*REVERSAL OF BASELINE RELATIONS AND
STIMULUS EQUIVALENCE: II. CHILDREN*

CAROL PILGRIM, LORI CHAMBERS, AND MARK GALIZIO

UNIVERSITY OF NORTH CAROLINA AT WILMINGTON

In a systematic replication of a study using college-student subjects (Pilgrim & Galizio, 1990), 5- to 7-year-old children learned two conditional discriminations (i.e., A1B1, A2B2, A1C1, and A2C2) in a two-choice arbitrary match-to-sample task and showed the emergence of two three-member equivalence classes (A1B1C1 and A2B2C2). Baseline conditional discrimination performances were quickly controlled by reversals of the AC reinforcement contingencies (i.e., choosing Comparison Stimulus C2 was reinforced given Sample A1, and choosing C1 was reinforced given Sample A2) when the reversals were introduced in restricted baselines. On reflexivity, symmetry, and transitivity/equivalence probes following the reversal, there was some limited indication of equivalence-class reorganization (i.e., A1B1C2 and A2B2C1) in keeping with the concurrently performed baseline relations for 2 of 5 subjects, but the predominant pattern across probe trials was one of inconsistent conditional control. These findings suggest that, given similar challenges, equivalence-class performances may be more easily disrupted in young children than in adults.

Key words: stimulus equivalence, conditional discrimination, discrimination reversal, object displacement, children

Despite the recent explosion of empirical studies targeting the phenomenon of stimulus equivalence, only limited information is available regarding factors that may influence equivalence performances subsequent to their initial emergence. Such information is an important next step in understanding the functioning of “equivalence” and in furthering the analysis of its properties as an operant class. As one experimental strategy toward this end, identifying conditions that disrupt class performances may provide a clearer understanding of the variables controlling these discriminative patterns and their maintenance.

In a recent study from this laboratory (Pilgrim & Galizio, 1990), experimental manipulations were designed to bring about a modification or disruption of equivalence patterns. After learning baseline AB and AC conditional discriminations and showing the emergence of two three-member equivalence

classes (i.e., A1B1C1 and A2B2C2), college-student subjects were exposed to a reversal of the AC baseline relations. In the reversal condition, choosing Comparison Stimulus C2 was reinforced given Sample A1; choosing C1 was reinforced given Sample A2. This manipulation might have been expected to produce a reorganization of the classes (i.e., A1B1C2 and A2B2C1). The surprising results were that although symmetry probe performances were immediately controlled by the reversal of baseline relations for 3 of 4 subjects (i.e., A1 was chosen given a C2 sample, and A2 was chosen given a C1 sample), reflexivity and transitivity/equivalence performances remained consistent with the original equivalence classes. The generality of these basic findings has recently been extended in further analysis with 5 additional young adults, for whom symmetry but not transitivity/equivalence performances were immediately controlled by baseline reversals (Pilgrim & Galizio, 1995).

The inconsistencies between transitivity/equivalence and baseline performances are interesting because baseline relations are commonly held to be the basis for equivalence-class performances. Other researchers have described a similar lack of correspondence between equivalence patterns and reversed baseline relations using somewhat different baseline procedures (Saunders, Saunders, Kirby, & Spradlin, 1988; Spradlin,

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Correspondence and reprint requests may be sent to the first author, Department of Psychology, University of North Carolina at Wilmington, 601 South College Road, Wilmington, North Carolina 28403 (E-mail: pilgrimc@vxc.ocis.uncwil.edu).

Saunders, & Saunders, 1992). However, modified transitivity/equivalence patterns, in keeping with reversed baseline relations, have also been reported (Dube, McIlvane, Maguire, Mackay, & Stoddard, 1989; Saunders *et al.*, 1988; Spradlin, Cotter, & Baxley, 1973; Spradlin *et al.*, 1992). Even more notable with respect to the Pilgrim and Galizio (1990, 1995) data, however, was the contrast between transitivity/equivalence and symmetry test performances, because equivalence classes are defined by congruent patterns of responding on all tests of equivalence properties (Sidman & Tailby, 1982). Such a finding has not been reported elsewhere as a function of reversal manipulations; in other studies involving reversal of a baseline relation, symmetry tests were either omitted (Saunders *et al.*, 1988; Spradlin *et al.*, 1973, 1992) or were not possible given the baseline (Dube *et al.*, 1989).

