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Establishing eight-member classes with class-specific reinforcers

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by

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Running head: ESTABLISHING EIGHT-MEMBER CLASSES WITH CLASS-SPECIFIC REINFORCERS

Establishing Eight-Member Classes with Class-Specific Reinforcers

by

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Abstract

In this systematic replication of Meleshkevich (2007), a typically-developing adult was taught two separate, non-overlapping sets of conditional discrimination baselines (AC, BC; and DF, EF) with common class-specific reinforcers (e.g., A1-C1-Reinforcer1 [R1], A2-C2-R2...; D1-F1-R1, D2-F2-R2...) in PowerPoint® using a match-to-sample format. Performances on unreinforced tests for emergent relations between stimuli from the separate baselines met criterion (at least 16/18 correct), indicating that the separately established equivalence classes had merged to include all conditional and discriminative stimuli associated with particular reinforcers (e.g., A1, B1, D1, F1; A2, B2, D2, F2). Further tests indicated that the class-specific reinforcers (e.g., R1 and R2), and unique stimulus features of the class-specific reinforcers (i.e., token color and name/logo of back-up reinforcer) were also class members. These data support Sidman's (2000) assertion that equivalence relations are comprised of "ordered pairs of all positive elements that participate in the contingency" (p. 128).

Keywords: Stimulus equivalence, class members, class-specific reinforcement

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Establishing Eight-Member Classes with Class-Specific Reinforcers

Equivalence is established when untrained relations among stimuli emerge following the training of a few conditional relations (Sidman & Tailby, 1982). The first stimulus equivalence study was conducted by Sidman (1971). The participant was a 17-year-old boy with intellectual disabilities who could match spoken words to pictures and name pictures, but could not read printed words aloud and could not match printed words to their picture referents. The participant was taught to match spoken words to printed words using a match-to-sample (MTS) procedure. After this initial training he was able to match printed words to pictures, pictures to printed words, and orally name the printed words. The emergence of these new relations was the first demonstration of what we call stimulus equivalence today. Since the first demonstration, stimulus equivalence has been demonstrated in many areas such as mathematics (Lynch & Cuvo, 1995) and reading (Kennedy, Itkonen, & Lindquist, 1994; Rose, De Souza, & Hanna, 1996).

Sidman and Tailby (1982) found that after certain conditional relations were taught, others emerged without directly being taught and they further defined the requisite properties of equivalence to include reflexivity, symmetry, and transitivity. Reflexivity is defined as matching a stimulus to itself (A-A, B-B, C-C). Symmetry shows the reversibility of a relation directly taught, an example of this is when given sample A1, selection of B1 is reinforced; given A2, selection of B2 is reinforced. The untrained relations that might emerge and would be named symmetry are when given sample B1, the participant selects A1; when given sample B2, the participant selects A2. Transitivity is the relation of new stimulus combinations through shared membership after two conditional discriminations are taught. Given sample A1, the participant is trained to select C1 and given sample B1 to select C1; given sample A2, the participant is

trained to select the comparison C2 and given sample B2 to select C2. Positive outcomes on a combined (transitivity and symmetry) test for equivalence would be shown when given sample stimulus A1, the participant selects B1, and sample B1 the participant selects A1; also, given the sample stimulus A2, he or she selects B2 and given sample B2 he or she selects A2. If reflexivity, symmetry, and transitivity are demonstrated, then the criteria for equivalence have been met.

Sidman, Kirk, and Willson-Morris (1985) used a MTS procedure to teach conditional discriminations with six sets of stimuli, with three stimuli per set. First, conditional discriminations AB and AC were trained. For the AB relation, when given a spoken word, the participant selected the corresponding upper case symbol. For example, when given the spoken word “delta”, if participant selected the upper case delta symbol (and not one of the other two present), that response was reinforced. Given the spoken word “sigma,” selection of the upper case sigma symbol was reinforced; and when the sample was the spoken word “chi,” selection of the upper case chi symbol was reinforced. For the AC relation, given a spoken word, the participant selected the corresponding lower case symbol. For example, when given the spoken word “delta”, if the participant selected the lower case delta symbol, that response was reinforced. This training was followed by tests for three-member ABC classes. For the CB test, given the lower case symbol, the participant was expected to select the upper case symbol. For the BC tests, given the upper case symbol, the participant was expected to select the corresponding lower case symbol. Once the criteria for equivalence had been demonstrated, conditional discriminations DE and DF were taught, followed by tests for three-member DEF classes (more sets of unfamiliar Greek symbols). Lastly, EC conditional discriminations were taught. In these conditional discriminations, E stimuli were presented as samples and C stimuli

as comparison. When stimulus E1 was presented, the participant's response was reinforced when he or she selected the C1 comparison stimulus. When E2 was presented, the response C2 was reinforced; and when E3 was presented, selection of C3 was reinforced. After the EC relations were taught, tests for six-member equivalence were conducted. These included presenting sample and comparison stimuli that had never before appeared together. For example, E stimuli presented as samples and B stimuli as comparisons, or C stimuli as samples and F stimuli presented as comparisons. The results indicated that training EC functioned to merge two independently established equivalence classes (ABC and DEF). In total, there were 60 emergent relations that were a result of 15 relations taught with the reinforcement procedures. Figure 1 shows 20 dotted arrows which represent the emergent relations. There were three classes of stimuli, so each dotted arrow represents three emergent relations for a total of 60.

It is important to note that in Sidman et al. (1985), the conditional discriminations were taught using differential reinforcement in which the same reinforcing consequence was used for correct responses on all sample/comparison relations. In other words, within a teaching session the same reinforcer was delivered for all correct responding. Given the spoken word "delta," the participant received reinforcer 1 (R1) if he or she selected the upper case delta symbol. Given the spoken word "sigma", the participant again received R1 if he or she selected the upper case symbol sigma.

Sidman (2000) made two assertions that will be discussed here. The first is that equivalence emerges directly from the reinforcement contingency. It is the reinforcing consequence that is responsible for these emergent relations, which are tested for in the absence of reinforcement. The second is that reinforcers may become class members if the same

reinforcing consequence is used with teaching class-designated relations (i.e., class-specific reinforcement).

