*CHILDREN'S IDENTITY MATCHING AND ODDITY:
ASSESSING CONTROL BY SPECIFIC AND GENERAL
SAMPLE-COMPARISON RELATIONS*

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After children in Experiments 1 and 2 learned identity matching or oddity, control by sample-comparison relations was assessed. Tests for generalized control displayed novel samples and two comparison stimuli, one identical to the sample. Specific relations were tested with identical or non-identical sample-comparison stimuli from one set of stimuli and substitute comparisons from either the other training set or from a novel set. When tests displayed identical stimuli, patterns of comparison selection suggested control by generalized identity and oddity. However, selection patterns varied when stimuli were nonidentical and familiar or novel substitute comparisons were used. Therefore, control by specific relations is not a precondition for generalized identity and oddity. One set of training stimuli was used in Experiment 3, and generalized performances occurred again. Moreover, control by specific relations was shown by the oddity subjects and 2 of 6 identity subjects. Generalized and specific control may therefore exist simultaneously. In Experiment 4, selections were irregular on tests displaying substitute comparisons and samples and familiar comparison stimuli; this finding supported the relational account of specific sample-comparison control found in Experiment 3.

Key words: stimulus control, identity matching to sample, oddity from sample, window press, children

In identity matching to sample and oddity from sample a subject might be given three stimuli on a given trial: a sample stimulus displayed on the center stimulus/response window and comparison stimuli on the two side windows. When identity-matching contingencies are in effect, selecting the identical comparison stimulus is reinforced; in oddity, selecting the differing comparison stimulus is reinforced. Identity matching and oddity are conditional discriminations because the S+ and S- functions of comparison stimuli change from trial to trial conditionally upon different stimuli (Cumming & Berryman, 1965).

Human identity matching and oddity performance may be controlled by the general or specific relations among samples and comparison stimuli. Evidence for generalized control is inferred from performance on test trials that display arrays of novel stimuli. These arrays

permit selections based on identity or oddity (i.e., a sample and two comparison stimuli, one identical to the sample). The two types of specific sample-comparison control are the positive relations between samples and S+ comparison stimuli (sample/S+ relations) and negative relations between samples and S- comparison stimuli (sample/S- relations) (Stromer & Osborne, 1982). Control by these relations is inferred under test trials that display novel stimuli as substitute comparisons.

Children are capable of generalized identity and oddity performance (Levin & Maurer, 1969; Saunders & Sherman, 1986; Scott, 1964; Sherman, Saunders, & Brigham, 1970). Consistent with their training history, they select either the identical or odd stimulus from a novel array of three stimuli. Further, recent research suggests that children's identity matching may also be controlled by specific sample/S+ and sample/S- relations (Dixon & Dixon, 1978; Dixon, Dixon, & Spradlin, 1983). In Dixon and Dixon's Experiment 2, for example, preschoolers were first taught AA matching: given Sample A1, to select Comparison Stimulus A1 and not A2; and given A2, to select A2 and not A1. The children were also trained with a second set of stimuli (BB matching): if B1, select B1 and not B2; and if

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B2, select B2 and not B1. Next, tests for sample/S- control displayed the following stimuli: an A sample (e.g., A1), its corresponding S- A comparison stimulus (e.g., A2), and a substitute B comparison stimulus (e.g., B1). Control by specific sample/S- relations was shown when all children consistently rejected the S- A comparison stimuli and selected the substitute B comparison stimuli. Control by sample/S+ relations (e.g., if A1, select A1; if A2, select A2) was not assessed in this study, but it was shown in a related study with mentally retarded subjects (Dixon et al., 1983). The possibility that the subjects were also capable of control by generalized identity relations was suggested but not assessed.

The development of control by both positive and negative sample-comparison relations may be an important characteristic of human conditional discrimination that possibly is related to the ability to perform generalized identity matching and oddity (Stromer & Osborne, 1982). Perhaps, control by the general relations in fact depends on the ability to learn both sample/S+ and sample/S- relations. This suggestion gains support from research with pigeons. Under typical identity-matching procedures, pigeons apparently learn which comparison stimulus is "correct" on a given trial but fail to learn which is "incorrect" (Berryman, Cumming, Cohen, & Johnson, 1965; Carter & Werner, 1978; Cumming & Berryman, 1961; Urcuioli, 1977; Urcuioli & Nevin, 1975). With these same procedures, pigeons also fail to display generalized identity. However, when pigeons are explicitly trained to differentiate between specific sample/S+ ("correct") and sample/S- ("incorrect") relations, they show some evidence of generalized control (Santi, 1982; Urcuioli, 1977; Urcuioli & Nevin, 1975).