Collectively, the data from Pilgrim and Galizio (1990) have been viewed as a potentially significant challenge to current theoretical formulations of equivalence (Carrigan & Sidman, 1992). More specifically, these data raise questions about the integrity of the equivalence phenomenon, as defined by cohesiveness among the properties of reflexivity, symmetry, and transitivity/equivalence. The present study was designed as a relatively straightforward systematic replication of our previous work. In an effort to test the generality of those findings, and because all reports of modified transitivity/equivalence performances following baseline reversals have involved subject populations other than college students, the present study was conducted with young children as subjects. Would the equivalence performances of young subjects show more or less sensitivity to the alteration of prerequisite baseline relations?

METHOD

Subjects

Subjects were 4 female and 4 male normally capable children who attended a local preschool or its after-school program. The preschool served a primarily lower socioeconomic level population, with many students' enrollment subsidized by New Hanover County (North Carolina) Developmental Ser-

vices. Subjects were between 5.0 and 7 years 3 months old at the start of this study (DI, 5.0 years; LU, 5.0 years; ZK, 5 years 1 month; KI, 5 years 4 months; ST, 5 years 4 months; DN, 5 years 8 months; DR, 7 years 2 months; LA, 7 years 3 months).

All subjects had participated in a project focused on the acquisition of conditional discriminations prior to their involvement in this experiment. The specific procedures used to facilitate initial discrimination learning in that study varied across subjects (sample naming for LA, DI, and KI; instructions for LU, ST, ZK, and DN; thematic matching, in which sample and correct comparison were members of a familiar category, for DR), but all subjects had mastered at least one conditional discrimination via differential reinforcement procedures alone prior to their participation in the current study.

Apparatus

Subject and experimenter sat on opposite sides of a small table, with a modified Wisconsin General Test Apparatus (WGTA) placed between them. The WGTA has been described fully elsewhere (Pilgrim & Galizio, 1990). Stimuli were 15 three-dimensional wooden or plastic objects of various abstract shapes and colors (approximately 2 cm by 2 cm by 1 cm) mounted on black cardboard squares (5 cm by 5 cm). Six stimulus objects were selected for each subject, with class designations and combinations that varied across subjects. Each group of six stimuli was chosen carefully to ensure that no two objects held color or other obvious physical characteristics in common.

All stimulus and reinforcer presentations were arranged manually by the experimenter, who raised the WGTA's guillotine door and slid a Plexiglas stimulus tray (25 cm in length) into the subject's half of the apparatus. Either the sample stimulus or the sample plus two comparison stimuli were presented; the sample stimulus was always located in the center of the tray, and the comparison stimuli were located on either side of the sample. Each stimulus object covered a concave well (3 cm in diameter) in which pennies could be placed. Subjects responded by displacing a stimulus object and removing a penny if one was present. After retracting the stimulus tray and closing the guillotine door, the ex-

perimenter recorded each response and prepared the next stimulus arrangement.

Procedure

General procedure. A two-choice, arbitrary, simultaneous match-to-sample procedure was used. A trial began with the presentation of a sample stimulus. Following an observing response to the sample, the stimulus tray was retracted, the guillotine door was closed, and the tray was immediately re-presented with two comparison stimuli on either side of the sample. On baseline trials with reinforcement, moving the comparison stimulus designated as correct revealed a penny, which was immediately exchanged for an edible reinforcer (small fruit or candy). Moving the stimulus designated as incorrect revealed an empty well. On baseline and probe trials without reinforcement, all stimulus wells were empty. A 20-s intertrial interval separated comparison choice and presentation of the next sample.

Sessions lasting approximately 15 min and consisting of 16 trials were conducted 5 days a week, or as often as possible given absences and schedule conflicts. Children who participated in all sessions possible for that week received a small toy after the Friday session.

Original baseline training. Subjects first learned an AB conditional discrimination (A1B1 and A2B2) to mastery (14 of 16 trials correct for two consecutive sessions) under continuous reinforcement conditions (i.e., all correct selections resulted in obtaining a penny). Trial blocks consisted of eight A1:B1B2 and eight A2:B1B2 trials presented in a quasi-random sequence, with the restrictions that the same sample could not appear on more than three trials in succession and that no comparison stimulus could appear in the same location for more than two trials in succession. Correct comparison stimuli could not appear in the same location, nor could they alternate, for more than three trials in succession. Each comparison stimulus appeared equally often in the two side positions.

