GENERALIZED BREAK EQUIVALENCE I.

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The present study attempted to produce generalized break equivalence responding with 5 adult subjects. A Generalized Break Equivalence Pattern (GBEP) involved responding in accordance with symmetry and transitivity but not with equivalence in new situations. That is, having been trained in two conditional discriminations, A1-B1/A2-B2 and B1-C1/B2-C2, subjects should produce the following derived relations; B1-A1, B2-A2, C1-B1, C2-B2, A1-C1, A2-C2, C1-A2, C2-A1. To achieve this goal, in Phase 1 subjects were exposed to explicit training in broken symmetry (A1-B1, A2-B2, B1-A2, B2-A1) with 3 different stimulus sets (4 stimuli per set). They were then trained in symmetry (A1-B1, A2-B2, B1-A1, B2-A2) with 3 new sets (4 stimuli per set). In Phase 2, subjects were exposed to Train Standard Equivalence (i.e., training in the conditional discriminations A1-B1, A2-B2, B1-C1, B2-C2). Then they received Train Break Equivalence (i.e., training in the conditional discriminations B1-A1, B2-A2, C1-B1, C2-B2 [symmetry]; A1- C1, A2-C2[transitivity], C1-A2, C2-A1 [break equivalence]) and were finally exposed to a no-feedback condition with the relations trained during the Train Break Equivalence. This sequence was repeated with three different stimulus sets (6 stimuli per set). Finally, in Phase 3 subjects were tested for the generalization of the BEP with a new stimulus set (6 stimuli per set). In this phase subjects were exposed to Train Standard Equivalence and immediately after to a Generalization Test (GT). Three subjects showed a clear GBEP, 1 subject produced a very close result to the GBEP with errors on the transitive relation, and 1 subject failed to show the predicted pattern. These data provide some support for the suggestion that derived relational responding is an overarching or generalized operant class.

Most of the experimental and theoretical works on stimulus equivalence and derived stimulus relations have examined the conditions under which equivalence relations are formed (e.g., Barnes, 1994; Barnes & Holmes, 1991; Barnes, McCullagh, & Keenan, 1990; Barnes, Smeets, & Leader, 1996; Carrigan & Sidman, 1992; Dube, Green, & Serna, 1993; Dube, McIlvane, Mackay, & Stoddard, 1987; Fields, Adams, Verhave, & Newman, 1990; Green, Stromer, & Mackay, 1993; Hayes, 1991,1994; Markham & Dougher, 1993; Roche, Barnes, & Smeets, 1997; Saunders, Saunders, Williams, & Spradlin, 1993; Sidman, 1990, 1992; Stromer, McIlvane, & Serna, 1993; Valero & Luciano, 1992, 1993). However, few studies have investigated the conditions under which equivalence relations can be weakened or substituted for new relations. Among the latter, Gomez, Huerta, Barnes, Luciano, and Smeets (1999) conducted a number of pilot experiments to produce what was defined as a Broken Equivalence Relation or a Generalized Break Equivalence Pattern (GBEP). Thes e terms are essentially synonymous and refer to responding in accordance with symmetry and transitivity, but not in accordance with combined symmetry and transitivity (we will refer to the latter relation as equivalence). Although there were variations across the different experiments, the general procedure was as follows (see Appendix A for a more detailed description of each experiment). Using the first of a number of stimulus sets (Set 1), subjects were explicitly trained to respond in accordance with A-B and B-C; B-A and C-B (symmetry); and A-C (transitivity) relations. However, the subjects were also trained on a broken equivalence relation (i.e., subjects were trained to choose Al in the presence of C2, and A2 in the presence of Cl). Subsequently, using Stimulus Set 2 (i.e., stimuli different from those used in Set 1), subjects were trained on baseline conditional discriminations (i.e., A-B and B-C) and were then tested to see if they would produce the GBEP. Results showed the GBEP in only 2 of 11 subje cts.

The procedures employed in the current study were based on those features of the Gomez et al.

(1999) experiment that we suspected may facilitate the GBEP. Additional features were also added in an effort to improve the GBEP effect reported by Gomez et al. Specifically, a history of symmetry breaking and nonsymmetry breaking was introudced in Phase 1. We suspected that breaking symmetry in the first part of the experiment may facilitate the subsequent breaking of equivalence relations. [1] We based this assumption on the fact that symmetry is one of the component relations involved in equivalence (i.e., combined symmetry and transitivity) (see Sidman, Wilson-Morris, & Kirk, 1986; Valero & Luciano, 1993, for empirical data; see also Barnes, 1994; Boelens, 1994, 1996; Hayes, 1991), and thus breaking symmetry may facilitate the subsequent breaking of a more complex relation in which it participates. We also included a history of symmetry training (after broken symmetry) so that subjects entered the next phase of the experiment with an immediate history of responding in accordance with "standard" symmetry relations.