Dube, McIlvane, Maguire, Mackay, and Stoddard (1989) used class-specific reinforcers for identity matching with A, B, C, and D stimuli. Matching A1 (and B1, C1, D1) to itself was followed by one specific reinforcer, R1 and matching stimuli A2 (and B2, C2, D2) to itself was followed by a different specific reinforcer, R2. Then the participants were taught AB arbitrary matching performances, where A1 and A2 stimuli were the samples, and B1 and B2 stimuli were the comparisons, and correct selections were followed by class-specific reinforcement. Given A1, selection of B1 was followed by R1 and given A2, selection of B2 was followed by R2. This was also true for BC trials. This was followed by tests for the formation of two stimulus classes (A1, B1, C1, D1; and A2, B2, C2, D2). These tests showed that equivalence relations had not only emerged for ABC, but also with D stimuli even though they had not appeared in any of the arbitrary matching trials before. Specifically, D1 shared class membership with A1, B1, C1; and D2 shared class membership with A2, B2, C2. It was the class-specific reinforcer that expanded the equivalence classes to include the D stimuli. This was the first demonstration of the importance of using class-specific reinforcers in expanding stimulus equivalence classes.

The current study extends the findings in Dube et al. (1989) of expanding stimulus classes, to merging stimulus classes using class-specific reinforcement. There are two questions this study attempts to address: Will class-specific reinforcers merge two separately established classes, ABC and DEF? Will the class-specific reinforcers be members of these classes? There were two reinforcers used to consequence responses within each class of stimuli. If the reinforcers can be established as members of that class then would it expand a six-member class to an eight-member class?

Method

Participant

The participant was a 25-year-old typically developing female adult (Maxine). She was a first year graduate student in a Master's program for applied behavior analysis.

Setting, Apparatus, and Session Information

Runs consisted of one or more sessions (each session was a block of 54 trials) and took place at the dining room table in the participant's apartment. Runs occurred 0-3 times per week; each run consisted of 1-6 sessions and lasted between 30 min and 2 hr. The stimuli were presented on an HP computer using PowerPoint® for Windows XP. The participant selected a stimulus by checking a box underneath it using a wireless mouse. Sessions were video-taped either from behind the participant or to the left side of the participant. The experimenter sat to the right of the participant. Three different colored tokens (red, blue, and white) were delivered contingent on correct responding. The participant placed tokens in bowls (6 in diameter) that were the same colors as the tokens.

There were 18 arbitrary stimuli presented, organized into six groups with three stimuli per group (A1A2A3...F1F2F3, see Figure 2). MathCAD was used to randomly distribute trial types within sessions. A sample stimulus was presented in the middle of the bottom of the screen followed by three comparison stimuli at the top of the screen.

Procedure

A pre-training session was conducted with the participant prior to the experiment. In this session, three comparison stimuli were presented on the top of the screen along with a sample

stimulus on the bottom of the screen. The participant was instructed to put a checkmark in the box underneath one stimulus. The participant was also told she would sometimes receive a penny when she did this.

Just prior to the first session with the experimental stimuli, the participant was thanked for her time and asked to name three restaurants that she would like to earn money towards in exchange for participating in the experiment.

In all experimental sessions, a sample stimulus was presented on the computer screen followed by three comparison stimuli. A progressive prompt delay procedure (0.5 s, 3 s, no prompt) was used to teach conditional baseline discriminations. The delay value (i.e., 0.5 s or 3 s) was the duration of time following the presentation of sample and comparison stimuli until the prompt was delivered. The prompt was the flashing of the correct comparison three times. The criteria to move to a less intrusive prompt were at least 52/54 correct and no more than two errors with the same sample. If these criteria were not met, then the delay to present the prompt was decreased. For example if the participant scored 51/54 correct in AC 3-s delay, the next session would be AC 0.5 s.

There were two reinforcers. First, tokens (red, blue, or white) were delivered contingent on correct responses and the color depended on the experimenter-arranged class. Second, there were three participant-selected gift cards, each associated with a specific token color. Each token was placed into a same-color container bearing the name of the gift card associated with it. Each token represented an amount of money (about \$0.03) towards the gift card associated with that color token. Correct responding to Class 1 stimuli resulted in the delivery of a red token, and money towards Chipotle restaurant. Correct responding to Class 2 stimuli resulted in the

delivery of a blue token and money towards the Cheesecake Factory restaurant. Correct responding to Class 3 stimuli resulted in the delivery of a white token and money towards the Olive Garden restaurant. Test sessions were run under extinction and followed by a baseline session with double reinforcement (i.e., two tokens were delivered for each correct response). The participant made approximately \$ 8 per hour for participating in the experiment.

Phase 1: ABC baseline training and equivalence tests. The first training set was the ABC stimuli (see Figure 3). First, AC baseline conditional discriminations were trained. In these training sessions, A stimuli were presented as the samples, one per trial, followed by the three comparison C stimuli. If the A1 stimulus was presented, reinforcement was contingent on selections of the C1 comparison stimulus (and not C2 or C3). When A2 was presented, reinforcement was contingent on selections of the C2 comparison stimulus (and not C1 or C3 stimuli). When A3 was presented, selections of C3 were reinforced (and not C1 or C2). Next, BC relations were similarly trained. B stimuli were presented as the samples and C stimuli as comparisons. After AC and BC baseline conditional discriminations were trained to criterion, a mixed AC/BC baseline session was presented. In this session, both A and B stimuli were intermittently presented as samples with C stimuli as comparisons. In the AC, BC, and mixed AC/BC baseline sessions, all correct responses were followed by delivery of a token, and the color of the token delivered on each trial depended on which experimenter-defined class of stimuli the sample and comparison belonged. The mixed baseline was run under extinction before combined equivalence tests BA and AB, and symmetry tests CA and CB, which were also run under extinction. In each of these test sessions, there were 18 test trials (e.g., BA) intermixed with 36 AC/BC trials (that included both AC and BC relations). The tests sessions were preceded by a mixed AC/BC baseline (i.e., trained relations) session with reinforcement and

followed by a mixed AC/BC baseline session with double reinforcement. If criterion performance was not shown in tests, then error analyses were conducted to determine whether retraining on baseline relations was necessary before repeating tests with below-criterion performances. After criteria were met in the test session, the next set of stimuli, DEF, was trained.