An AC conditional discrimination (A1C1 and A2C2) was then trained to mastery, with procedures identical to those described for AB training. In the next phase, AB and AC trials were randomly mixed. Each of the four trial types (A1:B1B2, A2:B1B2, A1:C1C2, and A2:C1C2) was presented four times in a quasi-

random sequence, with the same restrictions described above. Upon reaching mastery of the mixed baseline, reinforcement density was reduced to 75% and then 50% by interspersing one and then two no-reinforcement trials of each type among the trials with reinforcement. When mastery was maintained at each level, probe sessions were introduced.

Once the testing phase began, each daily session consisted of 12 baseline trials (six AB and six AC) intermixed with four probe trials. Probe trials were never presented in succession. Reinforcement density remained at 50% for probe-trial sessions; one trial of each baseline type and all four probe trials were unbaited. On alternating sessions, probes tested for either symmetry (B1:A1A2, B2:A1A2, C1:A1A2, C2:A1A2 trials) or transitivity and equivalence (B1:C1C2, B2:C1C2, C1:B1B2, C2:B1B2 trials).

Testing conditions were in effect for a minimum of eight sessions and until stability criteria were met for all probe and baseline trial types. Stability criteria were met when the difference between the percentage of correct trials for the most recent two sessions of a given probe type (i.e., symmetry or transitivity/equivalence) and the immediately preceding two sessions of the same type was no greater than 10% of the grand mean for the four sessions. Thus, subjects were required to show stable performances on baseline, symmetry, and transitivity/equivalence trials concurrently across a minimum of eight sessions total before conditions were changed. (Experimenter error resulted in an exception to the stated minimum requirements for Subject LA.)

AC reversal. In the AC reversal condition, contingencies for the AC conditional discrimination trials were simply reversed. Given Sample A1, choosing Comparison Stimulus C2 revealed a penny; choosing C1 revealed an empty well. When A2 was presented as the sample, choosing C1 was reinforced and choosing C2 was extinguished. Contingencies for the AB conditional discrimination were unchanged from the original training conditions.

For the first 4 subjects tested in this condition (Subjects LU, ZK, ST, and DN), the reversed contingencies were initially arranged within the context of a regular probe session. Session composition was identical to

that of the previous testing phase, except that reversed reinforcement contingencies were in effect for the six AC baseline trials. If trends toward acquisition were not apparent within 10 sessions, the training baseline was restricted until mastery was achieved. For Subjects ZK and ST, sessions were first restricted to randomly mixed AB and AC trials (eight of each) and then AC trials only (16 total), both with continuous reinforcement. Subjects LU and DN received the AC-only training as their first restriction. Mastery of the reversed AC-only baseline was followed by either mixed AB and AC trials (Subjects ST and DN) or by a succession of conditions that included AB trials only, blocks of eight consecutive AB and then AC trials, and then mixed AB and AC trials (Subject LU). When acquisition problems occurred on the AC-only baseline (Subject LU), the experimenter presented the following instructions prior to each of the first five trials of a session and following any error: "When you see this one [Sample A1 was held in one hand], pick this one [Comparison C2 was presented in the other hand]. And when you see this one [A2 was presented], pick this one [C1 was shown]." When mastery was maintained with instructions omitted, the mixed AB and AC baseline was presented again.

Training continued until mastery was achieved with the mixed AB/AC baseline at 100%, 75%, and 50% reinforcement density. Three of these subjects (ST, ZK, and LU) left the preschool during reversal training and thus were unable to complete the experiment. All 3 subjects showed stable symmetry and transitivity/equivalence performances indicative of two three-member equivalence classes during original testing conditions, but given the absence of probe data following AC reversal, only their reversal acquisition data are included for comparative purposes.

Based on training outcomes from the first 4 subjects, reversed AC contingencies for the remaining subjects (DI, KI, DR, and LA) were initially presented in sessions consisting of AC trials only (16 trials with continuous reinforcement). Once the new AC relation was mastered, mixed AB and AC sessions were presented, and reinforcement density was decreased in successive phases to 50%.

