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EFFECTS OF PRIOR CONDITIONAL DISCRIMINATION TRAINING, SYMMETRY, TRANSITIVITY, AND EQUIVALENCE TESTING ON THE EMERGENCE OF NEW EQUIVALENCE CLASSES

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Prior studies have shown that the establishment of equivalence classes using the simple-to-complex protocol significantly enhanced the emergence of other new equivalence classes under the simultaneous protocol (yield). The current experiment showed how those enhancement effects were influenced by each component of the protocol used to establish the initial equivalence classes. Yield during the simultaneous protocol was not improved following the prior establishment of other baseline conditional discriminations alone. The prior establishment of the conditional discriminations plus symmetry testing produced a small increment in yield. The prior establishment of conditional discriminations plus transitivity testing produced a very large increment in yield. The prior establishment of conditional discriminations plus transitivity and symmetry testing, or symmetry, transitivity and equivalence testing (i.e., equivalence class formation) did not produce further increments in yield. Thus, the enhanced emergence of new equivalence classes under the simultaneous protocol was due to prior demonstrations of transitivity rather than to the prior establishment of other equivalence classes. Some possible behavioral processes responsible for these effects are discussed.

Training procedures that precede equivalence class training can influence the emergence of new equivalence classes, both positively and negatively. For example, Peoples, Tierny, Bracken, and Mackay (1998) experimentally established positive or negative valences for specific nonsense syllables before equivalence class training. Thereafter, equivalence classes were established with nonsense syllables and one of the positively or negatively valenced words. Likelihood of equivalence class formation increased when the classes included a positively valenced nonsense word and decreased when the classes included a negatively valenced word. Adams (1998) found that the prior formation of

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unrelated conditional discriminations interfered with the subsequent formation of new equivalence classes that did not contain the stimuli used in preliminary training. Wulfert, Dougher, and Greenway (1991) found that teaching subjects to respond to relations between the perceptual features of multielement stimulus arrays enhanced the subsequent formation of new equivalence classes that did not contain the stimuli used in preliminary training.

The identification of prior procedures that enhance the emergence of new equivalence classes requires the use of a training protocol that is relatively unlikely to induce equivalence classes; the simultaneous protocol is such a procedure. Using the simultaneous protocol, only 58% of college students showed the emergence of 1-node 3-member classes (Buffington, Fields, & Adams, 1997) and about 20% of college students showed the emergence of 3-node 5-member classes (Fields, Landon-Jimenez, Buffington, & Adams, 1995; Fields, Reeve, Rosen, Varelas, Adams, Belanich, & Hobbie, 1997). In contrast, almost all college students showed the emergence of analogous equivalence classes when the simple-to-complex protocol was used for training and testing (Adams, Fields, & Verhave, 1993).

Buffington et al. (1997) and Fields et al. (1997) found that the percentage of subjects who showed the emergence of new 3-member classes under the simultaneous protocol was a direct function of combined increases in the size and the number of nodal stimuli in equivalence classes that were previously established using the simple-to-complex protocol. After optimal preliminary training, which consisted of the establishment of 3-node 5-member classes under the simple-to-complex protocol, 100% of subjects formed new 1-node 3-member classes under the simultaneous protocol. Furthermore, Fields et al. (1997) found that the emergence of new 3-node 5-member classes under the simultaneous protocol was a direct function of separate increases in the size and the number of nodal stimuli in previously established equivalence classes. After optimal preliminary training, which consisted of the establishment of 3-node 5-member classes under the simple-to-complex protocol, 83% of subjects formed new 3-node 5-member classes under the simultaneous protocol.

It is possible, however, that the enhancement effects noted by Buffington et al. (1997) and Fields et al. (1997) were not produced by the establishment of equivalence classes per se, during preliminary training. Rather, the enhancement effect could have resulted from exposure to any of the components of the procedure used to establish equivalence classes, apart from class formation. These include the prior establishment of conditional discriminations that shared common nodal stimuli alone, and/or the presentation of symmetry, transitivity, or equivalence probes alone or in some combination along with the linked conditional discriminations. Indeed, this notion is compatible with a number of theoretical analyses, all of which suggest that the prior establishment of relational repertoires of reflexivity, symmetry, and transitivity are necessary prerequisites for the emergence of new equivalence classes (Boelens, 1994; Fields & Reeve, in press; Hayes & Hayes, 1992).

The current experiment determined how the emergence of new equivalence classes established under the simultaneous protocol was influenced by prior training that involved the establishment of conditional discriminations, along with the presentation of symmetry, transitivity, and equivalence probes, alone and in various combinations. A comparison of the percentage of subjects who showed the emergence of new equivalence classes under the simultaneous protocol across groups was used to identify the isolated effects of each component of preliminary training on the enhancement effect.

Method

Subjects

Participants in this study were 120 undergraduate students from Queens College. The students were volunteers from Introductory Psychology courses and had no prior experience with the research area. Students were randomly assigned to one of six groups. Each group differed in terms of preliminary training condition. Although each student received partial course credit for participating in the study, the credit was not contingent upon performance. Each student participated in one to four experimental sessions over the course of 1 to 2 weeks, with each session lasting 1-2 hr.

Apparatus and Stimuli

The experiment was conducted with IBM compatible microcomputers. The stimuli were presented to the subjects on the computer screen. Each subject was required to make all responses by pressing keys on the computer keyboard. Both the recording of responses and the presentation of stimuli were controlled by software designed to study equivalence classes.

Table 1 lists the consonant-vowel-consonant nonsense syllables that were used throughout the experiment with their corresponding symbolic representations (Fields, Verhave, & Fath, 1984). All stimuli were composed of white ASCII characters, each of which was 3 mm wide and 5 mm high on a black computer screen. The stimuli used in preliminary training constituted members of Sets 1 and 2 and are designated by the letters A through E. Stimuli used to form Equivalence Classes 3 and 4 under the simultaneous protocol are designated by the letters V through Z.

Procedure

Initial instructions. Prior to the experiment, subjects were presented with the following set of instructions on the computer monitor.

> Thank you for volunteering to be a subject in this experiment. PLEASE DO NOT TOUCH ANY OF THE KEYS ON THE KEYBOARD YET. In this experiment you will be presented with many trials. Each contains three CUES, these will be common

Table 1

Stimuli Used in Preliminary Training (Sets 1 and 2) and in Simultaneous Protocol (Classes 3 and 4)

CONDITION	SET or CLASS	STIMULI	LN
Preliminary	1	LEQ	A1
		HUK	B1
		POV	C1
		BAF	D1
		TIJ	E1
	2	MEV	A2
		GUQ	B2
		ZOJ	C2
		YAR	D2
		DIW	E2
Simultaneous	3	QIJ	V3
		TUW	W3
		COH	X3
		MEP	Y3
		RAB	Z3
	4	VIF	V4
		KUY	W4
		XOL	X4
		GEZ	Y4
		NAS	Z4

Note. Each stimulus is represented symbolically with a letter. The number following the letter indicates class membership.

> words, or three letter nonsense words such as ZEQ or WUV. YOUR TASK IS TO DISCOVER WHICH WORDS GO TOGETHER. Initially there will also be INSTRUCTIONS that tell you how to respond to the cues, as well as LABELS that will help you to identify the cues on the screen. The labels and the instructions which tell you which KEYS to press will slowly disappear. Your task will be to RESPOND CORRECTLY to the CUES and the INSTRUCTIONS by pressing a key on the computer's keyboard. The experiment is conducted in phases. When each phase ends, the screen will tell you how you did. If you want to take a break, please call the experimenter.