Phase 2: DEF baseline training and equivalence tests. Training sessions were conducted in the same manner as in the ABC baseline training. DF relations were trained first, and when the mastery criterion was met, EF relations were trained (see Figure 4). After DF and EF baseline conditional discriminations were trained, a mixed baseline session was presented. In this session, both D and E stimuli were intermittently presented as samples with F stimuli as comparisons. In the DF, EF, and mixed DF/EF baseline sessions all correct responding was followed by a token of the color related to the potential stimulus class. Combined equivalence tests ED and DE were followed by symmetry tests FD and FE; again all tests were run under extinction. Each of the tests was comprised of 18 test trials intermixed with 36 baseline trials (that included both DF and EF relations). Each test was preceded by a mixed baseline session with reinforcement and followed by a mixed baseline with double reinforcement. Criteria for positive outcomes or additional training or tests were similar to those for ABC, described above.

Phase 3: Tests for class merger. There were 18 tests for equivalence relations among the two separately established stimulus classes (ABC and DEF; see Table 1 and Figure 5). They were structured the same as previous symmetry and combined equivalence tests (i.e., 18 test trials interspersed with 36 baseline trials, but these baseline trials now included AC, BC, DF, and EF relations). Positive outcomes were defined as at least 5/6 correct for each sample type. Test sessions were preceded by a combined baseline (AC/BC/DF/EF) and were followed by the same

combined baseline with double reinforcement. The order of these tests was quasi-randomly arranged; E test trial types with the same sample or comparisons (e.g., AD and AE, or AD and DB) and inverse relation tests (e.g., CF and FC) were not presented sequentially. If performance on a test was not accurate, then it was retested at the end of the testing sequence.

Phase 4: Reinforcers as class member tests. The final phase of the experiment included six tests to assess whether the reinforcers were members of the equivalence classes. First, A and F stimuli were presented as samples and (graphic depictions of) tokens (R) as comparisons. Then, tokens were presented as samples and C and E stimuli as comparisons. Next, gift card logo (r) samples to B and D comparison stimuli were tested, followed by C and F samples to gift card comparisons, gift cards to tokens, and finally token to gift card relations (see Figure 6).

Following the last phase of the experiment, the participant was debriefed. This was done by presenting some of the baseline and test sessions that she had already completed. The experimenter asked her to narrate exactly what she was doing and why she was selecting certain stimuli.

Results

Pre-training

Maxine responded correctly in all 18 trials, by checking the correct comparison stimulus on the computer screen. She received a penny for every correct response emitted.

Phase 1: ABC Baseline, Mixed Baseline, Symmetry, and Combined Equivalence Tests

Maxine's performance met criteria (at least 52/54 correct and no more than one error with the same sample) in both the AC and BC conditional discrimination baseline training sessions. She did make some errors in the AC/BC mixed baseline session (see Table 2), which led to retraining of both the AC and BC relations. After retraining to criterion performance, Maxine only made one error on the rest of the AC/BC mixed baseline trials.

In the three-member symmetry and combined equivalence tests, positive outcomes were defined as at least 16 out of 18 correct with no more than one error with the same sample. Maxine showed 100% correct responding in all 18 tests trials on each test (see Figure 7), meeting the criteria for positive outcomes on these emergent relations with stimuli that had never appeared as samples and comparisons together in the same session.

Phase 2: DEF Baseline, Mixed Baseline, Symmetry, and Combined Equivalence Tests

The participant made a few errors during EF baseline training. She made the most errors during the DF/EF mixed baseline session. During her first DF/EF session, she made 18 errors in 54 trials. All of these errors occurred when E stimuli were presented as samples. The EF relation was retrained and the participant demonstrated 100% accuracy in responding. When the DF/EF baseline was re-presented, she made seven errors (five with E stimuli as samples and two with D stimuli as samples). Both DF and EF relations were retrained. Once mastery of these relations was again shown, the DF/EF mixed baseline was presented three times. Errors occurred only on the first session (three with DF relations); the last two sessions were completed with 100% accuracy (see Table 3). In the three-member symmetry and combined equivalence

tests, Maxine showed 100% correct responding on all 18 tests trials (see Figure 8), suggesting emergent performances indicative of equivalence relations.

Phase 3: Class Merger Tests and Combined Baseline (AC/BC/DF/EF)

There were two instances in which it took the participant multiple sessions to meet criteria with the combined baseline, AC/BC/DF/EF (see Table 4). This first occurred in sessions 22-30. After four sessions of the combined baseline, with five or more errors, all relations were re-trained with the 3-s delay procedure for each baseline (e.g., AC, BC, DF, EF). Maxine demonstrated 100% correct responding in one session of each conditional discrimination performance. Following this, two more combined baseline sessions were presented. She made four errors in each of these sessions; most errors were on BC trials. Next, BC 0.5 s, 3 s, and mixed AC/BC sessions were presented. She demonstrated proficiency with 100% correct responding in all of these sessions. Three combined baseline sessions were then presented in which she demonstrated 100%, 98.5%, and 100% accuracy. At session 35, Maxine had several errors in the AC/BC/DF/EF combined baseline, which did not meet criteria to move on to test sessions. The errors that Maxine made were with the AC/BC and DF relations. The sessions re-presented were AC 0.5 s, BC 0.5 s, mixed AC/BC, and DF 0.5 s. She showed proficiency with 100% correct responding in all of these sessions. Next, two combined baseline sessions were presented in which she demonstrated 100% and 98.5% accuracy.

The order of the class-merger test types was quasi-randomly arranged by the experimenter. Test trial types with the same sample and comparisons were never presented consecutively, for example, if C to F was presented in session 1, F to C would not be presented in session 2 (see Figure 9 and Table 4). Positive outcomes on class-merger tests, defined as at least 5/6 correct for each sample type, was demonstrated in 16/18 tests. Her performance did not

meet criteria in the first test, CF, and the fourth test, BF. In the CF test, four errors were made when C1 was the sample and she selected comparison F3. Maxine made nine errors in the BF test: when B1 was the sample, she selected F3 five times. When these sessions were repeated at the end of the testing sequence, she demonstrated positive outcomes with just one error on the CF retest. All other errors that occurred in the class-merger tests were on baseline trials. Thus, the positive outcomes on these class-merger tests demonstrated equivalence relations among the stimuli in the separately-established baselines.