Upon mastery in all training phases, testing procedures like those described above were

reintroduced. In this condition, probe sessions tested for either symmetrical or transitive stimulus control in an alternating sequence, and reflexivity probe sessions were introduced into the test sequence at different points for 4 subjects. Subjects DI and KI received reflexivity probe sessions from the beginning of their reversal testing phase, Subject DR received reflexivity sessions for the first time exactly halfway through reversal testing, and for Subject DN, reflexivity probe sessions were first introduced during a second original baseline training with new stimuli. Once introduced, reflexivity probe sessions alternated with symmetry and transitivity sessions in a regular sequence. Subject LA received only symmetry and transitivity/equivalence probe sessions. The AC reversal condition remained in effect until subjects met stability criterion for all trial types (AB and AC baseline, BA and CA symmetry, transitivity/equivalence, and reflexivity) simultaneously or until either 15 (Subject LA) or 20 (Subjects DI, KI, DN, and DR) sessions of each probe type had been completed.

Return to baseline. Contingencies for the AC conditional discrimination were returned to those of the original training condition (i.e., given Sample A1, choosing Comparison C1 was reinforced and given Sample A2, choosing C2 was reinforced), while AB contingencies remained unchanged. For all 5 subjects, original contingencies were first reinstated in the context of AC-only sessions. Mixed AB and AC sessions and reductions in reinforcement density followed.

Testing began upon mastery of the baseline, and was conducted as described previously. Symmetry, transitivity/equivalence, and reflexivity probe sessions alternated regularly, in that order, for all subjects except LA, who received only symmetry and transitivity sessions. Testing in this condition continued until stability criteria were met (Subject LA), 20 sessions of each trial type had been completed (Subject DR), or for as long as the subject was available for testing (Subjects DI, KI, and DN). Subject DN left the preschool for a period of time following her first return-to-baseline condition. Upon her return, two new conditional discriminations were trained with new stimulus objects, and the entire sequence of experimental conditions was repeated.

Fig. 1. Performances on the AB (open triangles) and AC (filled circles) baseline conditional discrimination trials of every session for Subjects LU, ZK, ST, and DN. Consecutive sessions are represented on the horizontal axis. The vertical axis represents the percentage of AB or AC baseline trials on which responses were consistent with the original training contingencies. Labels at the top of each set of coordinates indicate the reinforcement contingencies in effect (original or reversed). Labels within each panel indicate the composition of the baseline being tested (i.e., full probe baseline including AB, AC, and probe trials, or restricted baselines with mixed AB and AC trial types, AC trials only, AC trials with instructions, AB trials only, or blocks of eight AB and then AC trials).

RESULTS

Figures 1 and 2 each show data from 4 subjects for AB and AC baseline performances by session. The figures begin with the original baseline and probe testing phase and show all baseline performances for the experiment's duration. Each open triangle represents the percentage of six AB baseline trials on which responding was consistent with the original conditional discrimination training contingencies. Similarly, each filled circle represents the percentage of six AC baseline trials on which responding was consistent with original contingencies.

The data for all 8 subjects show strong control of baseline performances by the original contingencies (left panel for each subject and Panel OR2 for DN; Figure 1). The second

panel for each subject in Figure 1 shows performances when the AC contingency reversal was first arranged as part of the full, ongoing probe baseline. Even after extended experience, none of the 4 subjects exposed to this condition mastered the new contingency, although AC, and often even AB, performances were clearly influenced by the contingency change. When the training baseline was restricted to mixed AB and AC trials for Subjects ZK and ST (third panel), AC performances were further changed from baseline but remained erratic, as did AB performances.

In contrast, when the baseline was restricted to AC trials, control by the new contingency was quickly established (third panel for LU and DN, fourth for ST), and was well main-

Fig. 2. Performances on the AB (open triangles) and AC (filled circles) baseline conditional discrimination trials of every session for Subjects DI, KI, DR, and LA. Consecutive sessions are represented on the horizontal axis. The vertical axis represents the percentage of AB or AC baseline trials on which responses were consistent with the original training contingencies. Labels at the top of each set of coordinates indicate the reinforcement contingencies in effect (original or reversed). Labels within each panel indicate the composition of the baseline being tested (i.e., full probe baseline including AB, AC, and probe trials, or restricted baselines with mixed AB and AC trial types, AC trials only, AC trials with instructions, AB trials only, or blocks of eight AB and then AC trials).

tained when AB and AC trials were mixed in the next phase (Subjects ST and DN). Subject LU was unique in that AB and AC performances never became consistent with post-reversal contingencies when trial types were mixed (Panels 6 and 10), despite control established by each contingency independently.