Trial structure, contingencies, and responses within a trial. Each trial began when the words "Press Enter to continue the Experiment" appeared on the screen. After the subject pressed the ENTER key, a sample stimulus was displayed in the upper portion of the computer screen and remained on until the end of the trial. The subject was then required to press the space bar to display the comparison stimuli along with the sample on the screen. All stimuli were displayed in a triangular pattern, with the sample stimulus at the vertex of the triangle, and each of two comparison stimuli at the corners of the base of the triangle. During each trial, the sample stimulus and the positive comparison stimulus

(Co+) were from the same class, whereas the negative comparison stimulus (Co-) was from the other class. The subject selected the comparison on the left by pressing the "1" key and selected the comparison on the right by pressing the "2" key. After the subject made a response, a feedback message was displayed on the screen. If the subject selected the Co+, the word "RIGHT" appeared on the screen until the subject pressed the R key. If the subject selected the Co-, the word "WRONG" appeared on the screen until the subject pressed the W key. During noninformative feedback trials, the letter E appeared on the

Table 2

Sample and Comparison Configurations Used in All Trials

Condition	Operation	Relation	%FeedBack	Sa	Co+	Co-	Trials
3MEM	Train AB	Baseline	100	A1	B1	B2	8
	Train AB	Baseline	75, 25, 0	A1	B1	B2	4
	Test BA	Symmetry	0	B1	A1	A2	8
			"	A1	B1	B2	8
	Train BC	Baseline	100	B1	C1	C2	4
			"	A1	B1	B2	4
	Train BC	Baseline	75, 25, 0	B1	C1	C2	2
			" " "	A1	B1	B2	2
	Test CB	Symmetry	0	C1	B1	B2	4
			"	A1	B1	B2	4
			"	B1	C1	C2	8
	Test BA/CB	Symmetry	0	A1	B1	B2	4
			"	B1	C1	C2	4
			"	B1	A1	A2	4
			"	C1	B1	B2	4
	Test AC	Transitivity	0	A1	B1	B2	4
			"	B1	C1	C2	4
			"	A1	C1	C2	8
	Test CA	Equivalence	0	A1	B1	B2	4
			"	B1	C1	C2	4
			"	C1	A1	A2	8
	3MIX Test	BL, S, T, E	0	A1	B1	B2	4
			"	B1	C1	C2	4
			"	B1	A1	A2	2
			"	C1	B1	B2	2
			"	A1	C1	C2	2
			"	C1	A1	A2	2
4MEM	Train CD	Baseline	100	C1	D1	D2	2
			"	B1	C1	C2	2
			"	A1	B1	B2	6
	Train CD	Baseline	75, 25, 0	C1	D1	D2	2
			" " "	B1	C1	C2	2
			" " "	A1	B1	B2	2
	4MIX Test	BL, S, T, E	0	C1	D1	C2	2
			"	B1	A1	A2	4
			"	C1	B1	B2	4
			"	A1	C1	C2	4
			"	C1	A1	A2	4
			"	D1	C1	C2	4

			"	B1	D1	D2	4
			"	A1	D1	D2	4
			"	D1	B1	B2	4
			"	D1	A1	A2	4
5MEM	Train DE	Baseline	100	A1	B1	B2	2
			"	B1	C1	C2	2
			"	C1	D1	D2	2
			"	D1	E1	E2	6
	Train DE	Baseline	75, 25, 0	A1	B1	B2	2
			" " "	B1	C1	C2	2
			" " "	C1	D1	D2	2
			" " "	D1	E1	E2	2
	5MIX Test	S, T, E	0	E1	D1	D2	2
			"	A1	E1	E2	2
			"	E1	A1	A2	2
			"	B1	D1	D2	2
			"	D1	B1	B2	2
			"	C1	E1	E2	2
			"	E1	C1	C2	2
5SIM	Train VW, WX, XY, YZ	Baseline	100	V3	W3	W4	4
			"	W3	X3	X4	4
			"	X3	Y3	Y4	4
			"	Y3	Z3	Z4	4
	Train VW, WX, XY, YZ	Baseline	75, 25, 0	V3	W3	W4	2
			" " "	W3	X3	X4	2
			" " "	X3	Y3	Y4	2
			" " "	Y3	Z3	Z4	2
	Mixed Test	BL, S, T, E	100	V3	W3	W4	2
			100	W3	X3	X4	2
			100	X3	Y3	Y4	2
			100	Y3	Z3	Z4	2
			0	W3	V3	V4	2
			"	X3	W3	W4	2
			"	Y3	X3	X4	2
			"	Z3	Y3	Y4	2
			"	V3	X3	X4	2
			"	V3	Y3	Y4	2
			"	V3	Z3	Z4	2
			"	W3	Y3	Y4	2
			"	W3	Z3	Z4	2
			"	X3	Z3	Z4	2
			"	X3	V3	V4	2
			"	Y3	V3	V4	2
			"	Z3	V3	V4	2
			"	Y3	W3	W4	2
			"	Z3	W3	W4	2
			"	Z3	X3	X4	2

Note. The stimuli used as samples and comparisons in trials for Set 1 and Class 3 are represented symbolically. A parallel set of trials with samples from Set 2 and Class 4 were also presented in the experiment, although they are not listed in this table. Each row indicates one configuration which contains a sample, a positive, and a negative comparison, all of which were presented together. The stimuli in each configuration were presented the number of times indicated in the column headed "Trials." The comparisons in each configuration appeared equally often on the left and the right. The trials for Sets 1 and 2 were presented in the same block as the trials for Classes 3 and 4, respectively. For example, the 3MEM block used for training AB contained (A1 B1 B2), (A1 B2 B1), (A2 B2 B1), and (A2 B1 B2) trials. BL, S, T, and E refer to baseline conditional discriminations, symmetry, transitivity, and equivalence probes, respectively. An xMIX test consisted of a block that contained symmetry, transitivity, and equivalence probe trials. The 3MIX and 4MIX test blocks also contained baseline review trials. The specific trials used for preliminary training in each group are specified in Table 3.

screen after the subject's response regardless of comparison selection. It remained on the screen until the subject pressed the E key. We selected the E key for this purpose because it indicated the END of a trial, and it is between the W and R keys on a QWERTY keyboard.

Trial block structure and contingencies. Each phase of training and testing consisted of trials presented in blocks. Table 2 lists the type and number of trials presented in each block, as well as the sample and comparisons included in each trial. The trials in each block were presented in random order without replacement. Each Co+ and Co- appeared equally often on the left and right sides of the computer screen within each block.

Whenever conditional discriminations were being established, each trial in a block was presented with informative feedback during the initial phases of training. Each block was repeated until all trials within the block occasioned selection of class-consistent comparisons; this performance was defined as the mastery criterion. After the mastery criterion was reached, the percentage of trials in a block that produced informative feedback was reduced from 100% to 75% to 25% and, finally, to 0% across blocks, provided there was no change in the accuracy of responding. If the subject did not meet the mastery criterion within three blocks at a given feedback level, (s)he was returned to the prior level of feedback until 100% class-consistent responding was achieved.

When test blocks were presented during preliminary training, they always contained emergent relations probes and sometimes contained baseline review trials. All trials in these test blocks were presented with noninformative feedback. During the simultaneous protocol, the test blocks (the 5SIM mixed test) contained baseline review trials and emergent relations probes. While the emergent relations probe trials were never presented with informative feedback, informative feedback was always presented following comparison selection on all baseline review trials. The criterion for emergence was defined as at least 98.44% correct in a test block (one error) within five test blocks throughout all phases of the study.

Keyboard familiarity training. All subjects were taught the keyboard skills required to progress through each trial in the experiment. To facilitate this process, semantically related English words were used as samples and comparisons along with five instructional prompts. The prompts were deleted in a serial manner as training progressed. The prompts included in each trial and the order of deleting the prompts are indicated in Figure 1. This procedure is similar to that described by Fields, Adams, Verhave, and Newman (1990).