It is also possible, however, that control by general and specific relations may be independent and perhaps mutually exclusive in some cases. Variables such as the number of relations trained and tested are likely to influence whether a subject who is capable of learning both positive and negative relations in fact does so (cf. McIlvane, Munson, & Stoddard, 1988). Generalized stimulus control implies that control is not restricted to sample-comparison relations involving specific stimuli. Indeed, generalized control requires appropriate responding to entirely new stimulus arrays.

Moreover, control by specific stimuli may be incompatible with, or discouraged, when pitted against generalized control. For example, Stoddard (1968) taught children to select an "odd" S+ line tilted to the right of vertical from an eight-stimulus array; the remaining S- stimuli were lines tilted to the left of vertical. During a test for generalized control, the stimulus display was reversed: A single line tilted to the left of vertical was shown with seven lines tilted to the right of vertical. Selecting the odd line tilt during this test was evidence of control by the general relation of oddity. A subsequent test assessed control by the specific stimuli; an S+ line tilt (the former odd stimulus) was displayed with a single S- line tilt. On this test, children whose initial test performance suggested control by oddity typically did not select the S+ line reliably. In contrast, reliable selections were made by children whose initial test performance did not suggest oddity.

The present study sought to clarify variables that may contribute to the emergence of generalized and specific sample-comparison control. In Experiments 1 through 3, children were trained with either an identity-matching or oddity procedure. Thereafter, they received tests for specific sample-comparison control. Variables examined included the relative novelty of stimuli substituted during testing and the number of stimuli used in baseline training. Control by the general relations of identity and oddity was also assessed with selected children. Experiment 4 served as a control, examining selections of comparison stimuli used during training in the presence of substitute samples.

EXPERIMENT 1

When one comparison stimulus involved in a previously established conditional relation is replaced by a novel comparison stimulus, selection or rejection of the substitute stimulus may be due to its novelty alone (Dixon & Dixon, 1978; Stromer & Osborne, 1982). Dixon and Dixon in their Experiment 2 sought to minimize novelty effects by giving the children a brief history with the substitute stimuli (e.g., Set B) prior to testing. However, the history was considerably shorter than that of the set (e.g., Set A) used to assess sample/S- relations in identity. One could argue, there-

fore, that relative novelty could have led to the sample/S- control found in that experiment.

To control for novelty in the present experiment, children were trained with stimulus Sets A and B from the outset (AA/BB training). The reinforcement histories of the A and B stimuli were thus equated prior to tests for sample/S+ and sample/S- control. Further, control by positive and negative relations was evaluated with children who were given oddity training. Test arrays were the same for both groups of children; the critical variable was the identity versus oddity training histories. Of primary interest was whether identity training would result in sample/S- control and whether oddity training would result in sample/S+ control. As will be seen in more detail below, both groups were given tests that displayed samples and nonidentical comparison stimuli from one set (e.g., Sample A1 and Comparison A2) and a substitute comparison stimulus from the other (e.g., B1). For identity subjects, samples and nonidentical comparison stimuli from the same stimulus set could be involved in sample/S- relations; for oddity subjects these stimuli could be involved in sample/S+ relations. In addition, generalized identity or oddity was assessed with some subjects. A finding of generalized control during these tests would replicate previous studies (Levin & Maurer, 1969; Saunders & Sherman, 1986; Scott, 1964; Sherman et al., 1970) and address the question of the coexistence of control by specific sample-comparison relations and control by generalized relations.

METHOD

Subjects

The subjects were 12 experimentally naive children (6 females and 6 males). Their mean age was 5 years 9 months (range, 4 years 8 months to 7 years 11 months).

Apparatus

The experimental console contained three Grason Stadler stimulus projectors (Model E5704B-3), a Gerbrands penny dispenser, and door chimes. The projectors were mounted in Grason Stadler display/response windows (Model E8670A) and produced white letter-like forms (16 mm) on dark backgrounds. The three windows (3.2 cm diameter) were arranged horizontally on the face of the console

(24.0 cm by 54.5 cm), with the two side windows spaced 12.7 cm to either side of the center window. Relay circuitry in an adjacent room controlled stimulus presentations. Window presses were recorded on digital counters and a Gerbrands six-pen event recorder (Model P2C-6).