In Phase 2, several exemplars (stimulus sets) were used to train the BEP because it has been shown that exposure to multiple-exemplars facilitates the emergence of generalized operant classes (e.g., Baer, Peterson, & Sherman, 1967; Harlow, 1949; Luciano, Herruzo, & Barnes-Holmes, 2001; Pryor, Haag, & O'Reilly, 1969). A no-feedback condition was also included with training sets to reduce the formal differences (in terms of feedback) between training and generalization test phases (e.g., Barnes, Browne, Smeets, & Roche, 1995; Devany, Hayes, & Nelson, 1986; McDonagh, McIlvane, & Stoddard, 1984; Pilgrim & Galizio, 1990, 1995; Sidman & Tailby, 1982; Valero, 1990). Finally, a common structure with respect to the order and session breaks during the training of the BEP and the test phase for the GBEP was employed. Providing this common structure, it was hoped, would facilitate a transfer of the contextual control over the BEP to the GBEP.

Method

Subjects

Participants in the experiment were 5 students, 3 male and 2 female. Their ages ranged between 18 to 20 years. All subjects were undergraduate nonpsychology students at the University of Almeria, and none of the subjects had participated in stimulus equivalence or related research. All subjects were recruited through in-class announcements made by the experimenter (the first author). The important part of the annoucement was as follows: "I am seeking volunteers to participate in a psychology experiment that has nothing to do with intelligence or personality measures. The experiment will be completed on a computer and will take around 3 hours. You do not have to know anything about computers and the timetable for the experiment will be adapted to your personal time constraints. You will receive a ticket at the end of the experiment that may be exchanged for a drink at the university bar."

Setting, Apparatus, and Stimuli Characteristics

The experiment was completed in a small, quiet experimental room with a chair, a table, and an Apple Macintosh Classic II computer positioned on the table. The computer was programmed in BBC BASIC to control the presentation of stimuli and to record responses. The stimuli were presented on the monitor screen in black characters on a white background. Six different stimulus sets (4 stimuli per set) consisting of three-letter nonsense syllables were used. For example, in Phase 1, Set a for Subject 1 consisted of A1=HIS, B1=PUL, A2=NEL, B2=RAB, and Set b consisted of A1=JON, B1=BIS, A2=TAC, B2=CEP, etc.). Several stimulus sets (6 stimuli per set) composed of novel three-letter nonsense syllables were used for Phase 2 and Phase 3 (e.g., Set 1: A1= CUG, B1=ZID, C1=DAX, A2=VEK, B2=YIM, C2=BOF; Set 2: A1=PAF, B1=JOM, C1=BEH, A2=QAS, B2=PUK, C2=QIJ, etc.). Note that subjects never saw the alphanumeric labels used in the current article.

Procedure

All training and testing trials were presented in a match-to-sample format. In each matching-to-sample trial the sample and comparisons stimuli always differed in at least two letters. On all trials, the sample appeared centered in the top half of the monitor screen simultaneously with the two comparisons stimuli, which were positioned below to the left and right of the sample. On each trial, the position of the comparison stimuli varied randomly (i.e., the correct comparison could appear on either the left or right with equal probability). Subjects responded by pressing one of the marked keys on the keyboard.

Programmed Consequences

Each correct response added one point and each incorrect response subtracted two points from an accumulated total (see procedure section). The correct completion of a matching-to-sample trial removed the stimulus display and produced, for 1 s, "CORRECT" in the center of the screen, accompanied by a high-pitched bleep, and the total number of points earned. The incorrect completion of a trial removed the stimulus display and produced "WRONG" in the center of the screen accompanied by the total number of points earned, again for 1 s (no auditory feedback was provided). During testing phases, no feedback was provided an each response, whether correct or incorrect, was followed by the presentation of the next trial. Subject's participation was voluntary, and at the end of the experiment, the students received a ticket that they could use to purchase a beverage at the university bar.

All subjects participated individually. When a subject entered the experimental room she or he was seated in front of the monitor screen, and the experimenter read aloud the following instructions (translated from Spanish):

To start the experiment you have to press the space bar twice. You will observe something like this on the monitor screen [the first stimuli appeared on the screen] e.g.:

ZID

CUG

DAX

Your task will be to look at the shape at the top [the experimenter pointed out the nonsense syllable CUG] and then to choose one of the shapes at the bottom [the experimenter pointed to ZID and DAX in this case]. You can take as much time as you like to make each choice. To choose the shape on the left, press the marked key on the left, to choose the shape on the right, press the marked key on the right. The computer will tell you whether you made the right or wrong choice. When you make a correct response the computer will emit a sound giving you one point for each correct response. After that, the word CORRECT will appear on the monitor screen together with the number of points you have accumulated so far. If you make an incorrect response there will not be any sound and the computer will subtract two points. Your goal is to make the correct choice on each trial, with as few errors as possible. The smaller the number of errors you make, the earlier you will finish the experiment. If at any time you are tir ed, please inform me and you can rest a few minutes if you like or delay the experiment until another day. Normally the computer will tell you if your responses are right or wrong, but sometimes the computer will not give you any feedback. In those cases you have to try to do your best. For experimental reasons you will not be allowed to ask questions about the experiment until the end of it. If you don't have any question, you can start. Good luck.