Figure 2 shows that when the AC reversal was initially introduced in the restricted context of AC-only trials, all 4 subjects' AC performances were immediately reversed (second panels), control by AB and AC contingencies was quickly established when the two were mixed (third panels), and performances were well maintained in the context of full probe sessions (fourth panels).

This same pattern of contingency control was reproduced with all subjects in the return to original baseline contingencies and with Subject DN during her second sequence of experimental conditions (Figure 1). In sum, baseline performances appeared to be sensitive to changes in contingencies, with strong control exerted by contingency reversals when implemented in isolation and then added to other baseline components.

The data of primary interest in the present study—the results from probe trials—are presented in Figures 3 through 6 and in Table 1. In each of these figures, subjects are presented in order of their age, with the youngest subject presented first and the oldest last.

Table 1
Number of trials consistent with original training and the total number of trials for each probe sample in each experimental condition.

Probe samples	DI			KI			DN			DR			LA		
	Orig	Rev	Orig	Orig	Rev	Orig	Orig 1	Rev 1	Orig 2	Rev 2	Orig 2	Rev	Orig	Rev	Orig
Reflexivity															
A1	—	11/15	4/6	—	11/12	11/12	—	—	4/4	12/15	2/3	6/6	11/11	—	—
A2	—	9/12	4/10	—	18/18	13/14	—	—	2/2	13/15	4/6	6/7	16/16	—	—
B1	—	10/15	2/7	—	9/10	10/14	—	—	3/3	13/14	2/4	4/6	16/16	—	—
B2	—	10/14	3/6	—	10/10	11/12	—	—	3/3	13/15	3/4	9/9	11/11	—	—
C1	—	8/12	2/8	—	15/15	9/10	—	—	2/2	8/10	4/6	6/6	14/14	—	—
C2	—	9/12	4/7	—	15/15	10/11	—	—	2/2	10/11	4/5	6/6	12/12	—	—
Symmetry															
B1	13/14	10/20	5/11	9/9	12/20	12/18	4/4	22/22	8/11	12/15	18/20	5/7	7/8	21/21	19/20
B2	14/14	11/20	5/11	9/9	10/20	11/18	4/4	20/22	8/11	15/15	17/20	5/7	8/8	18/21	18/20
C1	13/14	9/20	6/11	8/9	8/20	8/18	4/4	5/22	7/11	15/15	8/20	6/7	8/8	11/21	14/20
C2	14/14	4/20	7/11	9/9	12/20	7/18	4/4	5/22	5/11	14/15	8/20	5/7	7/8	7/21	9/20
Transitivity															
B1	15/15	6/20	5/12	9/9	9/20	10/18	5/5	7/23	7/11	17/17	13/20	5/6	9/9	13/21	13/20
B2	15/15	11/20	8/12	9/9	11/20	9/18	5/5	8/23	6/11	15/17	13/20	4/6	9/9	10/21	13/20
C1	15/15	5/20	5/12	9/9	11/20	11/18	5/5	8/23	6/11	17/17	8/20	4/6	9/9	14/21	14/20
C2	15/15	6/20	4/12	9/9	8/20	12/18	5/5	9/23	7/11	16/17	8/20	4/6	9/9	9/21	11/20

Note. Hit rate and false-alarm rate for choices consistent with original contingencies can be easily derived from this table if the signal-detection analysis suggested by Sidman (1992a) is preferred. For example, with respect to original symmetry responses to Sample B1, table entries showing 13/14 original responses for Symmetry Sample B1 and 14/14 original responses for Symmetry Sample B2 would yield a hit rate of 93% (for A1 given B1) and a false-alarm rate of 0% (for A1 given B2).

PERCENT ORIGINAL - CA SYMMETRY

Figure 3 shows CA symmetry responses by session; each data point represents the percentage of two CA probe trials on which responding was consistent with the equivalence classes established by original training conditions (i.e., A1B1C1 and A2B2C2). During the original baseline conditions (leftmost panel for all subjects plus fourth panel for DN), all 5 subjects came to demonstrate the stable choice patterns that would be predicted given their training (that is, C1 was selected given A1, and C2 was selected given A2).