Identity-Matching Procedure

The children were seen three to five times per week at about the same time each day during each meeting. Two to four 48-trial sessions, each lasting 5 to 10 min, alternated with 5- to 10-min play periods. The latter were held in a nearby room containing age-appropriate toys. Table 1 shows the type of training and order of test conditions each subject received. The number assigned to a given test condition (Test 1, Test 2, etc.) signifies the particular stimulus array (see Figure 1) used during the test.

Trials began when a sample stimulus was displayed on the center window. One press on the sample window illuminated the two side windows with comparison stimuli; the sample remained until a comparison stimulus was pressed. Samples were randomized across trials with the restriction that the same sample occurred no more than twice in succession. The left-right position of the correct and incorrect comparison stimuli varied unsystematically across trials, and each appeared in each position an equal number of times. In any given sequence of 48 trials, the same position was correct no more than three consecutive times. When feedback contingencies were in effect, pressing the S+ comparison stimuli resulted in chimes, the delivery of a penny, a 2-s intertrial interval with all windows dark, and the next trial. Pressing the S- comparison stimuli produced only the 2-s intertrial interval and the next trial.

Train AA/BB identity. Figure 1 shows the identity-matching task taught to 6 children (see Table 1): if Sample A1, select A1 and not A2; if A2, select A2 and not A1; if B1, select B1 and not B2; and if B2, select B2 and not B1. Before the first session the following instructions were given:

When you see this window (Experimenter pointing to sample stimulus) go on, push it with your finger; see, you made these windows (pointing to comparison stimuli) come on. Now, if you see this thing (pointing to the sample

Table 1

Conditions for identity and oddity (*) subjects in Experiment 1; all were trained with AA/BB stimulus arrays. Numbers in parentheses reflect sessions required to reach training criteria. Test sessions for sample/S+ (ST/S+), sample/S- (ST/S-), and generalized (Gen.) control are listed in the order given. Figures 1 and 2 show stimulus arrays given during the conditions. Test numbers in table and figures correspond.

NR	AS	NO	JB	BM	RJ
Trn (1-5)	Trn (1-8)	Trn (1-7)	Trn (1-7)	Trn (1-6)	Trn (1-8)
Test ST/S+ Control:	Test ST/S+ Control:	Test ST/S- Control:	Test ST/S- Control:	Test Gen. Identity:	Test ST/S- Control:
Test 1	Test 2	Test 1	Test 3	Test 1	Test 3
Test 2	Test 1	Test 2	Test 4		Test 4
		Test 3	Test 1	Test ST/S- Control:	Test 1
Test ST/S- Control:	Test ST/S- Control:	Test 4	Test 2		Test 2
		Test ST/S+ Control:	Test ST/S+ Control:	Test 1	Test ST/S+ Control:
Test 1	Test 3			Test 2	
Test 2	Test 4			Test 3	
Test 3	Test 1	Test 1	Test 2	Test 4	Test 2
Test 4	Test 2	Test 2	Test 1		Test 1
				Test ST/S+ Control:	Test Gen. Identity:
				Test 1	
				Test 2	Test 3
					Test 4
				Test Gen. Identity:	Test 1
					Test 2
				Test 2	
				Test 3	
				Test 4	

stimulus), push this thing (pointing to the correct comparison stimulus); if you do, you'll hear a bell and you'll get a penny in the cup. If you push this thing (pointing to the incorrect comparison stimulus), the bell won't go on and you won't get a penny. When we're all done you get to keep all the pennies that you make drop into the cup, so try to get as many pennies as you can. Here, let me show you how you can make pennies drop into the cup.

The child was then guided through four to six trials during which the consequences for correct ("Great, you made the bell go on and you got a penny.") and incorrect ("See, when you push that thing there's no bell or penny.") comparison selections were demonstrated. After this, the experimenter left the room and began the session. At first, each correct selection produced the chimes and a penny. Training continued until one session of 96 to 100% accuracy occurred. After a session, the child

was allowed to keep the pennies earned or to exchange them for coins of comparable worth. Next, the child was told that only some of the trials would produce the chimes and pennies, and "to do the best you can." At this point, 50% of the trials produced chimes and pennies. After one session of 96 to 100% accuracy, the schedule was reduced so that only 25% of the trials produced these consequences. This phase continued until a child responded with 96 to 100% accuracy in three consecutive sessions. Under intermittent reinforcement, pennies the child accumulated during a session were exchange for an amount either twice (50% schedule) or four times (25% schedule) the face value.