Any questions were answered by repeating the relevant section of the instructions, and then Phase 1 commenced. At the beginning of Phase 1, and all subsequent experimental phases, a message was presented on the monitor screen informing the subject to press the space bar twice. Having done so, the monitor screen remained white for 5 s until the first stimuli appeared.

Phase 1. This phase was composed of two stages. First, subjects were exposed to Train Break Symmetry across three stimulus sets and in a second stage they were exposed to Train Symmetry across three new stimulus sets (see Figure 1).

Train Break Symmetry All subjects were trained in the conditional discriminations tasks, A1-B1, A2-B2 and B1-A2, B2-A1, across three stimulus sets (4 stimuli per set) (see Figure 2). The four different trial types, with each stimulus set, were presented in a quasirandom order (i.e., each task was presented three times in each block of 12 trials) until the subjects produced 12 consecutively correct responses across one block of 12 trials. When the subject achieved this mastery criterion, the computer terminated the conditional discrimination training with that stimulus set ("please report to the experimenter" appeared on the computer screen). Based on pilot work, a second mastery criterion was also employed; the data were checked by the experimenter to determine whether the subject had produced less than 11 errors. If 11 or more errors had occurred, the subject was reexposed to Train Break Symmetry with the same stimulus set. This procedure was repeated until the subject completed the training with less than 11 errors. Subjects were first trained using Stimulus Set a, then Set b, and finally Set c.

Train Symmetry This stage of the experiment was identical to the previous stage, except that the trained conditional discriminations were A1-B1, A2-B2 and B1-A1, B2-A2 (Figure 2). Subjects were first trained using Stimulus Set d, then Set e, and finally Set f.

Phase 2. In this phase, subjects were exposed to three stages (two training and one without feedback) across Stimulus Sets 1, 2, and 3. Subjects were first exposed to Train Standard Equivalence, then to Train Break Equivalence, and finally to a no-feedback condition regarding the relations trained during the Train Break Equivalence. If subjects failed the no-feedback condition with any stimulus set (i.e., showing a pattern different from the BEP), they were reexposed to Train Break Equivalence and reexposed to the no-feedback condition until they showed the BEP (Figure 1).

Train Standard Equivalence. Subjects were exposed to a minimum of eight blocks, each consisting of the relations A-B and B-C (Figure 2). The order in which blocks were trained was A-B, B-C, A-B, B-C, A-B, B-C, A-B, B-C. In each block of A-B relations there were trials of A1-B1 and trials of A2-B2 presented in a quasirandom order (each task presented twice in each block of four trials) until a subject produced four consecutively correct responses. The B-C trials were presented in exactly the same manner. The monitor screen remained white for 3 s between blocks. The minimum number of trials to complete this stage was 32. The mastery criterion for successfully completing this stage required that the final 16 trials occur without any errors, or no more than 5 errors occur during exposure to this stage.

Train Break Equivalence. Subjects were exposed to blocks of four trials (two trial types each presented in a quasirandom order): symmetry relations; B-A (B1-A1, B2-A2) and C-B (C1-B1, C2-B2); transitive relations A-C (A1-C1, A2-C2); and break equivalence relations C-A (C1-A2, C2-A1) (Figure 2). Subjects were required to produce four consecutively correct responses in a given block (e.g., B-A symmetry relations) before proceeding to the next (i.e., C-B symmetry relations). The computer screen went blank for 3 s between each trial block except at the end of each B-A, C-B, A-C, C-A sequence where the screen went blank for 6 s. The mastery criterion for completion of this stage was 32 consecutively correct trials (i.e., two consecutive sequences of B-A, C-B, A-C and C-A blocks without any errors).

After subjects successfully completed the Train Break Equivalence they were exposed to a condition identical to the previous one (except no feedback was provided). It was composed of two sequences of B-A, C-B, A-C and C-A four-trial blocks. The mastery criterion required that subjects produced at least three out of four correct responses on each of the two exposures to the four-trial blocks (see Figure 2). If subjects did not pass this condition they were reexposed to the Break Equivalence Training and then reexposed to the no-feedback condition (Figure 1).

Having completed Train Standard Equivalence, Train Break Equivalence, and the no-feedback condition with Stimulus Set 1, the entire procedure was repeated with Stimulus Set 2, and then finally with Stimulus Set 3. Only then did subjects proceed to Phase 3.