Phase 4: Reinforcers as Class Members Test

Like the class-merger tests, positive outcomes on reinforcer-as-class-member tests were defined as at least 5/6 correct for each sample type. Maxine had one error in the CF-r test; otherwise, her performance was errorless (see Figure 10 and Table 5). Maxine's performance met criteria for positive results on all tests, suggesting that the reinforcers were indeed class-members and that our procedure had generated three, eight-member classes of equivalent stimuli.

Discussion

Positive results were achieved in tests in all four phases of the experiment. The use of class-specific reinforcers functioned to merge separately established classes and both types of reinforcers (tokens and gift cards) became members of the equivalence classes. After teaching relations within two separate groups of stimuli that had nothing in common other than the reinforcers, positive test results showed that their common link (the shared reinforcers) merged these two separate groups of three, 3-member classes into three, 8-member classes. Each class consisted of six experimental stimuli and two reinforcing stimulus members.

There were a few limitations in the procedure that may have affected the results of the experiment. The wrong class-specific reinforcer was delivered in some trials (e.g., a class 1 token was delivered for correcting responding to a class 3 comparison in 9% of the DF baseline training trials). At times there were long delays between runs, which led to the need to retrain some relations and possibly hindered progress. The most significant limitation was that the participant was a graduate student studying applied behavior analysis. Her graduate instruction focused on stimulus equivalence after she had completed one-third of the 6-member emergent relation tests (i.e., after she took was the DA test). This extra-experimental history is a major confound in this experiment. Additional research with naïve participants is warranted.

Also, additional research on classroom applications is necessary. Incorporating class-specific reinforcers when training relations may be a powerful tool we can use to teach more effectively and efficiently. This may be particularly important when teaching individuals with developmental disabilities. Individuals with developmental disabilities may acquire skills at slower rates compared to typically developing individuals. In stimulus equivalence, when certain relations are taught, others emerge without specifically being taught. This is a powerful teaching tool because students may demonstrate skills (emergent relations) without being taught them directly.

In summary, this study supports Sidman's assertions about the role of reinforcement in equivalence and demonstrates that reinforcers can in fact become class members. The future directions of the research that should be explored include classroom applications of stimulus equivalence with the use of class-specific reinforcers, particularly in teaching new relations to individuals with developmental disabilities.

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Table 1

18 Test Types and Relations Tested

Test Type	Relations Tested
CF	C1F1; C2F2; C3F3
FC	F1C1; F2C2; F3C3
DC	D1C1; D2C2; D3C3
CD	C1D1; C2D2; C3D3
EC	E1C1; E2C2; E3C3
CE	C1E1; C2E1; C3E3
AF	A1F1; A2F2; A3F3
FA	F1A1; F2A2; F3A3
BF	B1F1; B2F2; B3F3
FB	F1B1; F2B2; F3B3
AD	A1D1; A2D2; A3D3
DA	D1A1; D2A2; D3A3
BE	B1E1; B2E2; B3E3

Table 2

Order of Session Types per Run in Phase 1 (BL, mixed baseline, or test)

Run	Session	Number Incorrect
1	AC 0.5 s	0
	AC 3 s	1
	AC no prompt	0
2	BC 0.5 s	0
	BC 3 s	0
	BC no prompt	0
3	AC/BC	11
	AC 3 s	1
	BC 3 s	0
	AC/BC	0
	AC/BC (EXT)	0
4	AC/BC	0
	BA (EXT)	0
	AC/BC	0
5	AC/BC	0
	AB (EXT)	0
	AC/BC	0
6	AC/BC	1
	CA (EXT)	0
	AC/BC	0
7	AC/BC	0
	CB (EXT)	0
	AC/BC	0

Note. Sessions labeled 0.5 s represent a 0.5-s delay, 3 s a 3-s delay and sessions without reinforcement are labeled EXT. The right column indicates the number of incorrect responses.

Table 3

Order of Session Types per Run in Phase 2 (BL, mixed baseline, or test)

Run	Session	Number Incorrect
8	DF 0.5 s	0
	DF 3 s	0
	DF no prompt	0
9	EF 0.5s	0
	EF 3s	2
	EF no prompt	0
10	DF/EF	18
	EF 0.5s	0
	EF 3s	0
11	EF 3s	0
	EF no prompt	0
	DF no prompt	0
12	DF/EF	7
13	DF 0.5s	0
	DF 3s	1
	DF no prompt	0
14	EF 0.5s	0
	EF 3s	0
	EF no prompt	1
15	DF/EF	3
	DF/EF	0
16	DF/EF	0
	DF/EF	1
	DF/EF	1
	ED (EXT)	0
	DF/EF	1
17	DF/EF	5
18	DF/EF	1
	ED (EXT)	1
19	DF/EF	0
	DF/EF	1
	DF/EF	0
	DE (EXT)	1
20	DF/EF	0
	DF/EF	0
	DF (EXT)	0
21	DF/EF	0
	DF/EF	0

FE (EXT)	0
DF/EF	0

Note. Sessions labeled 0.5 s represent a 0.5-s delay, 3 s a 3-s delay and sessions without reinforcement are labeled EXT. The right column indicates the number of incorrect responses.

Table 4

Order of Session Types per Run in Phase 3(baseline, combined baseline or test)

Run	Session	Number Incorrect
22	AC BC DF EF	5
23	AC BC DF EF	8
24	AC BC DF EF	6
25	AC BC DF EF	6
26	AC 3 s	0
	BC 3 s	0
27	DF 3 s	0
	EF 3 s	0
28	AC BC DF EF	4
	AC BC DF EF	4
29	BC 0.5 s	0
	BC 3 s	0
	AC/BC	0
30	AC BC DF EF	0
31	AC BC DF EF	1
	AC BC DF EF	0
	CF (EXT)	4
	AC BC DF EF	0
32	AC BC DF EF	0
	DB (EXT)	0
	AC BC DF EF	0
33	AC BC DF EF	0
	AE (EXT)	1
	AC BC DF EF	0
	BF(EXT)	9
	AC BC DF EF	3
34	AC BC DF EF	1
	DA (EXT)	1
	AC BC DF EF	1
35	AC BC DF EF	9
	AC BC DF EF	10
36	AC 0.5 s	0
	BC 0.5 s	0
	AC/BC	0
37	DF 0.5 s	0
	AC BC DF EF	0