Experimental design. Subjects received preliminary training that consisted of either (a) the establishment of equivalence classes, which involved the training of linked conditional discriminations and the presentation of symmetry, transitivity, and equivalence probes, (b) the training of linked conditional discriminations and the presentation of symmetry and transitivity probes, (c) the training of linked conditional discriminations and the presentation of transitivity probes, (d) the training

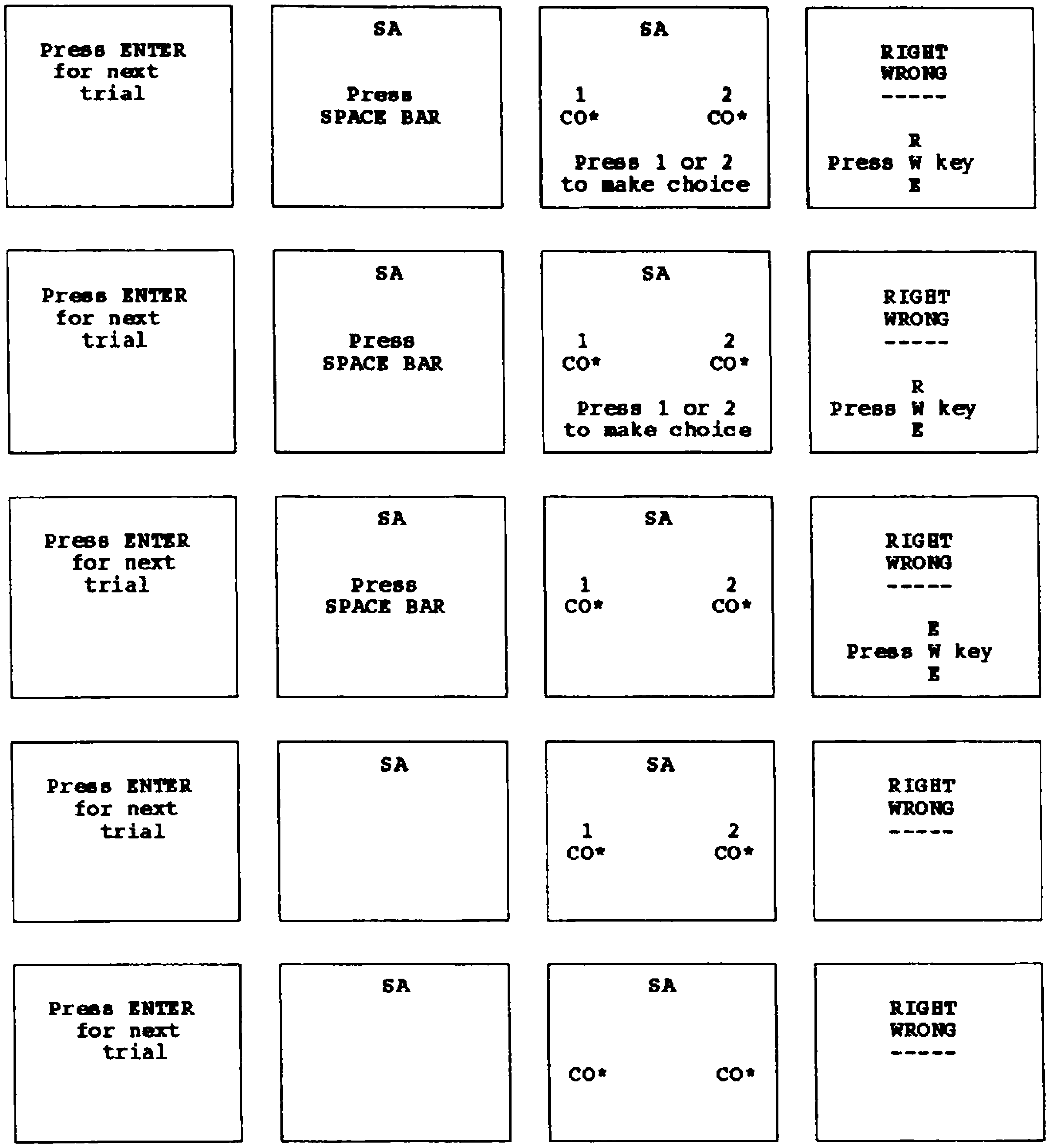

Figure 1. Fading out of prompts. Sequential changes in the stimuli and the prompts that were presented during a trial are illustrated across the frames in each row of Figure 1. The order in which prompts were deleted is indicated in successive rows.

of linked conditional discriminations and the presentation of symmetry probes, (e) the training of linked conditional discriminations only, or (f) no preliminary training. A 3-node 5-member structure was used during preliminary training because the prior establishment of classes with this size and structure maximized the overall percentage of subjects who showed the emergence of new equivalence classes under the simultaneous protocol (Buffington et al., 1997; Fields et al., 1997).

Once preliminary training was completed, subjects in all groups attempted to learn new 3-node 5-member equivalence classes under the simultaneous protocol. A comparison of the percentage of subjects who showed the emergence of new equivalence classes under the simultaneous protocol across groups was used to identify the isolated effects of each component of preliminary training on the enhancement effect.

Table 3

Sequence of Trial Introduction During Preliminary Training

GROUP	TYPE	3-MEMBER								4-MEMBER		5-MEMBER	
1	BL	AB	AB	BC	AB, BC	AB, BC	AB, BC	AB, BC	AB, BC	CD	AB, BC, CD	DE	
	Sym		BA		CB	BA, CB			BA, CB		BA, CB DC		BA, CB DC ED
	Tty						AC		AC		AC BD, AD		AC BD, AD CE, BE, AE
	Eqv							CA	CA		CA DB, DA		CA DB, DA EC, EB, EA
2	BL	AB	AB	BC	AB ,BC	AB, BC	AB, BC	AB, BC	AB, BC	CD	AB, BC, CD	DE	
	Sym		BA		CB	BA, CB			BA, CB		BA, CB DC		BA, CB DC ED
	Tty						AC		AC		AC BD, AD		AC BD, AD CE, BE, AE
3	BL	AB	AB	BC	AB, BC	AB, BC	AB, BC	AB, BC	AB, BC	CD	AB, BC, CD	DE	
	Tty						AC		AC		AC BD, AD		AC BD, AD CE, BE, AE
4	BL	AB	AB	BC	AB, BC	AB, BC	AB, BC	AB, BC	AB, BC	CD	AB, BC, CD	DE	
	Sym		BA		CB	BA,CB			BA,CB		BA,CB DC		BA,CB DC ED
5	BL	AB	AB	BC	AB, BC	AB, BC	AB, BC	AB, BC	AB, BC	CD	AB, BC, CD	DE	

Note. The order of introducing baseline conditional discriminations and emergent relations probes for each group that received some form of preliminary training. The same order of introducing trial types was used in all preliminary training conditions. Table 2 illustrates the actual trial content for each stimulus-stimulus relation indicated here.

Group 1: Equivalence class formation. During preliminary training, two 3-node 5-member equivalence classes were established in three stages, as illustrated in Table 3. First 3-member classes were established under the simple-to-complex protocol (Adams et al., 1993; Buffington et al., 1997; Fields, Reeve, Adams, & Verhave, Fields et al., 1991; 1997; Lynch & Cuvo, 1995; Schusterman & Kastak, 1993). Following the establishment of the AB relations, the symmetrical property of AB was assessed with BA probes. When the BA test was passed, BC was trained for each class, and the symmetrical property of these trained relations was assessed with CB probes. After a combined review of BA and CB symmetrical relations, transitivity was tested with AC probes. Once a subject passed the AC transitivity test, equivalence was assessed with CA probes. Finally, a mixed review of all baseline, symmetrical, transitive, and equivalence relations was conducted. Class-consistent responding on more than 98% of all test trials indicated the establishment of two 3-member classes.

Once the 3-member classes were established, class size was expanded to 2-node 4-member classes by training CD. The expansion of class size was then assessed with the presentation of a test block (4MIX) that contained all possible emergent relations probes used to assess symmetry, transitivity, and equivalence, along with CD trials that assessed maintenance of the baseline relations. The block was repeated until all tests for emergent relations were passed, or for a maximum of six blocks.