Phase 3. Testing for the generalization of the BEP with new stimulus sets was the purpose of Phase 3. Subjects were exposed to Train Standard Equivalence and then to a Generalized Test (GT).The GT was identical to the no feedback condition in Phase 2, the only difference being that no Train Break Equivalence was provided with the new set. If subjects produced the GBEP, the experiment terminated at that point. If subjects did not produce the GBEP they were exposed to Train Break

Equivalence and to the no-feedback condition with that stimulus set (as happened in Phase 2). Then subjects were trained with a new stimulus set (composed of 6 stimuli) on Standard Equivalence and were exposed to a new GT. This sequence was repeated until the GBEP was obtained or until the subject asked to terminate his or her participation in the experiment (Figure 1).

Results

Only 1 subject showed a GBEP on the first GT. In the last GT, 2 additional subjects produced a perfect GBEP, a subject (4) showed a very similar pattern, and a final subject did not produce the expected pattern (see details below). A detailed outline of the results will be presented according to the different phases described in the procedure section.

In Phase 1, all subjects required two or three exposures to Train Break Symmetry with Set a before achieving the mastery criteria, and several subjects needed two exposures with Sets b and c. None of the subjects, however, required more than one exposure to Train Symmetry with Sets d, e, and f (a detailed breakdown of each subject's performance is shown in Appendix B).

In Phase 2, all subjects successfully achieved the mastery criteria associated with the training of Standard Equivalence, Break Equivalence, and with the no-feedback condition across the three stimulus sets. The only exceptions were Subjects 1 and 5 who failed the first no-feedback condition with Set 1 (see Appendix B). For reasons unrelated to the experiment, Subject 1 was unable to participate for 14 days after having been exposed to Train Standard Equivalence and Train Break Equivalence with Set 1. After this 2-week gap, however, the subject continued participation on a daily basis.

Figure 3 shows subjects' responding across relations in the successive GTs to which they were exposed in Phase 3. For the purposes of communication the data will be summarized according to three categories. Producing symmetry, transitivity, or equivalence required that the subject choose the experimenter-designated correct comparisons at least six times across eight exposures to a particular conditional discrimination (e.g., B1-A1, four responses; B2-A2, two responses). The term disruption is applied when a subject chose the experimenter-designated correct comparisons between three and five times across eight exposures to a particular conditional discrimination (e.g., C1-B1, three; C2-B2, two). Finally, breaking a relation is used to label a performance in which a subject chooses only the experimenter-designated correct comparison one or two times across eight exposures to a particular conditional discrimination (e.g., C1-A1, one; C2-A2, one).

Subject 1 (see Figure 3) showed the GBEP with no errors on the first GT. Subject 2 failed to break the C-A relation on the first GT (Stimulus Set 4) but produced a perfect GBEP in the second GT (Set 5). Subject 3 showed a perfect GBEP on her fifth GT (Set 8). The most frequent error for this subject was breaking the C-B relation, with some errors on the other relations. Subject 4 produced a pattern very close to the GBEP in his sixth GT (Set 9), but errors appeared on the transitive relation A-C. In the previous GTs, he responded with more variability than previous subjects alternating between symmetry (B-A), transitivity (A-C), and equivalence (C-A), and the disruption or breaking of these relations; the one exception being the C-B relation, in which he alternated between breaking and symmetry only. Subject 5 was exposed to 11 GTs but he did not show a perfect GBEP in any of them. He showed a high tendency to produce breaking or disruption patterns with all relations except on C-A. However, he produced resp onding according to the GBEP on A-C and C-A relations on the last two GTs.

Discussion

The current findings suggest that adding Phase 1 improved the procedures used to produce the GBEP. Certainly, when compared with our previous research, which did not provide a history of broken symmetry training (see Gomez, 1998), the number of trials needed to train the BEP was reduced. For example, the mean number of trials by subject during the training of the BEP with three stimulus sets in the present experiment was 525, whereas the mean number of trials needed in two other experiments in which broken symmetry training was not provided was 1251 and 773 (n=5 in each experiment). In effect, 3 of the 5 subjects in the present experiment needed less training trials than any subjects in the two other experiments. Also, when compared with the Gomez et al. (1999) study in which a history of broken symmetry was not provided, the success rate of the present study (60%) is higher than the success rate of any of the three experimental conditions from that study. But, of course, future research will be needed to co nfirm whether a history of symmetry breaking does in fact facilitate the training of the BEP.

The data from the first GT shows that the number of subjects who produced breaking or disruption increased from B-A, to C-A (i.e., B-A, 1 subject; C-B, 2; A-C, 3; C-A, 3) (see Figure 3). Given the sequence in which the relations were trained and tested (B-A, C-B, A-C and C-A), and the reinforcement of breaking responses was always with respect to the C-A relation, it might be the case that the probability of breaking responses at the end of the sequence was higher than at the beginning, not unlike an FI "scallop" effect. Furthermore, without explicit contextual cues to differentiate between C-A and other relations in which C was also present (i.e., to establish the position of the C stimuli as samples as discriminative for breaking equivalence relations), the probability of breaking was higher in relations in which C stimuli were present (e.g., C-B, A-C and C-A) than in those in which they were not (e.g., B-A).

