial procedure serves to maintain comparison discrimination and reversal within the context of the arbitrary matching task; it also incorporates features that promote sample control of comparison selection (see K. Saunders & Spradlin, 1989, p. 7). In the previous study, neither differential sample responding alone nor differential sample responding in combination with independent training of the comparison discrimination were sufficient to establish arbitrary matching. However, when the blocked-trial procedure was presented with maintenance of the differential sample responses, both subjects acquired the conditional discrimination. This established the effectiveness of the blocked-trial procedure, but left open the question of whether differential sample responses contributed to acquisition. Evidence that the blocked-trial procedure alone can be insufficient to establish arbitrary matching may be found in the preexperimental histories of the 2 subjects of the previous study and of Subject CS in the present study: All failed to acquire arbitrary matching under the blocked-trial procedure alone. The present study provided further evidence. Subject KR was exposed to the blocked-trial procedure for an extended number of sessions without acquiring the conditional discrimination; the addition of differential sample responses promoted acquisition. Additional evidence of the effectiveness of differential sample responding is provided by the finding that sample naming alone promoted acquisition of Subject CS's first conditional discrimination. These findings corroborate other demonstrations of facilitation by differential sample responses in pigeons (e.g., Cohen, Looney, Brady, & Aucella, 1976), normal children (Sidman et al., 1982), and nonhuman primates (Sidman et al., 1982).

Positive tests for symmetry, which is one property of equivalence relations (Sidman et al., 1982), showed that the relations learned were more than just rote, invariant chains. The role of stimulus naming in conditional discrimination and stimulus equivalence is a matter of current interest (see McIntire, Cleary, & Thompson, 1987; K. Saunders, 1989; Sidman, Willson-Morris, & Kirk, 1986). Some studies have attempted to relate stimulus naming to the emergence of equivalence relations by asking subjects to name visual stimuli after tests have been conducted. In the present study, stimulus naming was monitored throughout the acquisition of the conditional discriminations and the demonstration of symmetry. The role of naming in each of these phases of performance warrants discussion.

Naming was taught merely as a convenient means of establishing the sample discrimination; the use of this tactic raises several questions. Is the acquisition of a conditional discrimination also promoted by a nonlanguage differential sample response? Studies with human (Sidman et al., 1982) and nonhuman (Cohen et al., 1976; Eckerman, 1970; Sidman et al., 1982) subjects indicate that facilitation can occur when differential sample responses are not spoken names. Does the acquisition of sample discriminations continue to depend on the emission of a differential naming response? Subject CS's untrained naming during trial-and-error conditions suggested that it might, but the acquisition of two new conditional discriminations was not prevented when CS was required to say the same name in the presence of both samples. Although the role of CS's spontaneous naming is unclear, differential sample naming was not necessary to the acquisition of subsequent conditional discriminations.

Is sample naming effective because the naming response itself controls selections? This outcome, which occurs when other types of differential responses are used with nonhuman animals, can interfere with the development of direct control of comparison stimuli by the sample (Urcuioli, 1984, 1985). However, in our previous study (K. Saunders & Spradlin, 1989), conditional discrimination accuracy was well maintained when differential sample responses (button presses) were eliminated. In addition, positive symmetry tests indicated that the trained conditional discrimination did not consist of an invariant stimulus–response–stimulus chain. The present study made no attempt to eliminate naming once it had been established for a particular set of samples. Nevertheless, data from Subject CS suggest that naming need not exert stimulus functions because on two occasions sample naming and comparison selection diverged. After acquiring her second conditional discrimination, naming accuracy became unstable but comparison selection accuracy remained high. In two no-feedback sessions following acquisition of the third conditional discrimination, sample naming was 100% correct and selections were 100% incorrect. These data suggest that the primary function of both types of differential sample responses (naming and button presses) was simply to establish the discrimination between the sample stimuli.

It is also possible that sample naming facilitated acquisition because the subjects began covertly naming comparison stimuli with the same name as the corresponding samples. Results of some of the early symmetry tests suggested that this did not necessarily occur. If it had, when comparison stimuli became samples on test trials, they should readily have been named correctly.

What relation did naming have to the demonstration of symmetry? Because probe trial sample naming and comparison selection tended to correspond, one might assume that one performance was dependent on the other. However, these results do not allow a conclusion beyond that dictated by parsimony: that both performances were the result of the training procedures (see Sidman et al., 1986). The results of an explicit manipulation suggest that symmetry need not depend on differential naming. Symmetry was shown for two conditional discriminations that Subject CS learned with nondifferential sample naming. Although it is possible that covert differential naming also occurred, this possibility seems remote given the developmental limitations of the subject. These findings corroborate other findings suggesting that derived relations need not depend on common names within stimulus classes and different names across classes (Lazar, Davis-Lang, & Sanchez, 1984; Sidman et al., 1986).

The training procedures described here established arbitrary matching in retarded subjects for whom trial-and-error procedures had been unsuccessful. After learning a number of conditional discriminations, the performances of these subjects became virtually indistinguishable from those of intellectually normal subjects: Symmetry test results were positive, and new conditional discriminations were learned under trial-and-error procedures with few errors. Continued development of these procedures will not only provide a means of teaching many important academic and language skills to developmentally limited individuals but will also promote the pursuit of basic research questions that require baseline performances of arbitrary matching to sample.

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