Having demonstrated the emergence of the 4-member classes, expansion to 3-node 5-member classes was accomplished by training DE. The expansion of class size was assessed with the presentation of a test block (5MIX) that contained probes that assessed symmetry, transitivity, and equivalence along with the DE baseline relations. The block was repeated until all of these tests for emergent relations were passed, or for a maximum of six blocks. The specific stimuli used in all trials of the entire simple-to-complex protocol are listed in the Group 1 panel of Table 3.

Group 2: Linked baselines, symmetry and transitivity probes. For subjects in this group, preliminary training consisted of the establishment of a set of linked conditional relations, and the presentation of symmetry and transitivity probes. It excluded the presentation of equivalence probes.

Group 3: Linked baselines and transitivity probes. For subjects in this group, preliminary training consisted of the establishment of linked conditional relations and the presentation of transitivity probes only. It excluded the presentation of equivalence and symmetry probes.

Group 4: Linked baselines and symmetry probes. For subjects in this group, preliminary training consisted of the establishment of linked conditional relations and the presentation of symmetry probes. It excluded the presentation of transitivity and equivalence probes.

Group 5: Linked baselines. For subjects in this group, preliminary training consisted of the establishment of the same conditional discriminations established in the other groups. It excluded the presentation of all emergent relations probes.

Group 6: No preliminary training. Subjects in this group received no preliminary training.

Similarities among groups. In Groups 2-5, the preliminary training conditions involved the introduction of each trial type in the same temporal order used during the establishment of the equivalence classes in Group 1. Therefore, the sequence of training and testing across experimental conditions was matched to the maximal extent possible.

Assessing the effects of training with the simultaneous protocol. Following the completion of preliminary training, subjects in all groups were exposed to the simultaneous protocol in an attempt to establish two new 3-node 5-member classes. First, the conditional relations VW, WX, XY, and YZ were established on a concurrent basis. All of the trials needed to establish these relations were presented in a single training block. In each block, each trial type was presented an equal number of times in a random order without replacement. During the initial phases of training, each trial in a block was presented with informative feedback. The training block was repeated until all trials within the block occasioned class-consistent comparison selections. After this mastery criterion was reached, the percentage of trials in a block that produced informative feedback was reduced from 100% to 75% to 25% and, finally, to 0% as long as the mastery criterion was maintained at the prevailing level of feedback.

After the completion of training, all of the baseline conditional relations as well as the symmetry, transitivity, and equivalence probes were presented in a single test block. As in training, all trials in the test block were presented in random order without replacement. During this test block, informative feedback was provided only for selections made on baseline trials. Non-informative feedback was presented for selections made on all emergent relations test trials. The test block was repeated until criterion was met, or for a maximum of five blocks. The stimuli used in each trial presented during the simultaneous protocol are listed in Table 2.

Table 4

Average Number of Blocks (X) to Establish Each Baseline Conditional Discrimination and To Pass Each Emergent Relations Test For Each Preliminary Training Condition

		Preliminary Training Group/probe									
		5-B		4-B S		3-B T		2-B S T		1-B S T E	
Trial Type	Stim	X	SE	X	SE	X	SE	X	SE	X	SE
BL	AB	6.2	0.3	6.2	0.4	6.4	0.5	6.9	0.8	6.1	0.3
	BC	6.6	1	7.2	0.8	8	1	5.9	0.5	6.9	1.2
	CD	5.4	0.2	6.5	0.7	8.4	1.8	6	0.4	5.4	0.2
	DE	8	1.5	5.4	0.3	6.3	0.6	5.2	0.3	6.5	0.8
SYM	BA			1.1	0.1			1.1	0.1	1.1	0.1
	CB			1	0			1.1	0.1	1.2	0.1
	DC			1	0			1.1	0.1	1.1	0.1
	ED			1.1	0.1			1	0	1.4	0.2
TTY-1	AC					1.2	0.1	1	0	1.2	0.1
	BD					1.5	0.2	1.3	0.1	1.3	0.1
TTY-2	CE					1.3	0.2	1.2	0.1	1.1	0.1
	AD					1.5	0.2	1.2	0.1	1.3	0.1
	BE					1.3	0.1	1.1	0.1	1.1	0.1
TTY-3	AE					1.3	0.1	1.4	0.1	1.2	0.2
EQV-1	CA									1	0
	DB									1.3	0.1
	EC									1.3	0.1
EQV-2	DA									1.2	0.1
	EB									1.1	0.1
EQV-3	EA									1.3	0.2

Note. SE indicates one standard error. In addition, the percentage correct on the initial presentation of each probe is listed. B, S, T, and E refer to baseline conditional discrimination training only, and the inclusion of symmetry, transitivity, and equivalence probes during preliminary training. TTY-X and EQV-X refer to transitivity and equivalence probes, respectively, where the value of X designates the number of nodes that characterize each probe.

Results

Acquisition of baseline conditional discriminations during preliminary training. The first four rows of Table 4 shows that a similar average number of blocks was needed to acquire each baseline conditional discrimination in a given preliminary training condition. In addition, a similar number of blocks was required to establish the same baseline conditional discrimination across preliminary training conditions. All of these averages were derived from the individual subject data included in Appendix 1.

Probe performances during preliminary training. The average number of blocks needed to pass each type of probe presented during each preliminary training condition is also listed in Table 4. Very few test blocks were needed to pass most emergent relations tests. In addition, there was little intersubject variability in blocks to pass emergent relations tests across probe types within and across preliminary training conditions. A visual inspection of the data show that the small differences that were observed were not systematic. The averages were derived from the individual subject data presented in Appendix 2.

Table 5

Average Number of Blocks Needed to Establish Conditional Discriminations During Training Portion of Simultaneous Protocol for Each Preliminary Training Condition

	Preliminary Training Group					
	6 NONE	5 B	4 B S	3 B T	2 B S T	1 B S T E
Blocks	22.2	15.3	18.4	16.9	15.7	15.6
SE	2.1	2.1	2.3	1.5	1.5	1.6

Note. SE indicates one standard error for the corresponding average. Baseline conditional discrimination training, symmetry, transitivity, and equivalence testing included in each preliminaty training condition are indicated by B, S, T, and E, respectively.

Baseline acquisition during the simultaneous protocol. All subjects acquired the baseline conditional discriminations under the simultaneous protocol regardless of preliminary training condition. As seen in Table 5, more trials were needed to establish the conditional relations during the simultaneous protocol when it was not preceded by preliminary training [$t(118) = -2.86$, $p = .005$]. In contrast, a similar number of trials were needed to establish the conditional relations during the simultaneous protocol for all conditions that had included some level of preliminary training [$F(99) = .51$, $p = .73$).

Emergence of equivalence classes under the simultaneous protocol. Figure 2 illustrates the effects of each preliminary training condition on the percentage of subjects who showed the emergence of equivalence classes under the simultaneous protocol. Table 6 shows the statistical significance of the differences in yields for all conditions on a pairwise basis. The lowest percentages of subjects who showed the emergence of new equivalence classes under the simultaneous protocol were observed after no preliminary training, or after preliminary training that involved the establishment of linked conditional discriminations only. These preliminary training conditions