Although broken equivalence responding (BEP) was trained more readily than in our previous research, we still found it relatively difficult to generate the GBEP. For example, only one subject produced the GBEP on the first GT; the two remaining subjects who produced this pattern required extensive multiple-exemplar training before the pattern finally emerged. This difficulty could be seen as supporting the suggestion that equivalence is the most common relational frame (e.g., Barnes, 1994; Hayes, 1991; Sidman, 1994). More informally, if subjects have an extensive history of equivalence responding, stretching back to early childhood, it should prove difficult to prevent the emergence of this pattern within the relatively short time frame provided by a psychology experiment. If this view of equivalence is correct, then it follows that it should be relatively difficult to produce a response pattern that involves breaking or preventing one of the component elements of this pattern.

Further support for the relational-frame interpretation is also provided by the fact that all of the subjects required many more training trials to complete the Break Symmetry Training than the Symmetry Training (i.e., from the relational-frame perspective, subjects will likely have had a more extensive history of symmetry responding than broken symmetry responding). Finally, consider also that during the Break Equivalence Training the highest number of errors was on C1-A2, C2-A1 (broken equivalence relation), as occurred in the Gomez et al. (1999) study. From the relational-frame perspective, the matching-to-sample format, the equivalence test itself, and the verbal instructions may function as contextual cues for responding in accordance with equivalence relations (Barnes & Roche, 1996, p. 502; Hayes & Hayes, 1989, p. 176). In effect, responding in accordance with equivalence, in certain contexts, may be a very strong response class that resurges in conditions of no-reinforcement (i.e., during a typical eq uivalence test) (see Luciano, 1989; Wilson & Hayes, 1996). As an aside, the present interpretation of these data may help to explain the reported difficulty in altering or disrupting equivalence relations (Pilgrim & Galizio, 1990, 1995; Saunders, Saunders, Kirby, & Spradlin, 1988; Spradlin, Saunders, & Saunders, 1992; Valero, 1990), or in producing patterns different from equivalence (see Home & Lowe, 1997, P. 283), or the reported loss of instructional control over generalized relational matching (see Lowenkron & Colvin, 1995). Similar difficulties have been reported in "breaking" preexperimentally established relations (e.g., Barnes, Lawlor, Smeets, & Roche, 1996; Eikeseth & Baer, 1997; Moxon, Keenan, & Hine, 1993; Ybarra & Luciano, 1998). Also, Roche et al. (1997, Experiment 3) demonstrated that once a matching-to-sample test performance had been established, it was highly resistant to change, even after repeated exposures to incongruous training and testing. We have yet to clarify exactly why such perform ances are so difficult to disrupt or change. However, the literature on overshadowing (Rescorla & Wagner, 1972) and behavioral momentum (Nevin, 1974) may be particularly relevant in this regard.

Dougher, Perkins, and Chiasson (1997) presented data that may be also relevant to the present study. Subjects were trained to form three 5member classes and one member of each class was given a different function. Then, a transfer of functions in a context defined by a color background was differentially reinforced. That is, the transfer of functions within classes was reinforced in the presence of one color background and punished in another. Training continued until the color background exerted contextual control over the transfer of functions. New functions were then given to the selected stimuli of each class and the transfer of these new functions was tested to determine whether the transfer was contextually controlled by the background color. Dougher et al. (1997) reported an "unexpected" difficulty in achieving this goal, in that it was necessary to establish 9 or 10 different functions to obtain generalization of the contextual control over the transfer of functions.

Although this difficulty in obtaining contextual control over a transfer of functions is interesting in its own right, the results may be seen as broadly consistent with the difficulty we have found in "breaking" equivalence relations. The GBEP involved maintaining the A-C transitive relation (A1-C1, A2-C2), but when the C stimuli functioned as samples and the A stimuli as comparisons the transitive relation was to be reversed (i.e., C1-A2, C2-A1). Hence, the same stimuli, depending on their spatial position with regard to one another (different contexts), had different functions. Functionally, this is not unlike the Dougher et al. study in which the transfer of functions among class members was brought under the contextual control of background color. It could be argued that the procedures did not really establish C1-A2 and C2-A1 conditional discriminations; instead subjects selected A2 by exclusion of A1 when C1 was the sample and selected A1 by exclusion of A2 when C2 was the sample (Carrigan & Sidman, 19 92). This type of reasoning however, would not explain why "broken" equivalence is so difficult. From Carrigan and Sidman's position, it should not be particularly difficult to establish mixtures of S+ and S- control rather than pure S+ or pure S- control. It is important to note here that this difficulty was also found in "breaking" symmetry (a more salient or less complex relation than equivalence). Of course, S- relations may well have been involved, but it seems likely that some form of contextual control was established by the current procedures over S+ and S- relations. In effect, the A-C stimulus configuration became a context for S+ responding, whereas the C-A context became a context for S-responding. The fact that this relatively subtle type of contextual control needed to be established across different stimulus sets may help to explain the difficulty we found in breaking equivalence relations. Future research will need to examine this suggestion.