Reversed AC contingencies produced an immediate change in CA response patterns (second panel for all subjects, plus fifth panel for DN). However, 3 of the 5 children (DI, KI, and DR) never developed a consistent response to CA probes throughout their exposure to the reversal condition, despite the new and consistent choice patterns being simultaneously exhibited on AC baseline trials. Interestingly, these same subjects continued to show erratic CA performance even after original reinforcement contingencies were reinstated. Table 1 provides the ratio of responses consistent with original training to the total number of trials on which each sample stimulus was presented in each experimental condition. This analysis revealed that there was no consistent conditional control exerted by either sample stimulus (C1 or C2) during the reversal or the return to original conditions for these 3 subjects.

One necessary limitation of the analysis provided in Table 1 is that it would not reveal systematic alteration of comparison choice or shifts from one consistent but short-lived pattern to another. However, no such trends were apparent from inspection of these data on a session-by-session basis. Neither were position preferences in evidence, either across the probes of any single session or across sessions for a given probe sample.

Two subjects (DN in her first reversal and LA; Panel 2 of Figure 3) did change their CA choice patterns in keeping with the reversed contingencies (i.e., C2 was chosen given A1,

and C1 was chosen given A2), but these new patterns took some time to develop. Interestingly, the oldest subject (LA) immediately returned to original CA patterns given original conditions (Panel 3), but CA patterns for DN became disrupted at this point (Panel 3). In her second reversal sequence (Panels 5 and 6), DN showed irreversible CA disruption like that of the first 3 subjects. Again, there was an absence of consistent conditional control by either Sample C1 or C2 (see Table 1). In general then, AC reversal tended to disrupt CA symmetry performances for these young subjects. Only the oldest showed CA patterns that were indicative of consistent control by the baseline conditional discriminations concurrently in evidence.

Figure 4 shows data analogous to those of Figure 3, but for BA symmetry probes. All subjects quickly showed performances indicative of BA symmetry in the original reinforcement condition. Interestingly, the AC baseline reversal produced disruption in BA choice patterns for the first 3 subjects that continued even when AC contingencies were returned to original conditions. This finding was of particular interest given that the unmodified AB conditional discrimination, on which probe responding was presumably based, was being consistently performed across these experimental conditions. Again, control by Samples B1 and B2 was equally disrupted for these subjects (Table 1). In contrast to the first 3 subjects, DR and LA showed little or no disruption of BA symmetry given the AC reversal. Interestingly, for this small sample of subjects, the extent of BA disruption was directly related to the subjects' age, with less disruption observed as age increased across subjects.

Figure 5 shows transitivity/equivalence responses by session; each data point represents the percentage of four probe trials on which responding was consistent with the equivalence classes established by original training conditions (i.e., A1B1C1 and A2B2C2). All 5 subjects showed the stable probe patterns in-

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Fig. 3. Performances on the two CA symmetry probe trials of every symmetry test session. Consecutive symmetry test sessions are represented on the horizontal axis. The vertical axis represents the percentage of CA probe trials on which responses were consistent with the equivalence classes established by the original training contingencies. Double vertical lines indicate intervening training sessions that did not include probe trials.

PERCENT ORIGINAL- BA SYMMETRY

dicative of transitivity/equivalence during original baseline conditions.

Reversed AC contingencies produced an immediate disruption in transitive/equivalence patterns for all 5 subjects, and with only one exception, no consistent probe pattern developed during the reversal condition, despite the coexistence of well-controlled baseline performances. Once again, pattern analysis revealed an absence of consistent conditional control by any of the sample stimuli (Table 1). Although DN developed performances consistent with the new baseline, the pattern did not reverse with a return to original contingencies and was not replicated in her second experimental sequence. When baseline conditions were reinstated, only the oldest subject, LA, shifted from the disrupted pattern, to an original transitivity/equivalence pattern. In general, transitivity/equivalence performances were altered by the AC reversal, but were not consistently controlled by the ongoing baseline for any subject.

Figure 6 data points represent the percentage of four trials on which responses reflected reflexivity. For 2 subjects (DI and DN), reflexivity performances became erratic in the AC reversal condition and remained so during the return to baseline contingencies. For these subjects, conditional control was equally disrupted for each of the sample stimuli presented on reflexivity probes (Table 1). In contrast, reflexivity was fairly consistently demonstrated across conditions for Subjects KI and DR.