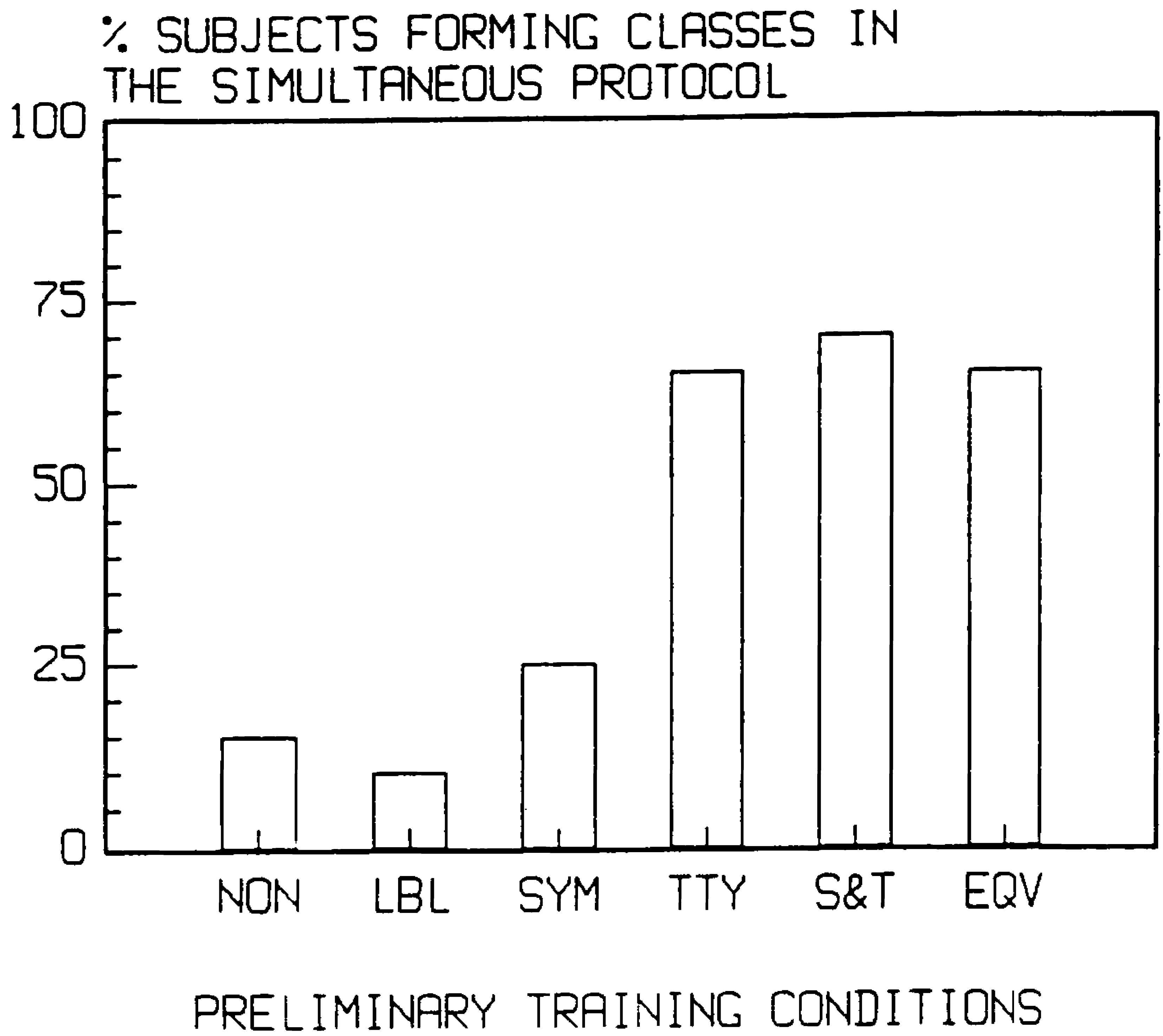

Figure 2. Percentage of subjects who showed the emergence of equivalence classes under the simultaneous protocol.

Table 6

Statistical Analysis of Yields Under Simultaneous Protocol

	LBL	SYM	TTY	S&T	EQV
NONE	0.63	0.42	0.00*	0.00*	0.00*
LBL		0.21	0.00*	0.00*	0.00*
SYM			0.01*	0.00*	0.01*
TTY				0.74	1.00
S&T					0.74

Note. Chi square comparisons of preliminary training conditions on the immediate and overall percentage of subjects who showed emergence of equivalence classes during the simultaneous protocol. Asterisks indicate statistically significant differences.

occasioned small differences in likelihood of equivalence class formation during the simultaneous protocol. As seen in Table 6, however, these differences were not statistically significant, as measured by chi square analyses.

An intermediate percentage of subjects showed the emergence of new equivalence classes under the simultaneous protocol after preliminary training that included the presentation of symmetry probes alone. Although the yield for this group was greater than that observed after no preliminary training or the preliminary training that involved the establishment of linked conditional discriminations, this trend was not statistically significant as seen in Table 6.

The highest percentages of subjects to show the emergence of new equivalence classes under the simultaneous protocol were observed after preliminary training that involved the presentation of transitivity probes alone, transitivity in combination with symmetry probes, or transitivity probes in combination with symmetry and equivalence probes. The small changes in yield produced by each of these preliminary training conditions were not statistically different from each other, as indicated in Table 6. All of them, however, were statistically different from those obtained after no preliminary training, preliminary training of conditional discriminations alone or in combination with the presentation of symmetry probes, as indicated in Table 6.

Kernel analysis of relational responding in simultaneous testing. A kernel analysis (Buffington et al., 1997; Fields et al., 1995) was used to measure conditional discriminative control of responding that was consistent with the experimenter-defined classes. When a two-choice matching to sample procedure is used, a kernel consists of four trials. Each of two stimuli (X1 and X2) serve as samples on two of the four trials. Two other stimuli (Y1 and Y2) are presented as a comparison pair on all trials. For each sample, the location of the comparison stimuli are switched across trials. The sample and comparison pairs are presented in a random order without replacement. When all trials in a kernel occasion the selection of comparisons that are consistent with the experimenter-defined classes, one instance of relational responding has been demonstrated. Level of relational responding is indexed by the percentage of kernels of a given type that produce the above-mentioned pattern of responding. The kernel analysis was applied to each of the trial types presented during the simultaneous protocol.

Because preliminary training did not influence the relational responding occasioned by the baseline kernels during the test blocks of the simultaneous protocol, the data for all groups were combined for presentation in Table 7. All baseline kernels evoked relational responding at the end of training in the simultaneous protocol. For most subjects who

Table 7

Baseline Disruption in Simultaneous Protocol Tests

Classes Formed in Simultan. Protocol	% Baseline Kernels that Evoke Relational Responding				
	100	75	50	25	0
YES	79	14	5	1	0
NO	24	13	18	12	12

Note. Percentage of subjects who responded relationally in varying degree to the baseline kernels presented during the test blocks of the simultaneous protocol.

formed classes, the baseline kernels continued to evoke relational responding during the initial test block. For the remaining subjects who formed classes, there were modest transient disruptions of relational responding evoked by the baseline kernels. In contrast, most of the subjects who did not form classes under the simultaneous protocol exhibited substantial and sustained disruptions of baseline responding during the test blocks in the simultaneous protocol.