Subsequent test sessions consisted of a mixture of 16 AA trials, 16 BB trials, and 16 test trials. Reinforcement was discontinued for all trials during testing, but subjects were given \$0.50 at the end of each session. Subjects in both groups each received tests for sample/S+ control and for sample/S- control. Four sub-

Table 1 (Continued)

JC*	NC*	NM*	CO*	MI*	DF*
Trn (1-5)	Trn (1-5)	Trn (1-7)	Trn (1-5)	Trn (1-7)	Trn (1-6)
Test ST/S- Control:	Test ST/S- Control:	Test ST/S+ Control:	Test ST/S+ Control:	Test ST/S+ Control:	Test Gen. Oddity:
Test 1	Test 2	Test 1	Test 3	Test 1	Test 3
Test 2	Test 1	Test 2	Test 4	Test 2	
		Test 3	Test 1	Test 3	Test ST/S+ Control:
Test ST/S+ Control:	Test ST/S+ Control:	Test 4	Test 2	Test 4	
Test 1	Test 3	Test ST/S- Control:	Test ST/S- Control:	Test ST/S- Control:	Test 3
Test 2	Test 4				Test 4
Test 3	Test 1	Test 1	Test 2	Test 1	Test 1
Test 4	Test 2	Test 2	Test 1	Test 2	Test 2
				Test Gen. Oddity:	Test ST/S- Control:
				Test 1	Test 2
				Test 2	Test 1
				Test 3	Test Gen. Oddity:
				Test 4	
					Test 4
					Test 1
					Test 2

jects (2 identity and 2 oddity) were added to the experiment after initial data were gathered; these subjects also received tests for generalized identity or oddity (see Table 1).

Tests for sample/S+ control. Figure 1 shows the two tests used to assess whether subjects would continue to select comparison stimuli when identical samples were presented and the remaining comparison stimuli were substituted from the other set of training stimuli. In Test 1, for sample/S+ control the trials involved samples from Set A, identical comparison stimuli, and substitute comparison stimuli from Set B. In Test 2, the tests involved samples and identical comparison stimuli from Set B and substitute comparison stimuli from Set A. To minimize the time devoted to the test series, and because the primary focus of the identity tests was on assessing control by sample/S- relations, only two of the four possible stimulus arrays for assessing sample/S+ control were given to each child.

Tests for sample/S- control. Figure 1 shows the four tests designed to assess control by negative relations (sample/S- control). Each test displayed a sample from one set (A or B), an S- comparison stimulus from that set, and a substitute comparison stimulus from the other set.

Tests for generalized identity. Figure 1 shows the tests used to assess generalized identity matching with Subjects BM and RJ. The four stimuli from Set Z were combined to produce four different test arrays, each with a sample, an identical comparison stimulus, and a non-identical comparison stimulus. These stimuli were not used during any other tests in this experiment.

Oddity Procedure

Figure 2 illustrates major trial types used during oddity training; representative tests for control by sample/S+, sample/S-, and generalized oddity arrays are also shown. Table

Train AA/BB Identity

Tests for Sample/S+ Control

Tests for Sample/S- Control

Tests for Generalized Identity

Fig. 1. Major trial types for identity matching in Experiment 1. Each trio of stimuli depicts a sample (center) and two comparison stimuli (sides). During training, selecting the identical comparison was reinforced (+) and selecting the nonidentical one was not (-). Reinforcement was not delivered on test trials. Sample/S+ tests displayed samples and S+ comparisons from one set of stimuli (A or B) and substitute comparisons from the other (B or A). Sample/S- tests displayed samples and S- comparisons from one set of stimuli and substitute comparisons from the other. Tests for generalized identity displayed three novel stimuli (Z).

1 lists the order of conditions given to each subject. The basic trial procedures, criterion levels, and methods of testing were the same as for identity matching.

Train AA/BB oddity. Oddity contingencies specified reinforcer delivery only if a child selected comparison stimuli that were not identical to the samples: if A1, select A2 and not A1; if A2, select A1 and not A2; if B1, select B2 and not B1; and if B2, select B1 and not B2.

Tests for sample/S+ control. Figure 2 shows that the stimulus arrays for these tests were the same as those used to assess sample/S- control with identity subjects: Samples and nonidentical comparison stimuli from one set

of stimuli were displayed with substitute comparison stimuli from the other. In Test 1, for example, if the positive relations between A samples and nonidentical A comparison stimuli control the behavior, subjects should continue to select the A comparison stimuli when given the alternate B comparison stimuli. The stimulus arrays for Tests 2 through 4 were the same as those shown in Figure 1 (Arrays 2 through 4, sample/S- control) for the identity subjects.