The variability observed in producing the GBEP suggests that the conditions that produce this response pattern have to be defined more precisely in future research. The variability also indicates that with the same procedure the behavior of different subjects might be controlled by different contextual cues, or perhaps the available cues might be more salient for some subjects than for others depending again on the subject's history (a variable rarely considered in stimulus equivalence research). These two aspects have been examined in other studies (Gomez, 1998).

The present study, combined with the work of Gomez et al. (1999), provides support for the generalized operant nature of derived relational responding (e.g., Barnes, 1994; Barnes-Holmes & Barnes-Holmes, 2000; Boelens, 1994; Hayes, 1991; Healy, Barnes, & Smeets, 1998). The contingencies that affected a specific stimulus set, which was used to train the BEP, not only affected that set but established the necessary history to produce the abstraction of a response pattern that could be actualized in a "new" situation (with a new stimulus set) (see Hayes, 1992, p. 110). This finding could be added to the literature on generalized operant classes (e.g., Harlow, 1949, the formation of learning sets; Baer et al., 1967, generalized imitation; Pryor et al., 1969, generalized novel behaviors; McIlvane, Dube, & Callahan, 1995, generalized attentive responding; Lowenkron & Colvin, 1995, generalized relational matching; Luciano et al., 2001, generalized say-do relations). One could argue that the GBEP could have been prod uced more readily via verbal instruction (i.e., simply telling the subjects to reverse the C-A relations during the equivalence tests). However, one of the aims of the current study was to determine whether relational responding shows some of the properties of a generalized operant class. Thus it was necessary to train the appropriate multiple exemplars with different topographies before testing for the abstraction of the relational class with new exemplars.

Discovering the conditions under which it is possible to "break" or prevent derived stimulus relations may have important implications in applied settings. Some authors have argued that certain behavioral problems may be interpreted as responding in accordance with inappropriate equivalence classes or relational networks (Hayes, Strosahl, & Wilson, 1999). For example, the statement, "Don't get romantically involved and you won't get hurt" could be interpreted as an equivalence relation between "avoid intimacy" and "protect yourself." In the short term, responding in accordance with this equivalence relation may afford some protection, but in the long run such behavior may lead to loneliness, social isolation, and depression. One of the goals in behavior therapy, therefore, may be to undermine or break this problematic equivalence relation. Basic research in this area may be of benefit if experimental analyses help to determine the key variables involved in breaking or preventing equivalence relations. The pr esent study aimed to contribute towards this end by developing an experimental procedure that could reliably generate the GBEP by direct contingencies in this case, instead of using other procedures as metaphorical or instructed verbal formulas (Luciano, 1999).

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(1.) Breaking symmetry and breaking equivalence are only descriptive terms to define B1-A2, B2-A1 and C1-A2, C2-Al relations. We did not form symmetry or equivalence relations and then break them, we prevented the emergence of symmetry and equivalence relations reinforcing the above indicated conditional discriminations.

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Appendix A

Detailed Description of the G6mez et al. (1999) Study

In Experiment 1, Subject 1, was trained with Set 1 (formed by six nonsense syllables, e.g., A1=CUG, B1=ZID, C1=DAX, A2=BEK, B2=YIM, C2=BOX) on baseline conditional discrimination, symmetry and transitivity (i.e., subjects were trained on A-B and B-C; B-A and C-B; and A-C) but she was also trained on broken equivalence (i.e., subjects were trained to choose Al in the presence of C2, and A2 in the presence of Cl). After that, with Stimulus Set 2 (formed also by nonsense syllables, but different from those used in Set 1), she was trained on baseline conditional discrimination (i.e., A-B and B-C) and was then tested to see if she produced the GBEP. Subject 2, was exposed to the same procedure, with the exception that the BEP was trained with three different sets before training baseline conditional discriminations and test for the GBEP with Set 4. Two additional subjects were exposed to the same procedures as Subjects 1 and 2 and none of them succesfully produced the GBEP, success rate, 0%).

In Experiment 2, 4 subjects were exposed to the training of the BEP with Set 1 (formed this time by structured stimuli, e.g., A1=X, B1=SS, C1=WWW, A2=O, B2=TT, C2=***) and were then exposed to training on baseline conditional discrimination and a test for the GBEP with Set 2 (also formed by structured stimuli, but different from those used in Set 1). Under these conditions only 1 subject produced the GBEP (success rate, 25%).