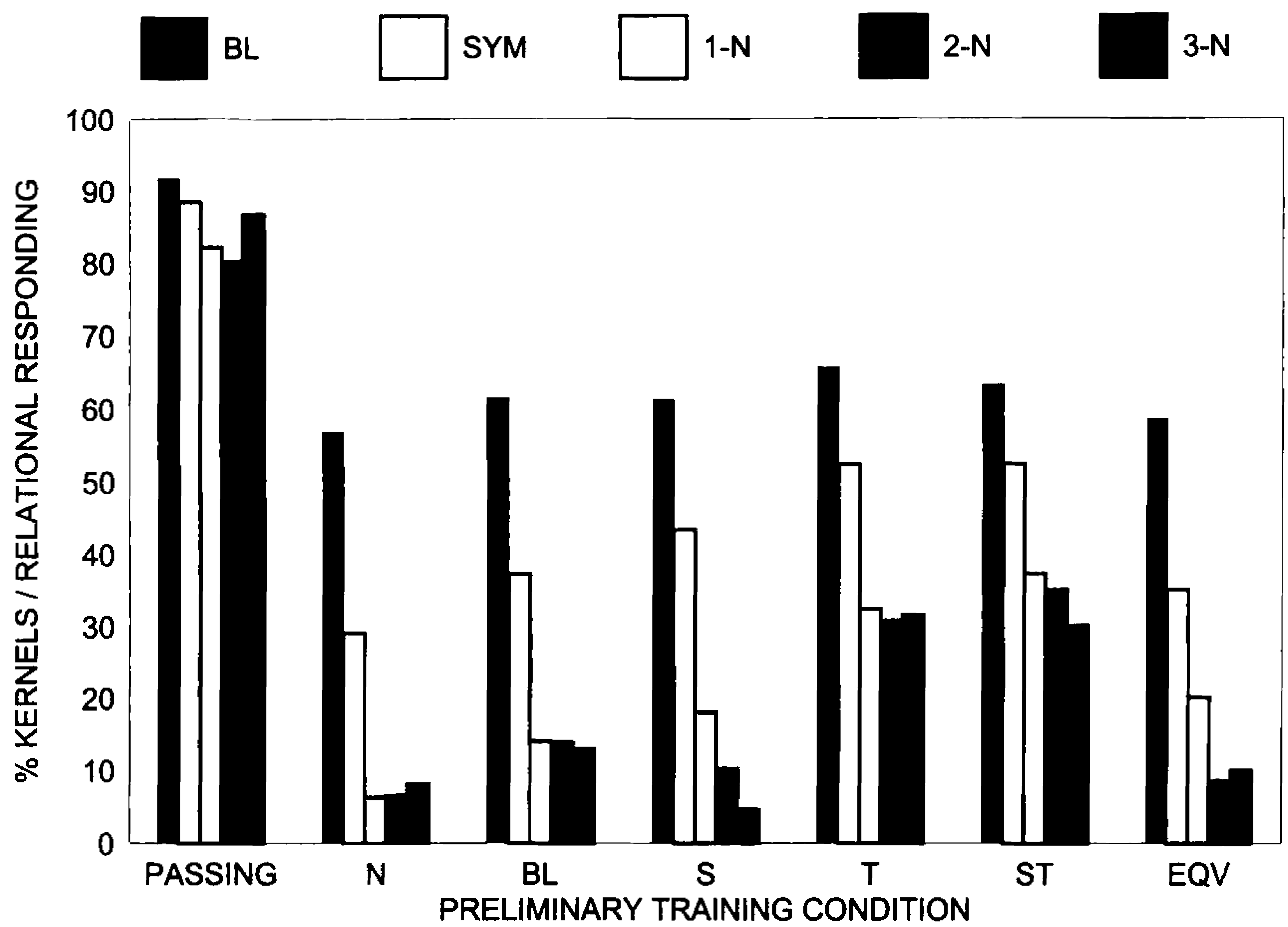

Figure 3. Percentage of baseline, symmetry or 1-node kernels, 1-, 2-, and 3-node kernels that evoked relational responding in the test blocks presented under the simultaneous protocol. Data for subjects who formed classes are collapsed across all preliminary training conditions and are presented on the left. Data for subjects who did not form classes are presented on the right and are displayed as a function of preliminary training condition. For each condition indicated on the abscissa, moving from left to right, the five bars in the contiguous cluster represent data occasioned by the baseline, 0-, 1-, 2-, and 3-node kernels

Figure 3 shows the relational responding evoked by each type of kernel presented during the test blocks in the simultaneous protocol. Data for the subjects who formed classes are presented in the left-most panel. Because there were no systematic differences in the effects of preliminary training, data were averaged across all conditions. For these subjects, a high percentage of all types of kernels evoked relational responding regardless of preliminary training.

Data for subjects who did not form classes are presented in the remaining portion of Figure 3. Because the performances occasioned by the various types of kernels were differentially influenced by preliminary training, separate sets of kernel-based data are presented for each preliminary training condition. In general, the level of relational responding evoked by each kernel type was much lower for these subjects than for subjects who formed classes under the simultaneous protocol. For these subjects, between 55 and 65% of the baseline kernels evoked relational responding during the test blocks. In addition, all emergent relations kernels evoked less relational responding than the baseline kernels, regardless of preliminary training conditions. When the emergent relations kernels are considered, relational responding was an inverse function of nodal distance. Nodal distance refers to the minimal number of nodes that separated the stimuli in the conditional discriminations that were established by training (Fields et al., 1984;1990; 1995; Fields & Verhave, 1987; Spencer & Chase, 1996). The slopes of these nodal distance functions were rather steep and became asymptotic at different nodal numbers, a finding also reported by Buffington et al. (1997) and Fields et al. (1995). These slopes and asymptotes did not vary systematically with preliminary training condition. The stimuli in each set of linked conditional discriminations, then, were systematically related to each other even though the type of relation was not one of equivalence (Hayes & Hayes, 1992; Pilgrim & Galizio, in press; Saunders & Green, 1992; Sidman, 1994).

When the 0-node (i.e., symmetry) and 1-node kernels are considered, each preliminary training condition differentially influenced the magnitude of relational responding. These two types of kernels evoked the lowest levels of relational responding after no preliminary training and increased systematically as preliminary training changed from the establishment of conditional discriminations alone, to the testing of symmetry alone, to the assessment of transitivity alone or transitivity and symmetry alone. Thus, there was a corresponding decrease in the disparity between the performances evoked by the baseline kernels on the one hand and the symmetry or 1-node kernels on the other. Unexpectedly, the 0- and 1-node probes occasioned relatively low levels of relational responding after preliminary training that involved the establishment of equivalence classes.

The various preliminary training procedures had a different effect on the performances occasioned by the 2- and 3-node kernels presented during the test blocks of the simultaneous protocol. These kernels occasioned relatively high levels of relational responding when they were presented in the simultaneous protocol test blocks that followed preliminary training involving the assessment of transitivity alone, or symmetry and transitivity. In addition, both types of kernels produced similar levels of responding. In contrast, these kernels evoked similar low levels of relational responding after no preliminary training, or preliminary training that involved the establishment of conditional discriminations alone, the assessment of symmetry alone, or, unexpectedly, the establishment of equivalence classes.

Discussion

Performances during preliminary training. During preliminary training all of the emergent relations tests were passed almost immediately. These findings can be attributed to the highly programmed characteristics of the simple-to-complex protocol used during preliminary training (Adams et al., 1993; Fields et al., 1995).

During preliminary training, all of the baseline conditional discriminations were acquired at the same speed for subjects in Groups 1-5. During preliminary training, the conditional discriminations were established in isolation for subjects in Group 5 and among the presentation of a variety of emergent relations probes for subjects in Groups 1-4. Thus, the rate of learning new conditional discriminations was not influenced by the interleaved presentation of test blocks that contained single or multiple emergent relations probes.

Because the successive training of new conditional discriminations is similar to the procedures that produce learning set effects, each new conditional discrimination should have been acquired more rapidly than the previously established conditional discriminations (Harlow, 1949; Mackintosh, 1977). The constancy with which the conditional discriminations were acquired, however, did not show the effects of learning set. In studies that have shown learning set effects, however, subjects were required to learn sets of discriminations, each of which contained many problems (Harlow, 1949; Mackintosh, 1977). In contrast, the effects of learning set may have been obviated in the current experiment by requiring subjects to learn only one conditional discrimination at a time.

Baseline acquisition under the simultaneous protocol. The conditional discriminations trained during the simultaneous protocol were acquired faster following any of the preliminary training conditions than after no preliminary training. In addition, rate of acquisition was the same after all forms of preliminary training. These results imply that some factor common to all preliminary training procedures was responsible for the increase in acquisition speed. The only factor that was constant across preliminary training conditions was the training of linked conditional discriminations. Thus, the prior establishment of one set of conditional discriminations enhanced the rate of acquiring a new set of concurrently trained conditional discriminations: a learning set effect.

Although rate of baseline acquisition was influenced by preliminary training, subjects in all conditions acquired all of the baseline conditional discriminations under the simultaneous protocol. Thus, prior exposure to preliminary training did not influence the likelihood of forming new conditional discriminations. The various preliminary training conditions, then, did not influence the emergence of new equivalence classes under the simultaneous protocol through their effects on the formation of the conditional discriminations under that protocol.