	AC BC DF EF	1
38	AC BC DF EF	5
	AC BC DF EF	3
	AC BC DF EF	2
	AC BC DF EF	0
39	AC BC DF EF	1
	FB (EXT)	1
	AC BC DF EF	0
40	AC BC DF EF	0
	EA(EXT)	0
	AC BC DF EF	0
41	AC BC DF EF	0
	AF(EXT)	0
	AC BC DF EF	0
42	AC BC DF EF	0
	BE(EXT)	1
	AC BC DF EF	0
43	AC BC DF EF	2
	CD (EXT)	0
	AC BC DF EF	0
44	AC BC DF EF	0
	FC (EXT)	0
	AC BC DF EF	0
45	AC BC DF EF	4
46	AC BC DF EF	1
47	AC BC DF EF	3
	AC BC DF EF	0
48	AC BC DF EF	5
49	AC BC DF EF	0
	EB (EXT)	0
	AC BC DF EF	0
50	AC BC DF EF	0
	DC (EXT)	0
	AC BC DF EF	0
51	AC BC DF EF	1
	FA (EXT)	1
	AC BC DF EF	0
52	AC BC DF EF	3
53	AC BC DF EF	0
	CE (EXT)	0
	AC BC DF EF	0
54	AC BC DF EF	0
	BD (EXT)	0
	AC BC DF EF	0
55	AC BC DF EF	1
	EC (EXT)	0

	AC BC DF EF	0
	AD (EXT)	0
	AC BC DF EF	0
56	AC BC DF EF	0
	CF (EXT)	1
	AC BC DF EF	0
57	AC BC DF EF	0
	BF (EXT)	0
	AC BC DF EF	0
58	AC BC DF EF	1

Note. Sessions labeled 0.5s represent a 0.5-s delay, 3 s a 3-s delay and sessions without reinforcement are labeled EXT. The right column indicates the number of incorrect responses.

Table 5

Order of Session Types per Run in Phase 4 (combined baseline or test)

Run	Session	Number incorrect
59	AC BC DF EF	0
	AF -R (EXT)	0
	AC BC DF EF	0
60	AC BC DF EF	1
	R - CE (EXT)	0
	AC BC DF EF	0
61	AC BC DF EF	0
	r- BD (EXT)	0
	AC BC DF EF	1
	CF-r (EXT)	1
	AC BC DF EF	0
62	AC BC DF EF	0
	r-R (EXT)	0
	ABCDEF	0
	R-r (EXT)	0
	AC BC DF EF	0

Note. Sessions without reinforcement are labeled EXT. The right column indicates the number of incorrect responses. Capital R represents tokens and lower case r represents gift cards.

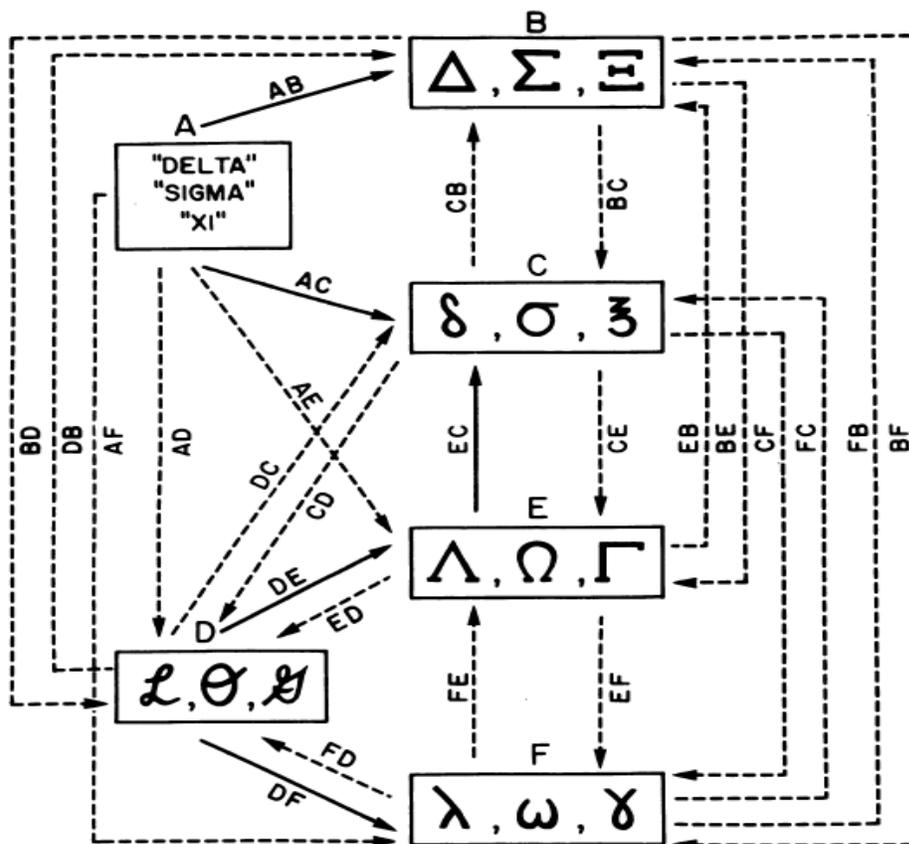


Figure 1. Shows the 15 trained relations (solid arrows) and 60 emergent relations (dashed arrows) in Sidman et al. (1985).

	<u>Class 1</u>	<u>Class 2</u>	<u>Class 3</u>
<u>Sets of Stimuli</u>			
A			
B			
C			
D			
E			
F			

Figure 2. This figure shows the stimuli used in the current experiment. The numbers represent the classes of stimuli (1, 2, 3) and the letters represents the sets of stimuli (A, B, C, D, E, F).

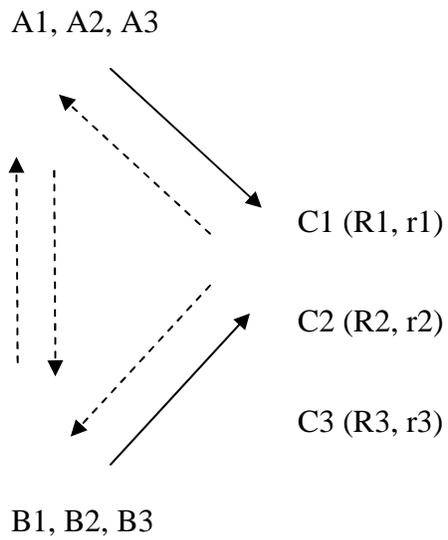


Figure 3. The solid arrows represent the trained relations AC and BC. The dashed arrows represent the emergent relations (combined equivalence, AB and BA; and symmetry, CA and CB). The capital “R” represents the tokens and the lower-case “r” represents the gift cards.

