BRIEF REPORT

REARRANGEMENT OF EQUIVALENCE CLASSES AFTER REVERSAL OF A SINGLE BASELINE RELATION: INFLUENCE OF CLASS SIZE.

Aline G. Folsta and Julio C. de Rose

UNIVERSIDADE FEDERAL DE SÃO CARLOS

Experimental studies of stimulus equivalence typically have two phases: the first teaches a set of baseline conditional discriminations, and the second tests for emergent relations. For instance, after a participant learned baseline conditional discriminations AB and BC, emergence of conditional relations BA and CB documents symmetry, emergence of relation AC documents transitivity, and emergence of relation CA documents combined symmetry and transitivity. Positive results on tests for these properties document the formation of equivalence classes (e.g., Fields, Verhave, & Fath, 1984; Sidman & Tailby, 1982). Studies often omit tests for reflexivity and, less frequently, take combined symmetry and transitivity as the sole evidence of equivalence.

An important question about equivalence classes is their flexibility, i.e., to what extent classes can be altered after they have formed. Studies investigating this question typically have two additional experimental phases after the demonstration of equivalence. The first is a modification in the baseline, most often a partial reversal of the baseline conditional discriminations. For instance, after training of AB, and BC, with two samples and two comparison stimuli in each relation, and demonstration of two classes of equivalent stimuli (A1/B1/C1, and A2/B2/C2), a reversal of the original AB relation is trained, so that selections of B1 in the presence of A2 and of B2 in the presence of A1 now produce reinforcers. This reversal training is followed by another phase of equivalence tests, to verify whether classes modify according to the reversed baseline.

From a purely logical perspective, in the test after reversal training the classes should rearrange to A1/B2/C2, and A2/B1/C1, according to the most recent training. Earlier studies, however, did not find the predicted rearrangement (Pilgrim & Galizio, 1995; Saunders, Saunders, Kirby, & Spradlin, 1988). Pilgrim and Galizio trained conditional discriminations AC, BC, and AD and documented the predicted classes. Reversals of conditional discrimination AD, however, did not produce the expected rearrangement of the classes. Participants responded according to the reversed baseline in tests of symmetry, but not on the other tests.

Garotti, de Souza, de Rose, Molina, and Gil (2000) however, replicated the design of Pilgrim and Galizio (1995) and found that 6 out of 9 participants rearranged the classes according to the most recent baseline. A study by Smeets, Barnes-Holmes, Akpinar and Barnes-Holmes (2003) also reversed conditional discriminations and found consistent class rearrangement. These data suggest that classes may in fact rearrange after reversal training and that earlier negative results were due to methodological differences. A subsequent study (Garotti & de Rose, in press) found that classes always rearranged when baseline reviews preceded tests and did not rearrange when, as in the study of Pilgrim and

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Send correspondence about this article to Julio C. de Rose, Departamento de Psicologia, Universidade Federal de São Carlos, Caixa Postal 676; 13565-905, São Carlos, SP; Brazil. E-mail: djcc@power.ufscar.br.

Galizio (1995), tests were not preceded by baseline reviews.

The present study investigated the effects of class size on class rearrangement after reversal of one of the baseline conditional discriminations. The study compared classes of four and eight members each. Classes with four members require training of three conditional discriminations, whereas eight-member classes require training of seven conditional discriminations. Therefore, the reversal of a single conditional discrimination represents a third of the total number of trained baseline relations in the case of 4-member classes, but only a seventh in the case of 8-member classes. Larger classes might, therefore, be more resistant to change after reversal of a single conditional discrimination because a larger portion of the original training remains unchanged.

METHOD

Participants, Setting, and Equipment

Twelve Portuguese-speaking college students participated, six male and six female, ages 18 to 26 years. Experimental sessions were conducted in a quiet room containing an Apple Macintosh Performa 630 with the software MTS®, v. 10.32 (Dube & Hiris, 1997).

Procedure

The experimental task consisted of conditional discriminations in the matching to sample format. Stimuli were arbitrary pictures (see Figure 1), drawn in black over a light gray background, displayed on three windows on the computer screen. The participant selected stimuli moving the computer's mouse in order to place a cursor on the stimulus' window and click it.

Conditional discrimination trials started with the presentation of the sample stimulus. A mouse click on its window produced the presentation of two comparison stimuli, randomly positioned in two of the outer windows. Selection of the comparison designated as correct produced a tone and the word "correto" (correct) appeared on the screen. A 1.5 s blackout followed incorrect selections. The intertrial interval was 1.5 s long. Pre-training and training were conducted in a series of trial blocks and each block was repeated until the participant scored at least 90% correct. The session ended whenever a participant did not achieve criterion after three presentations of a block.