Finally in Experiment 3, 3 subjects were exposed to the training and test of the BEP with Set 1 (structured stimuli) and training of baseline discriminations and test for the GBEP with Set 2 (structured stimuli) and Set 3 (nonstructured stimuli). Only 1 of the subjects produced the predicted GBEP (success rate, 33.3%).

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 Appendix B
 Detailed Results for Each Subject
 SUBJECT 1
 Phase 1
 SETA SETA SETB SETB SETC SETD SETE SETF
Tr. Brek. Symmetry 108 44 88 23 23 No. correct trials
 24 4 20 1 1 No. errors
Tr. Symmetry 47 30 48 No. correct trials
 13 6 12 No. errors
 Phase 2
 SET1 SET2 SET3
Std. Equiv. Tr. 116 36 36 No. trials
Tr. Brek. Equiv. 428 92 116 80 No. trials
No feedbak cond.
B1-A1 4 4 4 4
B2-A2 4 4 3 4
C1-B1 4 4 4 4
C2-B2 4 4 4 4
A1-C2 3 0 0 0
A2-C1 4 0 0 1
C1-A2 4 4 4 4
C2-A1 4 4 4 4
 Phase 3
 SET4
Std. Equiv. Tr. 36 No. trials
Tr. Brek. Equiv. NO No. trials
Generalization Test GT
B1-A1 4
B2-A2 3
C1-B1 4
C2-B2 4
A1-C2 0
A2-C1 0
C1-A2 3
C2-A1 3
 PASS
 SUBJECT 2
 Phase 1
 SETA SETA SETB SETC SETD SETE SETF
Tr. Brek. Symmetry 73 23 21 20 No. correct trials
 35 1 3 4 No. errors
Tr. Symmetry 20 12 23 No. correct trials
 4 0 1 No. errors
 Phase 2
 SET1 SET2 SET3
Std. Equiv. Tr. 40 36 40 No. trials
Tr. Brek. Equiv. 144 100 32 No. trials
No feedbak cond.
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B1-A1 4 4 4
B2-A2 4 4 4
Cl-B1 4 4 4
C2-B2 4 4 4
A1-C2 0 0 0
A2-C1 0 0 0
Cl-A2 4 4 4
C2-Al 4 4 4
Phase 3
SET4 SET5
Std. Equiv. Tr. 32 40 No. trials
Tr. Brek. Equiv. NO 52 No. trials
GT or No feedbak GT GT
B1-A1 4 4 4
B2-A2 4 4 4
C1-B1 4 4 4
C2-B2 4 4 4
A1-C2 0 0 0
A2-C1 0 0 0
C1-A2 0 4 4
C2-A1 0 4 4
FAIL PASS
SUBJECT 3
Phase 1
SETA SETA SETB SETB SETC SETC SETD SETE SETF
Tr. Brek Symmetry 129 12 70 23 59 12
39 0 14 1 13 0
Tr. Symmetry 32 23 23
4 1 1
Tr. Brek Symmetry No. correct trials
No. errors
Tr. Symmetry No. correct trials
no. errors
Phase 2
SET1 SET2 SET3
Std. Equiv. Tr. 52 56 40 No. trials
Tr. Brek. Equiv. 180 148 120 No. trials
No feedback cond.
B1-Al 4 4 4
B2-A2 4 4 4
C1-B1 4 4 4
C2-B2 4 4 4
A1-C2 0 0 0
A2-C1 0 0 0
C1-A2 4 4 4
C2-A1 4 4 4
Phase 3
SET4 SET 5 SET 6 SET 7 SET 8
Std. Equiv. Tr. 40 92 36 40 36 No. trials
Tr. Brek. Equiv. No 60 NC 128 NO 176 NO 96 NO No. trials
GT or No feedbak GT GT GT GT GT
B1-A1 4 4 4 4 2 4 0 4 4
B2-A2 4 4 3 4 1 4 0 4 4
C1-B1 0 4 2 4 0 4 0 4 3
C2-B2 0 4 3 4 0 4 1 4 4
A1-C2 4 0 1 0 0 0 0 0 0
A2-C1 1 0 1 0 1 0 0 0 0
C1-A2 4 4 2 4 3 4 3 4 3
C2-A1 4 4 2 4 2 4 3 4 3
FAIL FAIL FAIL FAIL PASS
SUBJECT 4
Phase 1
SETA SETA SETA SETB SETC SETC SETD SETE SETF
Tr. Brek. Symmetry 76 12 45 12 49 12
32 0 15 0 23 0
Tr. Symmetry 28 22 30
8 2 6
Tr. Brek. Symmetry No. correct trials
No. errors