Tests for sample/S- control. Figure 2 shows that these test arrays were the same as those used for the identity subjects' sample/S+ tests (Arrays 1 and 2, Figure 1). But if sample/S- relations in oddity control the behavior, sub-

jects should consistently select the nonidentical comparison stimulus that had been substituted from the second stimulus set (e.g., if A samples and identical A comparison stimuli, select the B comparison stimuli).

Tests for generalized oddity. Generalized oddity was assessed with Subjects MI and DF with the same stimulus arrays used to assess generalized identity. Figure 2 shows the Test 1 array; stimulus arrays for Tests 2 through 4 were the same as those shown in Figure 1 for the identity subjects.

RESULTS

The identity subjects met the AA/BB training criterion in five to eight sessions. Oddity subjects took from five to seven sessions to meet criterion. Throughout testing, accuracy on the 32 AA/BB trials never fell below 94%.

Figure 3 shows percentages of selecting comparison stimuli on the 16 critical trials in each consecutive test session given to the 6 children trained on identity matching. During sample/S+ tests (open bars), subjects selected the identical comparison stimuli 88 to 100% of the time, performances consistent with their reinforcement histories during training. Selections of the substitute A or B comparison stimuli during sample/S- tests (diagonal bars) ranged from 6 to 94% with the majority of performances at or near 50%. During tests for generalized identity (solid bars), BM and RJ selected the identical comparison stimuli 81 to 100% of the time.

Figure 4 displays test results for the oddity subjects. During sample/S- tests (open bars), oddity subjects always selected the nonidentical substitute comparison stimuli, not the identical comparisons. During sample/S+ tests, percentages of selecting the S+ comparison stimuli (diagonal bars) ranged from 19 to 75%. During tests for generalized oddity (solid bars), MI and DF always selected the differing comparisons.

DISCUSSION

Both identity and oddity subjects showed consistent selection patterns only when tests displayed comparisons that were identical to the samples. Sample/S- control in identity and sample/S+ control in oddity could not be inferred. Thus, these findings do not support those previously reported (Dixon & Dixon, 1978; Dixon et al., 1983). The present data

Train AA/BB Oddity

Test 1 for Sample/S+ Control

Test 1 for Sample/S- Control

Test 1 for Generalized Oddity

Fig. 2. Major trial types for oddity and representative tests in Experiment 1. Each trio of stimuli depicts a sample (center) and two comparison stimuli (sides). During training, selecting the nonidentical comparison was reinforced (+) and selecting the identical one was not (-). Reinforcement was not delivered on test trials. Sample/S+ tests displayed samples and S+ comparisons from one set of stimuli (A or B) and substitute comparisons from the other (B or A). Sample/S- tests displayed sample and S- comparisons from one set of stimuli and substitute comparisons from the other. Tests for generalized oddity displayed three novel stimuli (Z).

could be interpreted as evidence of sample/S+ control for identity subjects and sample/S- control for oddity subjects (Berryman et al., 1965; Cumming & Berryman, 1961; Dixon et al., 1983), but control need not have been limited to specific relations involving identical same-set stimuli. Data from 4 subjects showed control by the general relations of identity (BM and RJ) and oddity (MI and DF). Control by the general relations could account for all subjects' performances during tests for sample/S+ (identity) and sample/S- (oddity) relations. During these tests, one of the two com-

Fig. 3. Test results for identity subjects in Experiment 1. Bars show percentages of selecting identical comparisons during tests for sample/S+ control and generalized identity or substitute comparisons during tests for sample/S- control. The 16 test trials (see Figure 1) were interspersed among 16 AA and 16 BB training trials. Bars are arranged in the order tests were given (see Table 1).

parison stimuli was always identical to the sample. Either general or specific sources of control could produce the selection patterns shown during these tests; appropriate performance would not necessitate control by specific relations among stimuli. Had subjects failed to show generalized control, the conclusion that there was control among identical same-set stimuli might be justified.

The irregular selection patterns during tests for sample/S- (identity) and sample/S+ (oddy) control are consistent with control by general relations. During these tests, neither comparison stimulus was identical to the sample; hence, the basis for control by the general relations was removed from the stimulus arrays. These findings are consistent with those suggesting the incompatibility of control by generalized and specific sample-comparison relations in identity-matching and oddity performance (Stoddard, 1968).