DISCUSSION

On probe tests following the original baseline conditional discrimination training, the performances of these children were highly similar to those of the adults from our previous work (Pilgrim & Galizio, 1990, 1995). Consistent symmetry and transitivity/equivalence responding by each child gave every indication of two well-established three-member equivalence classes. Further, sensitivity of

baseline conditional discriminations to manipulations of reinforcement contingencies was also apparent for these children. When reversed AC contingencies were first introduced in sessions restricted to AC trials, the new discrimination was learned rapidly, and efficient mastery of the mixed baseline followed.

However, the children did have difficulty acquiring the reversed discrimination when it was first presented within the full probe-baseline arrangement that was sufficient for adults (Pilgrim & Galizio, 1990, 1995). Other researchers have reported difficulty in reversing the conditional discriminations from which equivalence performances have emerged, particularly when the reversed relations were interspersed among unchanged discriminations (Saunders et al., 1988; Spradlin et al., 1992), and some have suggested an extreme resistance to change in relations that would modify class membership (Spradlin et al., 1992). An alternative interpretation of the present data, however, might emphasize a more general disruption in stimulus control, as opposed to a resistance to change. When AC contingencies were reversed within a mixed or full baseline context, responses on AC trials quickly became significantly different from original patterns but were erratic, as were the AB responses (for 3 of 4 subjects) for which contingencies had not been altered. Thus for these subjects, the performances seemed relatively easy to disrupt but, compared to adults, were difficult to bring under consistent conditional control within the more complex training baseline.

Differences between adult and child performances became much more dramatic on the probe trials following the AC contingency reversal. In general, the adults' symmetry responses proved to be tightly controlled by the baseline contingencies currently in effect. A similar pattern of control by baseline relations was seen for only the oldest of the children. Although all 5 children showed a change in CA patterns from original baseline

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Fig. 4. Performances on the two BA symmetry probe trials of every symmetry test session. Consecutive symmetry test sessions are represented on the horizontal axis. The vertical axis represents the percentage of BA probe trials on which responses were consistent with the equivalence classes established by the original training contingencies. Double vertical lines indicate intervening training sessions that did not include probe trials.

to AC reversal, performances were inconsistent, and only 2 subjects showed any clear impact of the return to the original conditions. Even BA responses were consistent with the baseline in only 5 of the 12 phases (total across all subjects) that followed reversal, despite the fact that AB baseline relations remained constant.

The children's transitivity/equivalence patterns following reversal were also in direct contrast to those shown by adults. Whereas adult transitivity had shown an impressive insensitivity to baseline manipulations, all 5 children were immediately influenced by the AC reversal, and 2 showed a definite change in pattern upon the return to the original conditions. As was the predominant case with symmetry, however, transitivity/equivalence patterns still remained erratic throughout 10 of 12 postreversal phases, even while baseline performances were stable.

Finally, reflexivity patterns, which had shown no effect of baseline modifications for adults, were disrupted for 2 of 4 children. Reflexivity was the predominant pattern for 2 other subjects, even though probes for reflexivity were not presented until after the reversal manipulation, thus removing the possibility that an original pattern was due simply to having behaved in that way prior to the reversal.

As judged by probe performances, the status and composition of adults' equivalence classes following baseline reversal were somewhat unclear (Pilgrim & Galizio, 1990, 1995). Symmetry patterns reflected baseline reversal and suggested equivalence-class modification, whereas the unchanged transitivity/equivalence patterns that occurred simultaneously were inconsistent with modified classes and instead remained entirely in keeping with the originally established classes. For the children of the present study, however, it appears that original equivalence classes were disrupted by the baseline manipulation. It has been noted that probe patterns may become indepen-

dent of the baselines from which they emerge (Saunders et al., 1988; Spradlin et al., 1992), but that did not appear to be the case for these children (nor for much of adult symmetry). Especially when compared to adult transitivity/equivalence, children's equivalence classes appeared to be more malleable, perhaps in keeping with the rapidly changing and expanding verbal abilities of increasing complexity that are characteristic of these ages. There was even some limited indication among the children of class reorganization following AC reversal. In her first reversal condition, Subject DN eventually reversed both transitivity/equivalence and CA symmetry patterns; thus, all probe performances were consistent with the equivalence classes that would follow from the modified baseline conditional discriminations (i.e., A1B1C2 and A2B2C1). However, her probe patterns became erratic when original contingencies were reinstated, and the within-subject replication revealed no evidence of new class formation. For Subject LA, symmetry patterns were consistently controlled by each of the baseline manipulations. Transitivity/equivalence performance was also significantly altered by the reversal, and although it never became completely consistent with the baseline, patterns did return to original when those contingencies were reinstated. Although these results may be suggestive of class reorganization, the failure to replicate with DN and the remaining inconsistency between transitivity/equivalence and baseline performances during the reversal condition for LA make such an interpretation tentative at best.