Baseline performances during simultaneous protocol testing. The introduction of the simultaneous protocol test block resulted in the disruption of performances occasioned by the baseline conditional discriminations for many subjects. Similar disruptions have been noted by others when using the simultaneous protocol (Buffington et al., 1997; Fields et al., 1995; 1997; Holth & Arntzen, 1998; Smeets, Leader, & Barnes, 1997). Because baseline performances are typically not disrupted when single emergent relations probes are introduced, it appears that the concurrent introduction of many emergent relations probes, as occurs during the simultaneous protocol, is the general source of the disruption. Additional research will be needed to isolate the degree of disruption that can be attributed to each type of emergent relations probe.

During the same simultaneous protocol test block, some subjects showed relatively small disruptions in baseline performances followed by a recovery of conditional discriminative control and eventual emergence of classes. Other subjects showed larger, permanent disruptions of baseline performances that were not followed by the emergence of equivalence classes. Additional research is needed to identify the variables that make conditional discriminative performances more resistant to disruption and more prone to recovery for some subjects and less so for others.

Emergence of equivalence classes in the simultaneous protocol. When no preliminary training was conducted, a very low percentage of subjects showed the emergence of new classes under the simultaneous protocol. The same low yield was obtained when preliminary training consisted of the establishment of baseline conditional discriminations alone. Thus, the enhanced emergence of new equivalence classes under the simultaneous protocol cannot be attributed to the prior establishment of other conditional discriminations.

When measured against the above mentioned yields, the largest increase in the percentage of subjects who showed the emergence of equivalence classes during the simultaneous protocol followed the three preliminary training conditions that included transitivity testing. These were (a) transitivity testing alone, (b) transitivity and symmetry testing, and (c) transitivity, symmetry and equivalence testing. Because all three conditions produced the same yields, a demonstration of transitivity alone during preliminary training was the factor most responsible for maximizing the emergence of new equivalence classes under the simultaneous protocol. The similarity in yield following both the first and third preliminary training conditions listed above, showed that it was not necessary to establish one set of equivalence classes during preliminary training to maximize the emergence of new equivalence classes during the simultaneous protocol.

Preliminary training that included symmetry testing resulted in a small increase in the percentage of subjects who showed the emergence of equivalence classes during the simultaneous protocol. The inclusion of symmetry with transitivity testing during preliminary training did not change yields during the simultaneous protocol. Although symmetry testing alone during preliminary training might produce a modest enhancement of yield during the simultaneous protocol, its effect is not strong enough to add to the efficacy of transitivity testing during preliminary training.

To summarize, the results of the current experiment showed how each component of the procedure used to establish equivalence classes during preliminary training influenced the percentage of subjects who showed the subsequent emergence of other equivalence classes under the simultaneous protocol. It is not yet known, however, why a particular preliminary training condition engenders class formation under the simultaneous protocol for one subject and not for another. The identification of the variables responsible for this intersubject difference would further enhance our understanding of the formation of equivalence classes by individual subjects.

Interpretation of prior findings. Buffington et al. (1997) and Fields et al. (1997) attributed the enhancement of equivalence class formation in the simultaneous protocol to the size and number of nodes that characterized previously established equivalence classes. The results of the current experiment suggest that the enhancement effects were due primarily to prior demonstrations of transitivity. Thus, the parameters that specified the size and number of nodes in the initially established equivalence classes actually had their effect by specifying number and diversity of transitivity probes used in preliminary training.

A behavioral process account of the enhancement effect. Preliminary training that included transitivity testing maximized the percentage of subjects who formed equivalence classes under the simultaneous protocol. Some behavioral processes that could account for this effect are suggested by the kernel analysis of the data obtained from the subjects who did not form classes under the simultaneous protocol. The account, however, does not include a consideration of the effects of equivalence class formation during preliminary training.

After preliminary training that included transitivity testing, the emergent relations kernels presented in the simultaneous protocol showed high levels of relational responding and a small disparity in the performances occasioned by the symmetry and baseline kernels. Following all other conditions, the emergent relations kernels showed low levels of relational responding and large disparities in the performances occasioned by the symmetry and baseline kernels. Thus, the emergence of equivalence classes in the simultaneous protocol was directly correlated with the level of relational responding evoked by emergent relations kernels and was inversely correlated with the disparity between the performances occasioned by the baseline and symmetry kernels. Furthermore, it can be assumed that each preliminary training condition had a similar effect on subjects who formed classes, but at higher levels. Thus, the above mentioned correlations imply that the induction of transitivity with one set of stimuli maximized the emergence of new classes under the simultaneous protocol by establishing or activating stimulus control repertoires that (a) made conditional discriminations more resistant to disruption and (b) enhanced the formation of novel relations among the new stimuli used in conditional discriminations. This analysis, however, does not account for the effects of preliminary training that involved equivalence class formation. That form of preliminary training produced high yields and low levels of relational responding by the subjects who did not form classes during the simultaneous protocol. This result also does not appear to be consistent with the results reported by Buffington et al. (1997) and Fields et al. (1997). The reasons for these inconsistencies are not yet understood.

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Appendix

Individual Subject Performance During Preliminary Training

Each condition and subject are listed listed as rows. Each column indicates a conditional discrimination or emergent relations test used during preliminary training. The data in columns AB, BC, CD, or DE show the number of blocks needed to establish the indicated conditional discriminations, in columns BA, CB, DC, or ED show the blocks needed to pass the indicated symmetry tests, in columns AC, BD, or CE show the blocks to pass the 1-node transitivity tests, in columns AD and BE the blocks to pass the 2-node transitivity tests, in column AE the blocks to pass the 3-node transitivity test, in columns CA, DB, and CE the blocks to pass the 1-node equivalence tests, in columns DA and EB the blocks to pass the 2-node equivalence tests, and in column EA the blocks to pass the 3-node equivalence test. Some columns do not contain data because the tests indicated by the column header were not included in that preliminary training condition.

		3-MEMBERS						4-MEMBERS						5-MEMBERS							
GROUP	SUBJ	AB	BA	BC	CB	AC	CA	CD	DC	BD	DB	AD	DA	DE	ED	CE	EC	BE	EB	AE	EA
1	1461NS	5	2	5	2	1	1	5	1	2	2	1	1	6	3	1	2	1	1	1	1
	1380CK	5	1	5	1	1	1	5	1	1	1	1	1	4	1	1	1	1	1	1	1
	1463SB	10	1	6	1	1	1	7	1	1	1	1	1	5	1	2	2	1	1	2	1
	1468DL	7	1	8	1	1	1	8	1	2	2	1	1	8	1	1	1	1	1	1	1
	1362LW	5	1	6	1	1	1	4	1	1	1	2	1	6	1	1	1	1	1	1	2
	1478EY	5	1	5	1	1	1	5	1	2	1	1	1	6	1	1	1	1	1	1	1
	1379PO	5	1	4	1	1	1	5	1	1	1	1	1	9	1	1	1	1	2	1	1
	1477FS	5	1	5	1	1	1	5	1	2	1	3	1	5	1	1	1	1	1	1	1
	1464JG	7	1	28	2	1	1	6	1	2	3	2	1	7	1	1	1	1	1	1	1
	1475LH	7	1	4	1	1	1	6	1	1	1	1	1	4	1	1	1	1	1	1	1
	1476LF	5	1	6	1	1	1	5	2	1	1	2	2	14	4	2	2	2	1	4	4
	1471KG	6	1	5	1	1	1	5	1	1	1	1	1	17	3	1	1	1	1	1	1
	1479MM	4	1	4	1	1	1	5	1	1	1	1	2	4	1	1	1	1	1	1	1
	1462JA	6	1	7	1	1	1	5	1	1	1	1	1	4	1	1	1	1	1	1	1
	1472JK	7	2	7	1	1	1	5	1	1	1	1	2	6	1	1	3	1	1	1	1
	1474SU	7	1	5	1	2	1	6	1	1	1	1	1	4	1	1	1	1	1	1	1
	1466SM	6	1	4	1	1	1	7	1	1	2	1	1	5	1	1	1	1	1	1	1
	1369FE	7	1	11	2	2	1	4	1	1	1	1	1	5	1	1	2	1	2	1	1
	1473RY	8	1	7	1	1	1	5	1	1	2	1	1	4	1	1	1	1	1	1	1
	1467JD	5	1	6	1	2	1	5	1	1	1	1	1	7	1	1	1	1	1	1	2
	MEAN	6.1	1.1	6.9	1.2	1.2	1.0	5.4	1.1	1.3	1.3	1.3	1.2	6.5	1.4	1.1	1.3	1.1	1.1	1.2	1.3
	SE	0.3	0.1	1.2	0.1	0.1	0.0	0.2	0.1	0.1	0.1	0.1	0.1	0.8	0.2	0.1	0.1	0.1	0.1	0.2	0.2