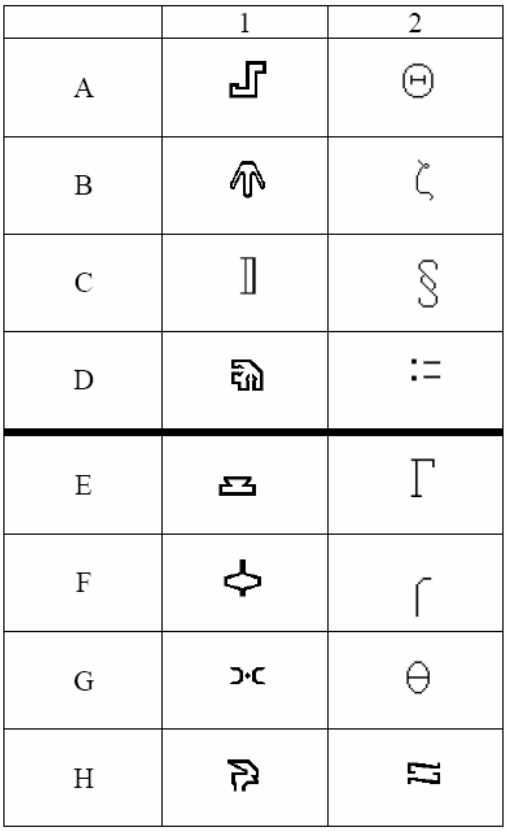

Figure 1

Pre-training consisted of two trial blocks, with 6 trials each. These blocks taught a conditional discrimination with two samples and two comparisons not used subsequently. In the first block, trials displayed a written prompt on the screen: the phrase "se este" (if this) appeared below the sample, and "escolha este" (select this) appeared below the correct comparison.

Group 1 (6 participants) was submitted to Training 1, leading to the formation of 4-member equivalence classes. They learned conditional discriminations AB, AC, and AD (each with two samples and two comparisons), henceforth designated as Training 1 stimuli. Each conditional discrimination was taught in a block of 10 trials, repeated until the participant scored at least 90% of correct responses (criterion used throughout the study, except in probe blocks). The next block mixed 4 trials each of AB, AC, and AD, in a randomized order. After participants achieved

criterion, this block repeated without differential consequences, preparing for the insertion of probe trials.

The experimental session continued with 12 trials of baseline review followed by 54 trials of conditional relations testing symmetry (BA, CA, and DA), and combined symmetry and transitivity (BC, CB, CD, DC, BD, DB). There were 6 trials of each relation, in a randomized order, without differential consequences. This test block repeated if a participant did not reach criterion for equivalence (at least 5 selections consistent with equivalence for each tested conditional relation). If criterion for equivalence was not met in the second presentation of this block, the baseline was trained again, and another block of equivalence probes followed.

The following session began with 12 trials of baseline review. Participants then learned the reversal of the AD conditional relation. In the presence of sample A1, selections of D2 were now reinforced whereas selections of D1 were reinforced in the presence of sample A2. After criterion on the reversed relation, the mixed baseline was conducted again, with conditional relations AB, AC, and reversed AD (4 trials of each). After participants reached criterion, this block repeated without differential consequences. Equivalence tests were then repeated.

Participants in Group 2 also received Training 1, followed by the same equivalence tests. After they met criterion in equivalence tests, they had Training 2, to expand the original classes to 8-member equivalence classes. Training 2 stimuli were sets E, F, G, and H. Participants learned conditional relations, HE, HF, HG, and DE. A baseline block then mixed 4 trials of each of these conditional discriminations, in a randomized order. After participants achieved criterion in this block with and without differential consequences, probes were conducted to verify equivalence with Training 2 stimuli (as well as symmetry of the DE relation). The probe block had 6 trials each of conditional discriminations testing symmetry (ED, EH, FH, GH) and combined symmetry and transitivity (EF, FE, GF, FG, EG, GE). A second equivalence test verified formation of 8-member equivalence classes, with 6 trials each of conditional discriminations HA, BG, and FC. Participants who did not form classes after two test sequences (including stimuli from Training 1 and 2) received baseline retraining followed by a retest of equivalence. The participants who did not show class formation in the retest were replaced. After criterion was met, conditional discrimination DA was then reversed and two blocks of equivalence tests were conducted: the first block mixed 6 trials each of conditional discriminations BA, CA, DA (symmetry with Training 1 stimuli), BC, CB, CD, DC, BD, DB (combined symmetry and transitivity with Training 1 stimuli); the second block mixed 6 trials each of conditional discriminations ED (symmetry with stimuli from Training 1 and Training 2), EH, FH, GH (symmetry with Training 2 stimuli), EF, FE, GF, FG, EG, GE (combined symmetry and transitivity with Training 2 stimuli) and HA, BG, and FC (combined symmetry and transitivity with stimuli from Training 1 and Training 2).