EXPERIMENT 2

One difference between Experiment 1 and previous experiments that demonstrated specific sample-comparison control (Dixon & Dixon, 1978; Dixon et al., 1983) was the relative novelty of the substitute stimuli used during testing. From the outset of training, subjects in Experiment 1 were exposed to both A and B stimuli, and baselines of AA/BB per-

formance were maintained throughout testing. Thus, during the critical tests for sample/S- control in identity and sample/S+ control in oddity, the substitute comparison stimuli were "novel" only in the context of the sample and comparison from the alternative set. The possibility exists, therefore, that the novelty of substitute comparison stimuli is an important variable in demonstrating control by specific sample-comparison relations. Had the children lacked prior exposure to the substitute comparison stimuli, patterns of specific sample-comparison control might have emerged (cf. Dixon & Dixon, 1978). In Experiment 2, sample/S- control in identity and sample/S+ control in oddity were assessed following AA/BB training using substitute X and Y comparison stimuli, stimuli that appeared for the first time during testing. These unfamiliar stimuli would, presumably, clearly reveal any influence of novelty.

METHOD

Subjects and Apparatus

The subjects were 12 children (4 females and 8 males). Their mean age was 5 years 7 months (range, 4 years 7 months to 7 years 2 months). Ten children were experimentally naive; 2 (CO and AS) had participated in Experiment 1. The apparatus was the same as in Experiment 1.

Fig. 4. Test results for oddity subjects in Experiment 1. Bars show percentages of selecting nonidentical comparisons during tests for sample/S- control and generalized oddity or S+ comparisons during tests for sample/S+ control. The 16 test trials (see Figure 2) were interspersed among 16 AA and 16 BB training trials. Bars are arranged in the order tests were given (see Table 1).

Procedure

The procedures for training and testing were essentially the same as in Experiment 1. Table 2 outlines the order of test conditions, using the stimuli shown in Figure 5. Six subjects were given identity training and 6 received oddity training. The training stimuli were the same as those used in Experiment 1 (Figures 1 and 2). Testing began after a subject met the AA/BB training criterion. CO and AS were given oddity and identity training, respectively, in Experiment 1. In Experiment 2, however, CO was given identity training and AS was given oddity training. Table 2 also shows that 4 subjects were given two additional tests for sample/S- (WB and SN) and sample/S+ (PS and JS) control. These tests were given to determine whether control by specific sample-comparison relations would emerge with additional testing.

Figure 5 shows the four types of test arrays used. The tests were like those in Experiment 1, except for the substitute X and Y comparison stimuli. For the identity subjects, stimulus arrays in Figure 5 were tests for sample/S- control and may be compared with those in Figure 1. For oddity subjects, these tests assessed control by sample/S+ relations and may be compared with those in Figure 2. Two subjects (SN and JS) were given somewhat different trial mixtures during testing. They received 16 test trials interspersed among 32

training trials from the same stimulus set (e.g., 32 AA trials plus 16 Test-1 trials). These test conditions were therefore comparable to Experiment 3. As in Experiment 1, 4 children were also given tests for generalized identity (CM and WJ) and oddity (RM and SG) (Figures 1 and 2).

RESULTS

The 12 children took from five to seven sessions to meet the identity or oddity criteria. During testing, they continued to respond correctly (97 to 100%) on training trials.

Figure 6 shows that during repeated tests for sample/S- control (diagonal bars), identity subjects selected the substitute X and Y comparison stimuli 12 to 75% of the time. Selections of the identical comparison stimuli during tests for generalized identity (solid bars) ranged from 75 to 100%. Figure 7 shows that oddity subjects' selections of the A or B comparison stimuli ranged from 19 to 75% on tests for sample/S+ relations. Selections of non-identical comparison stimuli during tests for generalized oddity ranged from 81 to 100%.

DISCUSSION

Following AA/BB training, control by specific sample-comparison relations was assessed using substitute X and Y comparison stimuli, stimuli that were totally unfamiliar to the children. Identity and oddity subjects gave no evi-

Table 2

Conditions for identity and oddity (*) subjects in Experiment 2; all were trained with AA/BB stimulus arrays. Numbers in parentheses reflect sessions required to reach training criteria. Test sessions for sample/S+ (ST/S+), sample/S- (ST/S-), and generalized (Gen.) control are listed in the order given. Figures 1, 2, and 5 show stimulus arrays given during the conditions. Test numbers in table and figures correspond.