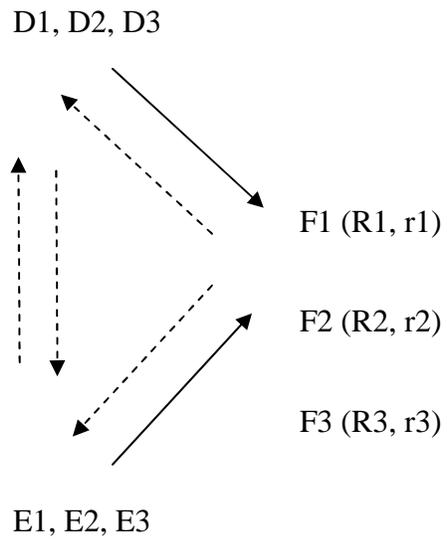


Figure 4. The solid arrows represent the trained relations DF and EF. The dashed arrows represent the emergent relations (combined equivalence, DE and ED; and symmetry, FD and FE). The capital “R” represents the tokens and the lower-case “r” represents the gift cards.

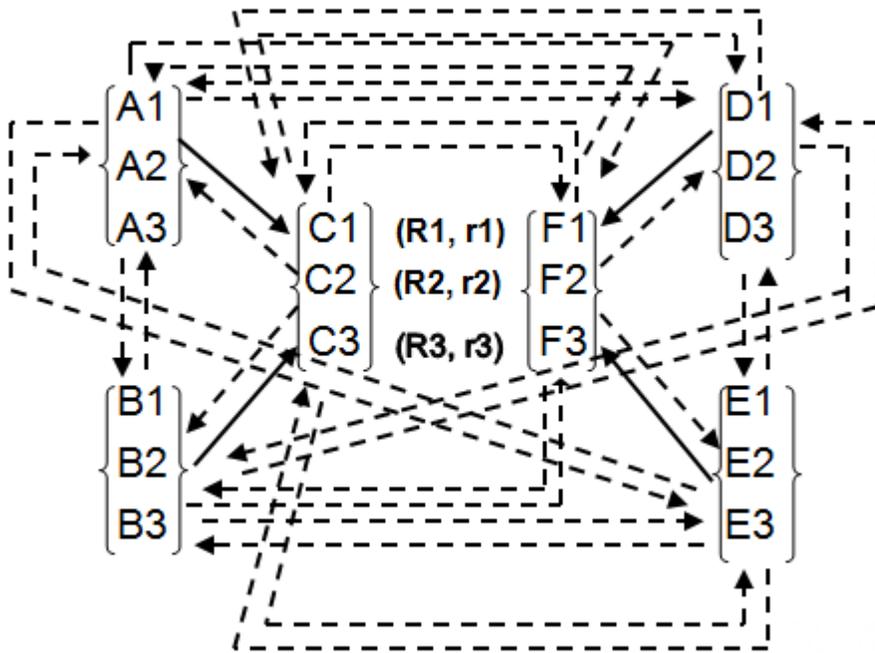


Figure 5. This diagram shows all of the relations trained and tested. The solid arrows represent the trained relations and the dashed arrows represent the emergent relations.

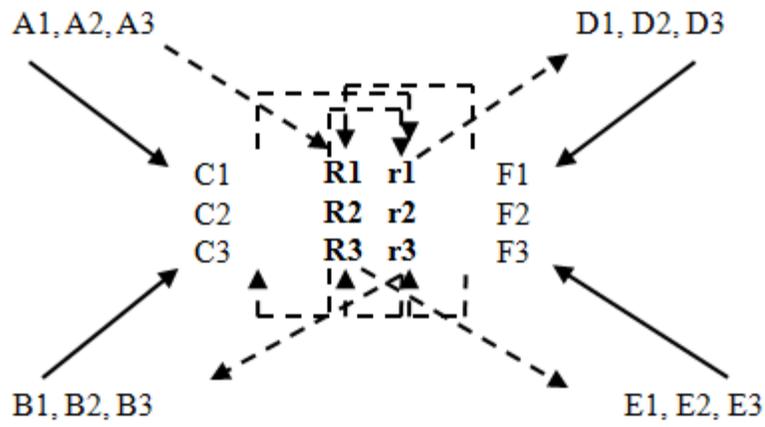


Figure 6. This figure shows the reinforcers as class-members. The solid arrows represent the trained relations and the dashed arrows represent the emergent relations.