RESULTS AND DISCUSSION

Participants in Group 1 needed from 54 to 144 trials to complete Training 1. Participants in Group 2 needed from 64 to 114 trials to complete

Table 1
Percent of correct selections in probes after AD reversal for participants in Group 1 who did not show class rearrangement.

	Symmetry			Transitivity					
Participant	DA	CA	BA	DB	BD	DC	CD	CB	BC
P1	83	100	100	0	100	100	100	100	100
P4	100	100	33	50	67	100	83	33	33

Table 2
Percent of correct selections in equivalence probes after AD reversal for participants in Group 2 who did not show class rearrangement.

	Probes with Training 1 stimuli					Probes with Training 1 and Training 2 stimuli		
Participants	DA	CD	DC	BD	DB	BG	FC	HA
P7	100	100	100	100	100	17	17	0
P8	100	17	67	100	83	0	0	0
P9	100	100	100	100	100	0	0	0
P10	100	100	100	100	100	0	0	0
P11	100	100	100	100	100	0	0	0

Note. Table shows only scores in probes where a reversal of selections was expected if classes rearranged.

the same training. They then needed from 72 to 224 trials to complete Training 2. Four participants in Group 2 did not achieve criterion in equivalence tests and were replaced, so that 6 participants in each group formed equivalence classes.

Reversal of conditional discrimination AD was accomplished in 10 to 80 trials for participants in Group 1. All participants in Group 2 learned AD reversal in one block (10 trials). Baseline review with reversed AD conditional discrimination took 2 to 4 blocks for Group 1, and 2 to 3 blocks for Group 2.

The variable of interest was performance in equivalence tests after reversal. If 4-member classes for Group 1 rearranged according to the most recent baseline, selections should reverse in the probes involving the D stimuli, and remain unchanged in the other probes. Selections consistent with rearranged classes were arbitrarily considered as correct. Participants 2, 3, 5, and 6 scored above 95% correct in probes DA, CD, DC, BD, and DB, indicating class rearrangement. Participants 1 and 4 did not show complete class rearrangement: their performance was partly consistent with the reversed classes and partly with the original ones. Table 1 presents their scores for all tested relations after AD reversal. P1 reversed performances on all emergent relations except the DB transitivity probes, where his performance was consistent with the original baseline. He also made an error in the DA symmetry probes (83% correct). P4 showed complete reversal in symmetry probes DA, as well as in transitivity probes DC. Performance was inconsistent on all other relations, including transitivity probes CB and BC, where a reversal was not expected.

If 8-member classes rearranged according to the reversed AD relation, it should reverse on all transitivity probes involving D and other Training 1 stimuli (CD, DC, BD, and DB), as well as on all relations between Training 1 and Training 2 stimuli (only a sample of the latter relations were probed, consisting of symmetry probes ED, and HA, BG, and FC transitivity probes). Performance should remain unchanged, however, on relations involving only Training 2 stimuli.

Only Participant 12 rearranged classes, as indicated by 100% correct choices in the probes. Table 2 shows performance of the other participants in Group 2 in the critical probes, the ones in which a reversal was expected. All

participants reversed performance in the DA symmetry probes involving only Training 1 stimuli, and all except P8 reversed performance on transitivity probes involving only Training 1 stimuli. P8 showed a tendency to reverse selections in BD and DB probes but not on CD and DC probes. None of these participants, however, reversed performance in probes linking Training 1 and Training 2 stimuli. Scores were usually 0%, which means that selections consistent with the original baseline were maintained.

Interestingly, Participants 10 and 11 also showed reversal of selections in the baseline DE relation in the probe block, although only DA reversal was trained. Their performance in the ED, HA, BG, and FC probes, although not consistent with the most recently trained baseline, was consistent, therefore, with their baseline performance during the probe block.

The present study suggests that the probability of class rearrangement is related to class size. Most participants in Group 2 rearranged the smaller classes comprised of Training 1 stimuli, but only one of them rearranged the larger classes comprised of both Training 1 and Training 2 stimuli. Larger classes involve a larger number of trained and emergent relations between class members. Therefore, for larger classes, training a single reversal alters a smaller proportion of relations. It is possible that an important factor influencing the probability of class rearrangement is the relation of number of reversed relations to total number of relations. Subsequent studies should investigate this possibility.

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