CO	JW	WB	SN	CM	WJ
Trn (1-5)	Trn (1-8)	Trn (1-5)	Trn (1-7)	Trn (1-7)	Trn (1-7)
Test ST/S- Control:	Test ST/S- Control:	Test ST/S- Control:	Test ST/S- Control:	Test Gen. Identity:	Test ST/S- Control:
Test 1	Test 3	Test 1	Test 3	Test 1	Test 3
Test 2	Test 4	Test 2	Test 4		Test 4
Test 3	Test 1	Test 3	Test 1	Test ST/S- Control:	Test 1
Test 4	Test 2	Test 4	Test 2		Test 2
		Test 1	Test 3		
		Test 3	Test 1	Test 1	Test Gen. Identity:
				Test 2	
				Test 3	Test 3
				Test 4	Test 4
				Test Gen. Identity:	Test 1
					Test 2
				Test 2	
				Test 3	
				Test 4	

dence of sample/S- and sample/S+ control, respectively. These results show that specific control does not result from the use of the novel substitute stimuli per se. Further, results thus far show that control by specific positive and negative relations is *not* prerequisite for generalized identity or oddity (cf. Berryman et al., 1965; Carter & Werner, 1978; Cumming & Berryman, 1961; Urcuioli, 1977; Urcuioli & Nevin, 1975) and may, in fact, be incompatible. This apparent incompatibility might be related to particulars of the training procedures. Simultaneous use of two training sets (AA/BB), as opposed to one, represents a major departure from previous procedures that demonstrated specific sample-comparison control (Dixon & Dixon, 1978; Dixon et al., 1983). The influence of this variable was assessed in the following experiment.

EXPERIMENT 3

Control by general rather than specific stimulus relations might be encouraged by simultaneous training with two stimulus sets instead of one. Training multiple exemplars of a stim-

ulus relation has been shown to promote generalized stimulus control (Stokes & Baer, 1977). Control established by general relations may, in turn, override control by specific relations among stimuli (Stoddard, 1968).

In Experiment 3, we asked whether the difference in results of Experiments 1 and 2 and those of Dixon and Dixon (1978) might be due to the more complex baselines of the present study. The tactic was to teach identity or oddity with only one set of stimuli (A or B) and then to test for sample/S- relations (identity subjects) or sample/S+ relations (oddity subjects) using substitute X and Y comparison stimuli. For the identity subjects, these conditions closely resembled those that led to control by nonidentical sample-comparison stimuli over unfamiliar or relatively unfamiliar substitute comparisons in the experiments of Dixon and Dixon. Selected subjects were also tested for generalized identity or oddity.

METHOD

Subjects and Apparatus

Ten experimentally naive children and 2 from Experiment 1 (NC and NO) served (5

Table 2 (Continued)

AS*	RG*	PS*	JS*	RM*	SG*
Trn (1-5)	Trn (1-7)	Trn (1-6)	Trn (1-5)	Trn (1-6)	Trn (1-7)
Test ST/S+ Control:	Test ST/S+ Control:	Test ST/S+ Control:	Test ST/S+ Control:	Test ST/S+ Control:	Test Gen. Oddity:
Test 1	Test 3	Test 1	Test 3	Test 1	Test 3
Test 2	Test 4	Test 2	Test 4	Test 2	
Test 3	Test 1	Test 3	Test 1	Test 3	Test ST/S+ Control:
Test 4	Test 2	Test 4	Test 2	Test 4	
		Test 1	Test 3		
		Test 3	Test 1	Test Gen. Oddity:	Test 3
					Test 4
				Test 1	Test 1
				Test 2	Test 2
				Test 3	
				Test 4	Test Gen. Oddity:
					Test 4
					Test 1
					Test 2

females and 7 males). Their mean age was 5 years 8 months (range, 4 years 8 months to 7 years 1 month). The apparatus was the same as in the previous experiments.

Procedure

The procedures were the same as in the previous experiments except for the use of a single stimulus set during training and the provision of 24 rather than 48 training trials per session; this change was made in an effort to equate the number of training trials with those given in Experiments 1 and 2. Test sessions, in which no reinforcers were delivered, consisted of 16 test trials interspersed among 32 of a subject's respective AA or BB training trials (these test conditions were comparable to those experienced by SN and JS in Experiment 2). Table 3 shows the training sets used and the order of tests across subjects. The training procedures used with NC and NO were identity and oddity, respectively; this training differed from that given in Experiment 1 (NC, oddity; NO, identity). The tests listed in Table 3 correspond to those shown in Figures 1, 2, and 5.