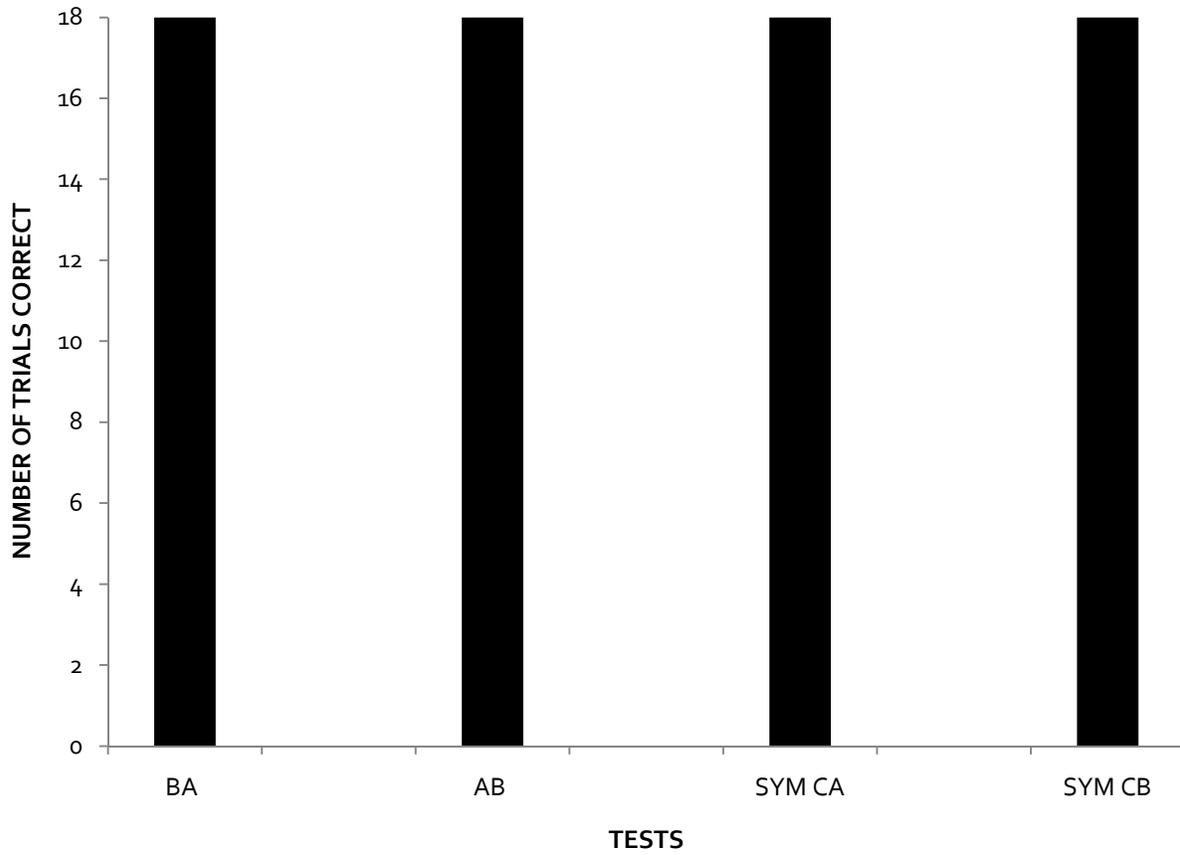


Figure 7. Number of correct responses on symmetry and combined equivalence probe trials for the AC and BC relations.

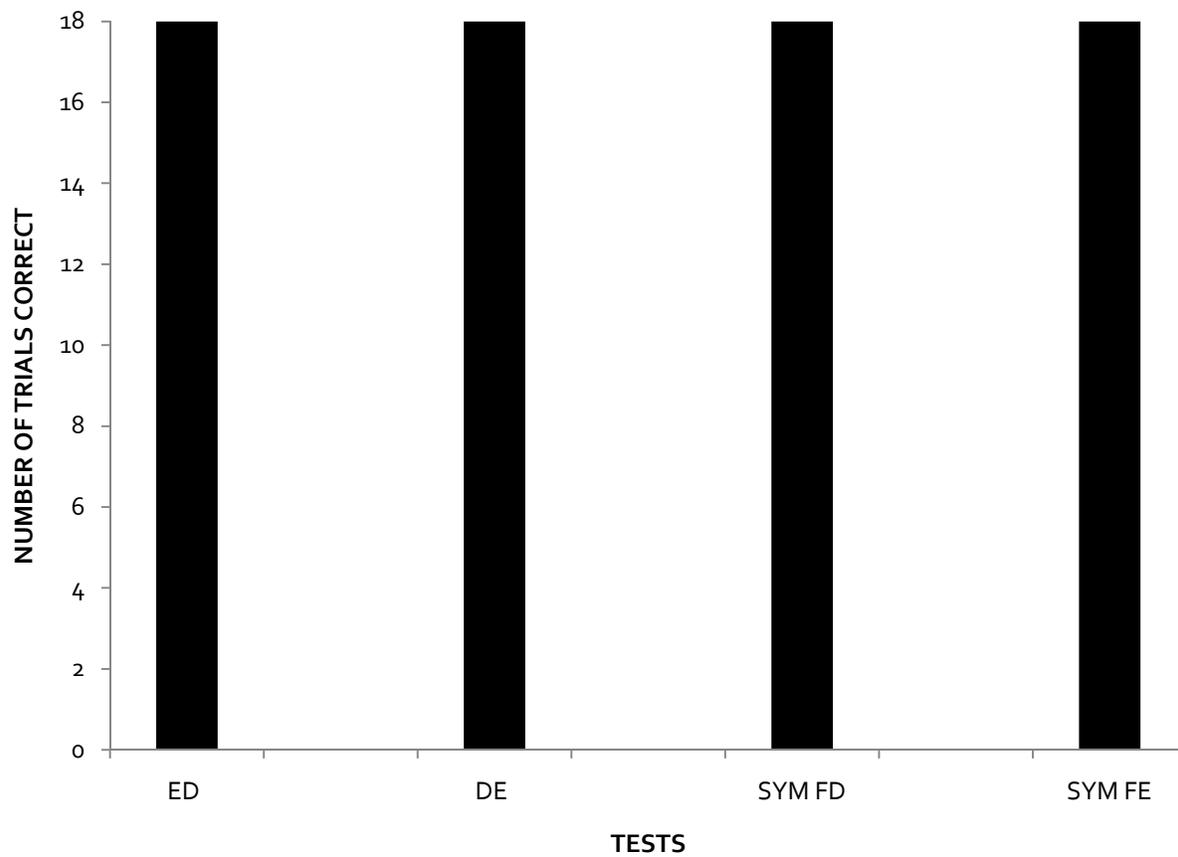


Figure 8. Number of correct responses on symmetry and combined equivalence probe trials for the DF and EF relations.