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Tr. Symmetry No. correct trials
 No. errors
 Phase 2
 SET1 SET2 SET3
Std. Equiv. Tr. 44 40 40 No. trials
Tr. Brek. Equiv. 60 208 196 No. trials
No feedbak cond.
B1-A1 4 4 4
B2-A2 3 4 4
C1-B1 3 4 4
C2-B2 4 4 4
A1-C2 0 0 0
A2-C1 0 0 0
C1-A2 4 4 4
C2-A1 3 4 4
 Phase 3
 SET4 SET5 SET6 SET7 SET8 SET9
Std. Equiv. Tr. 40 40 36 36 36 36 No. trials
Tr. Brek. Equiv. NO 220 NO 148 NO 56 NO 32 NO 56 NO No. trials
GT or No feedbak GT GT GT GT GT GT
B1-A1 1 4 3 4 4 3 1 4 0 4 4
B2-A2 2 4 4 4 4 4 4 4 0 4 4
C1-B1 0 4 2 4 1 4 4 4 4 4 4
C2-B2 2 4 4 4 0 4 4 4 4 3 4
A1-C2 3 0 0 0 2 0 0 0 0 0 2
A2-C1 3 0 0 0 4 0 0 0 0 0 2
C1-A2 2 4 0 4 0 4 4 4 0 4 4
C2-A1 1 3 1 4 4 4 4 4 0 4 3
 FAIL FAIL FAIL FAIL FAIL FAIL
 SUBJECT 5
 Phase 1
 SETA SETA SETB SETC SETD SETE SETF
Tr. Brek. Symmetry 81 12 21 50 No. correct trials
 51 0 3 10 No. errors
Tr. Symmetry 20 19 34 No. correct trials
 4 5 2 No. errors
 Phase 2
 SET1 SET2 SET3
Std. Equiv. Tr. 64 40 40 No. trials
Tr. Brek. Equiv. 376 292 176 76 No. trials
No feedbak cond.
B1-A1 4 4 4 4
B1-A2 4 4 4 4
C1-B1 2 4 4 4
C2-B2 2 4 4 4
A1-C2 0 0 0 0
A2-C1 0 0 0 0
C1-A2 4 4 4 4
C2-A1 4 4 4 4
 Phase 3
 SET4 SET5 SET6 SET7 SET8 SET9 SET10
Std. Equiv. Tr. 44 36 36 40 36 52 40
Tr. Brek, Equiv. NO 80 NO 104 NO 152 NO 224 NO 196 NO 124 NO
GT or No feedbak GT GT GT GT GT GT GT
B1-A1 4 4 3 4 2 4 2 4 1 4 2 4 0
B2-A2 4 4 4 4 2 4 2 4 0 4 2 4 0
C1-B1 4 4 3 4 4 4 4 4 0 4 0 4 0
C2-B2 4 4 4 4 4 4 4 4 1 4 0 4 0
A1-C2 2 0 2 0 1 1 2 0 2 0 4 0 4
A2-C1 1 0 2 0 2 0 2 0 2 0 4 0 3
C1-A2 1 4 1 4 0 4 4 4 4 4 0 4 2
C2-A1 0 4 1 4 0 4 4 4 4 4 0 4 3
 FAIL FAIL FAIL FAIL FAIL FAIL FAIL
 SET11 SET12 SET13 SET14
Std. Equiv. Tr. 36 36 36 40 32 No. trials
Tr. Brek, Equiv. 64 NO 56 NO 60 32 NO 56 NO No. trials
GT or No feedbak GT GT GT GT
B1-A1 4 0 4 4 4 4 0 4 0
B2-A2 4 0 4 3 3 4 0 4 0
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C1-B1 4 0 4 0 4 4 0 4 0
C2-B2 4 0 4 0 4 4 0 4 0
A1-C2 0 2 0 2 2 0 0 0 0
A2-C1 0 2 0 1 2 0 1 0 0
C1-A2 4 2 4 2 2 4 4 4 4
C2-A1 4 2 4 1 2 4 3 4 4
 FAIL FAIL FAIL FAIL
```

Tr. Brek. Symmetry = Train on Break Symmetry = Train on A1-B1,B1-A2 and A2-B2, B2-A1.

Tr. Symmetry = Train Symmetry = Train on A1-B1,B1-Al and A2-B2, B2-A2.

Tr. Std. Equiv. = Train Standard Equiv = A[right arrow]B and B-[right arrow]C relations.

Tr. Brek. Equiv = Train Break Equivalence = Training on simmetry (B1-Al, B2-A2; C1-B1, C2-B2), transitivity (A1-C1, A2-C2) but not equivalence (C1-A2, C2-Al).

No feedbak cond. = Blocks without feedback of the symmetry, transitive and broken equivalence relations.

GT- Generalization Test. Equal as the no feedback condition but without having received Train Break Equivalence with that Set