An alternative view of the children's performance is that equivalence classes were more fragile than malleable. Certainly the most common outcome involved probe performances that immediately reflected a change in baseline relations but remained inconsistent with both original and new baselines. The disruption of BA symmetry pat-

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Fig. 5. Performances on the four transitivity/equivalence probe trials of every transitivity test session. Consecutive transitivity test sessions are represented on the horizontal axis. The vertical axis represents the percentage of transitivity/equivalence probe trials on which responses were consistent with the equivalence classes established by the original training contingencies. Double vertical lines indicate intervening training sessions that did not include probe trials.

Fig. 6. Performances on the four reflexivity probe trials of every reflexivity test session. Consecutive reflexivity test sessions are represented on the horizontal axis. The vertical axis represents the percentage of reflexivity probe trials on which responses were consistent with the equivalence classes established by the original training contingencies. Double vertical lines indicate intervening training sessions that did not include probe trials.

terns for the 3 youngest subjects may be particularly important in this regard. Because AB baseline discriminations were constant across experimental phases, disrupted BA performances would not be expected to follow from a simple class reorganization or from competing control by original versus reorganized classes (see Spradlin et al., 1992).

Another possibility suggested by a comparison of these data with our findings from adults is that "consistency" in responding is a less well-established property, or higher order class, for young children. Recent theoretical analyses have emphasized that equivalence relations may be selected for on probe trials by virtue of their being the only relation between sample and comparison stimuli that is held in common by all probe trials (e.g., Sidman, 1992b; Spradlin et al., 1992). Given a particular reinforcement history in which "problems" always have a single correct "solution," subjects will come to consistently select comparisons on the basis of equivalence relations when that is the only consistent basis for selection (Sidman, 1992b). In essence, the consistency of the probe-trial arrangement is instructive of "what the experimenter is looking for," but in the absence of this history, there is no reason for consistent performance. Following from this, children, with less of a "one-solution" history, might be expected to respond less consistently on probes, particularly after learning more than one "solution" (i.e., original and reversed AC contingencies) to a single "problem" (i.e., the AC conditional discrimination). Other researchers have reported greater sensitivity to reinforcement contingencies in children than in adults, and have often attributed these differences in nonverbal performances to varying verbal abilities (e.g., Bentall, Lowe, & Beasty, 1985; Lowe, Beasty, & Bentall, 1983). The present data may indicate that contingency sensitivity is not due to an absence of language per se (the present subjects were quite verbal), but rather to less control by other possible demand characteristics of the social context (e.g., consistency).

As much of the preceding discussion implies, the present data may be of greatest value not because of answers that they provide but because of the empirical directions that they suggest. The contrasts between postreversal probe patterns of adults and children

described herein raise testable questions about potential sources of control over equivalence performances that run the gamut from methodological parameters to conceptual cornerstones. For example, if the inconsistent probe performances seen in the present study suggest a mix of select and reject forms of stimulus control (e.g., Carrigan & Sidman, 1992), follow-up studies using more than two comparisons should produce different outcomes. Similarly, if the two original classes collapsed into one, given a history of choosing C stimuli in the presence of both A1 and A2, future work might discourage collapse by programming reversals via punishment of choices of C1 given A1 or C2 given A2. Interestingly, the adult subjects in our earlier studies were exposed to such a contingency, suggesting that this procedural variable deserves further empirical evaluation. Other methodological differences between the present study and those with adults that warrant attention include the context in which the reversal was introduced, session duration, number of probes per session, and type of reinforcer.

In sum, it seems that the study of equivalence and contingency reversals in young, normally capable children is a promising strategy. If rapid disruption of equivalence performance is the rule, as it appeared to be here, the opportunity for experimental analysis of variables that allow for maintenance may be provided.

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