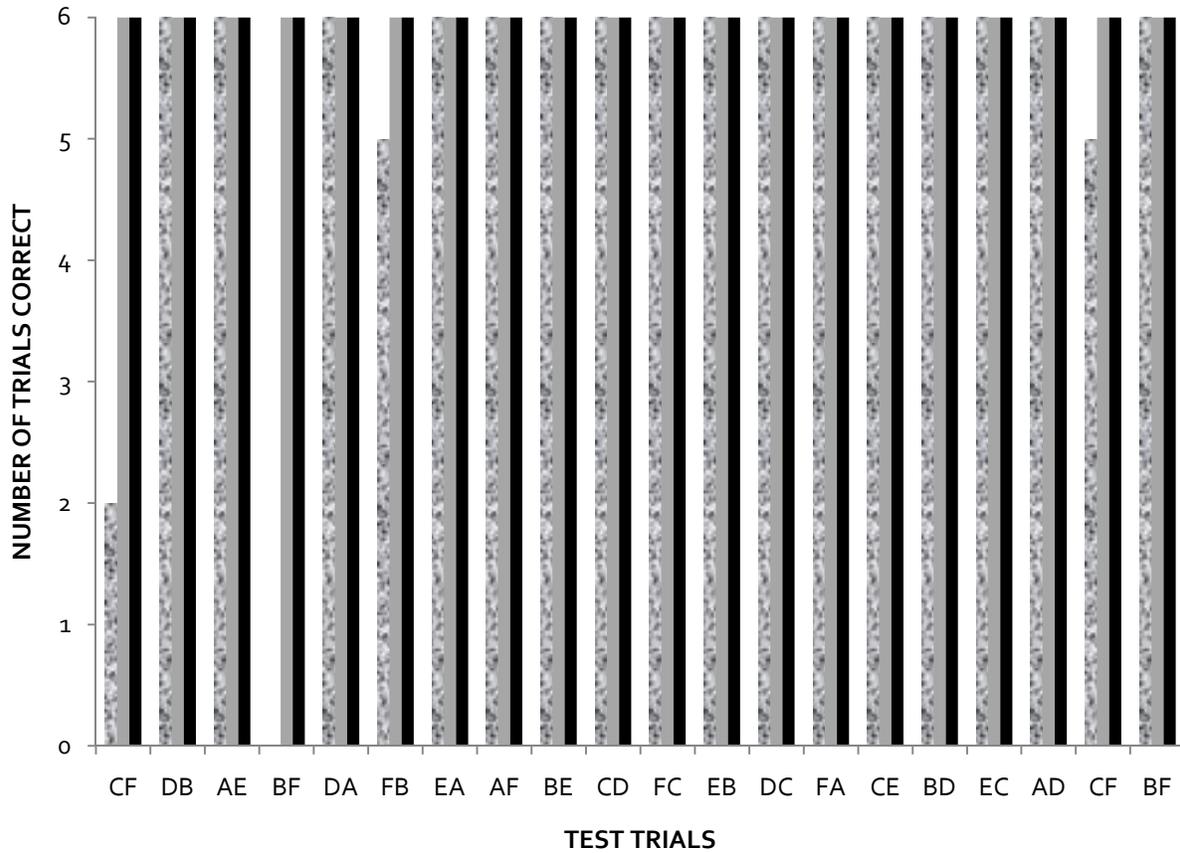


Figure 9. Number of correct responses for the emergent relations tests. The speckled bars represent correct responses to stimuli in class 1, the grey bars represent correct responding to stimuli in class 2, and the black bars represent correct responding to stimuli in class 3.

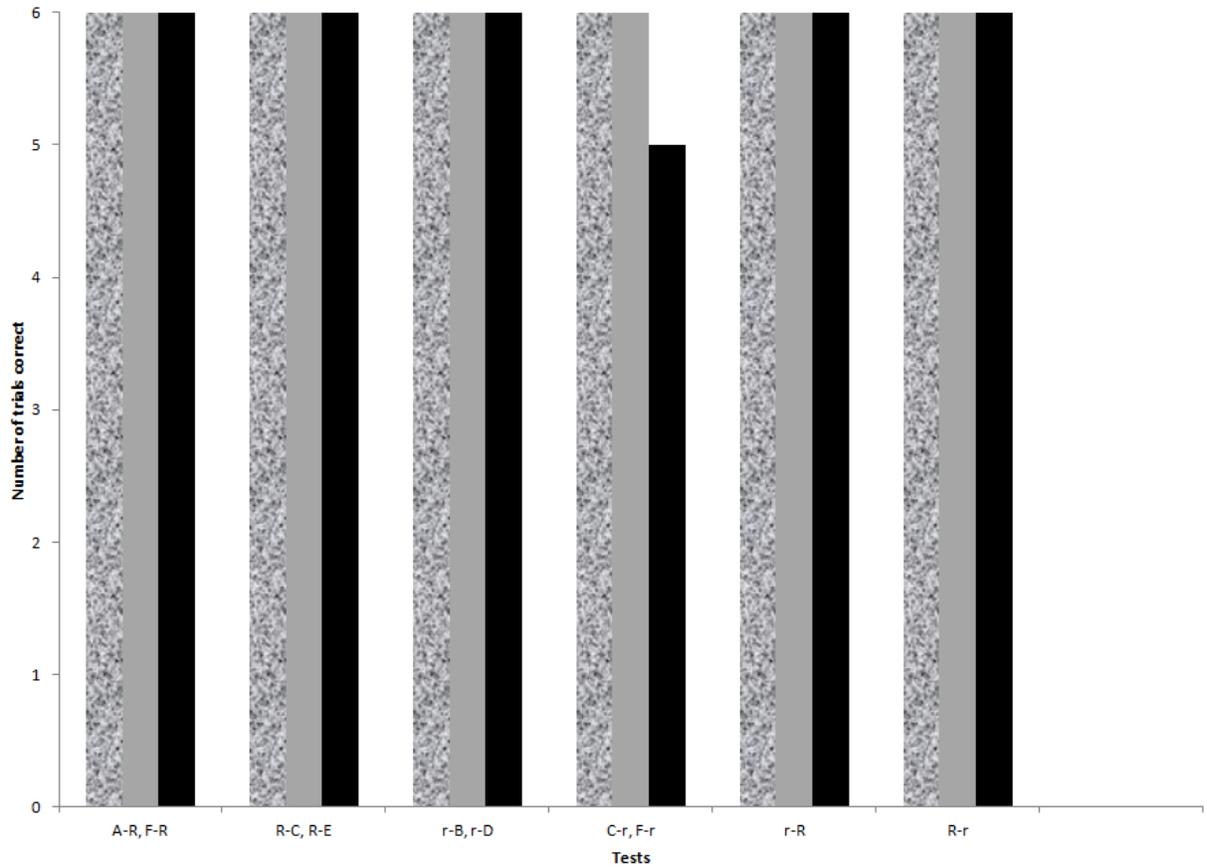


Figure 10. Number of correct responses for the reinforcers as class-members tests. The speckled bars represent correct responses to stimuli in class 1, the grey bars represent correct responding to stimuli in class 2, and the black bars represent correct responding to stimuli in class 3.