GROUP	SUBJ	AB	BA	BC	CB	AC	CA	CD	DC	BD	DB	AD	DA	DE	ED	CE	EC	BE	EB	AE	EA
2	1192GG	5	1	5	2	1		5	1	1		1		11	1	1		1		1	
	1241SA	10	1	5	1	1		10	1	1		1		6	1	1		1		2	
	1261SM	21	1	5	1	1		6	2	3		1		5	1	1		1		1	
	1207CL	6	2	9	1	1		5	1	2		1		5	1	1		1		1	
	1210DS	6	1	4	1	1		6	1	1		2		4	1	1		1		1	
	1238SE	7	1	5	1	1		6	1	1		1		5	1	1		1		2	
	1265SS	6	1	5	1	1		5	1	1		1		4	1	1		1		2	
	1250RR	6	1	6	1	1		4	1	1		1		5	1	1		1		1	
	1248LF	5	1	4	1	1		5	1	1		1		5	1	1		1		1	
	1202AM	8	1	4	1	1		5	1	1		1		5	1	1		1		1	
	1212RA	5	1	4	1	1		5	1	1		1		5	1	1		1		1	
	1196SC	6	1	6	1	1		4	1	1		2		6	1	1		1		2	
	1201IM	5	1	5	1	1		5	1	1		1		5	1	1		1		1	
	1229KM	7	1	11	1	1		8	1	1		2		5	1	3		1		1	
	1198GC	8	1	7	1	1		6	1	1		1		5	1	2		1		1	
	1259KL	5	1	4	1	1		9	1	1		1		5	1	1		1		1	
	1228SK	6	1	11	1	1		5	1	2		1		6	1	2		1		1	

		3-MEMBERS						4-MEMBERS						5-MEMBERS							
GROUP	SUBJ	AB	BA	BC	CB	AC	CA	CD	DC	BD	DB	AD	DA	DE	ED	CE	EC	BE	EB	AE	EA
	1232RT	6	1	7	1	1		9	1	2		1		4	1	1		2		1	
	1193RP	4	1	5	1	1		5	1	1		1		4	1	1		2		2	
	1218AA	5	1	5	1	1		6	1	1		2		4	1	1		1		3	
	MEAN	6.9	1.1	5.9	1.1	1.0		6.0	1.1	1.3		1.2		5.2	1.0	1.2		1.1		1.4	
	SE	0.8	0.1	0.5	0.1	0.0		0.4	0.1	0.1		0.1		0.3	0.0	0.1		0.1		0.1	
3	1122DD	6		6		1		8		3		2		5		1		1		1	
	1080JJ	4		4		1		5		1		1		5		1		2		2	
	1234JC	5		4		1		5		1		1		5		1		1		1	
	1184NV	6		4		1		4		1		1		5		1		2		1	
	1181NK	6		4		1		4		1		1		5		1		1		1	
	1124GL	5		4		1		5		1		1		5		1		1		1	
	1121ME	5		8		1		9		2		2		5		1		1		2	
	1190PP	5		5		1		6		1		1		4		1		1		1	
	1154JG	6		4		1		5		1		1		4		1		2		1	
	1126SM	6		16		3		13		2		3		6		1		1		1	
	1185RF	6		5		2		10		1		3		5		1		1		1	
	1128RS	15		7		1		6		2		2		4		1		1		1	
	1179GA	7		13		1		6		2		1		5		1		1		1	
	1129NM	6		8		1		41		1		2		10		1		1		1	
	1136ZS	6		4		1		5		1		1		5		1		1		1	
	1191RJ	6		8		1		12		1		1		11		3		1		1	
	1127KW	8		13		1		6		1		1		6		1		1		1	
	1187HY	5		15		1		5		2		1		5		1		1		1	
	1077KP	7		16		1		9		3		2		12		3		2		2	
	1189DD	7		12		1		4		1		1		13		3		3		3	
	MEAN	6.4		8.0		1.2		8.4		1.5		1.5		6.3		1.3		1.3		1.3	
	SE	0.5		1.0		0.1		1.8		0.2		0.2		0.6		0.2		0.1		0.1	

		3-MEMBERS						4-MEMBERS						5-MEMBERS							
GROUP	SUBJ	AB	BA	BC	CB	AC	CA	CD	DC	BD	DB	AD	DA	DE	ED	CE	EC	BE	EB	AE	EA
4	1097CK	7	1	4	1			6	1					4	1						
	1096IL	5	1	5	1			6	1					5	1						
	1091HL	5	1	10	1			5	1					5	1						
	1088MH	5	1	5	1			4	1					4	1						
	1093TM	4	1	5	1			5	1					4	1						
	1107KT	6	1	6	1			5	1					8	1						
	1116SB	7	1	14	1			18	1					8	1						
	1111KK	7	1	4	1			11	1					6	1						
	1113AD	7	1	9	1			4	1					5	1						
	1081VP	5	1	8	1			5	1					5	1						
	1095SG	6	1	4	1			5	1					5	1						
	1082CW	6	1	9	1			5	1					5	1						
	1108LS	5	1	7	1			4	1					5	1						
	1117CG	5	1	5	1			4	1					5	1						
	1104MS	6	1	6	1			10	1					5	1						
	1109PO	5	1	5	1			5	1					4	1						
	1094CL	6	2	5	1			5	1					9	1						
	1115DG	8	1	16	1			8	1					5	1						
	1106SC	6	1	5	1			8	1					4	1						
	1112LK	12	1	11	1			6	1					6	2						
	MEAN	6.2	1.1	7.2	1.0			6.5	1.0					5.4	1.1						
	SE	0.4	0.1	0.8	0.0			0.7	0.0					0.3	0.1						
5	1044YB	8		6				4						6							
	1275HM	5		9				5						6							
	1046DL	5		4				4						6							
	1043ZL	7		24				7						5							

		3-MEMBERS						4-MEMBERS						5-MEMBERS							
GROUP	SUBJ	AB	BA	BC	CB	AC	CA	CD	DC	BD	DB	AD	DA	DE	ED	CE	EC	BE	EB	AE	EA
	1041KF	6		4				5						8							
	1110MH	5		6				7						4							
	1051FK	7		6				5						6							
	1038SK	5		4				4						6							
	1045SA	6		5				5						6							
	1059CB	5		5				5						8							
	1048MG	8		6				6						11							
	1042NT	9		11				6						8							
	1047DL	6		4				4						6							
	1124MG	7		5				5						5							
	1119CS	5		5				5						5							
	1069JS	6		5				8						10							
	1036AG	5		5				5						5							
	1070SD	8		6				5						7							
	1049SG	5		6				6						7							
	1039AI	6		6				6						35							
	MEAN	6.2		6.6				5.4						8.0							
	SE	0.3		1.0				0.2						1.5							