RESULTS

The subjects took from five to eight sessions to meet training criterion. During subsequent testing their accuracy on training trials ranged from 97 to 100%.

Figures 8 and 9 show test performances for identity and oddity subjects, respectively. Figure 8 shows that CJ and TG were the only identity subjects who tended to select the substitute X and Y comparison stimuli during tests for sample/S- control (diagonal bars). Subjects who were given tests for generalized identity (FB and TG) typically selected the identical Z comparison stimuli (solid bars). Figure 9 shows that all 6 oddity subjects tended to select the S+ A or B comparison stimuli on sample/S+ tests, except on the initial ones for 4 subjects (CC, BK, GT, and MC). During tests for generalized oddity, GT and MC typically selected nonidentical comparison stimuli.

DISCUSSION

Results for 2 of 6 subjects who learned identity and for all 6 who learned oddity with only

Fig. 5. Major trial types used in Experiments 2 through 4 during unreinforced tests of either sample/S- control (for identity subjects) or sample/S+ control (for oddity subjects). Each trio of stimuli depicts a sample (center) and two comparison stimuli (sides). The substitute X and Y comparisons were used only during these tests.

one stimulus set provided evidence of control by specific sample-comparison relations. Thus, the findings differed from those of Experiments 1 and 2. In addition to control by the specific relations, however, results from selected subjects also provided clear evidence of generalized control. Most convincing were the performances of TG (identity), GT, and MC

(oddy). Therefore, generalized control does not necessarily preclude control by specific stimulus relations.

The reduction of the number of baseline relations was apparently responsible for the acquisition of specific controlling relations. The use of one rather than two stimulus sets meant that subjects needed to differentiate only two specific relations during testing (e.g., sample-comparison A1-A2 and A2-A1 stimuli) instead of the four required in Experiments 1 and 2. Therefore, it may have been easier to remember two as opposed to four nonidentical sample-comparison relations. Another possibility alluded to earlier is that identity or oddity dimensions may become more salient when training is conducted with two sets of stimuli as opposed to one (Stokes & Baer, 1977). The subjects may have been capable of demonstrating control by four nonidentical relations, but an immediate, firmly established history of generalized control may have discouraged such learning.

The differences across children in the emergence of specific controlling relations in this experiment are worth noting. Apparently, selecting the nonidentical (S+) stimuli in oddity, as opposed to rejecting nonidentical (S-) stimuli in identity, is more likely to produce specific control. These outcomes are pertinent to the issue of whether identity and oddity performances are governed by the same or different processes (e.g., Zentall, Edwards, Moore, &

Fig. 6. Test results for identity subjects in Experiment 2. Bars show percentages of selecting substitute X or Y comparisons during tests for sample/S- control or identical Z comparisons during tests for generalized identity. The 16 test trials (see Figure 5) were interspersed among 16 AA and 16 BB training trials or among 32 AA (during Tests 1 and 2 in Figure 5) and 32 BB (during Tests 3 and 4 in Figure 5) training trials (Subject SN). Bars are arranged in the order tests were given (see Table 2).

Fig. 7. Test results for oddity subjects in Experiment 2. Bars show percentages of selecting S+ comparisons during tests for sample/S+ control or nonidentical Z comparisons during tests for generalized oddity. The 16 test trials (see Figure 5) were interspersed among 16 AA and 16 BB training trials or among 32 AA (during Tests 1 and 2 in Figure 5) and 32 BB (during Tests 3 and 4 in Figure 5) training trials (Subject JS). Bars are arranged in the order tests were given (see Table 2).

Hogan, 1981). The present data support the latter contention.

It seems unlikely that the sample-comparison control demonstrated by the oddity subjects can be attributed solely to consistent avoidance of novel substitute stimuli. Recall that most subjects in Experiments 1 and 2 were indifferent to the substitute stimuli; they neither selected nor rejected them consistently. Moreover, the oddity subjects in Experiment 1 consistently *selected* the substitute stimuli under tests for sample/S- control. Finally, previous studies have, to some extent, controlled for novelty by conducting preference tests among substitute comparison stimuli (e.g., A1 as sample, and X1 and X2 as comparison stimuli) before and/or after critical demonstrations of sample-comparison control (Dixon et al., 1983; Stromer & Osborne, 1982).

With the present procedures, children seem to be capable of control by both general and specific relations among samples and comparisons. To strengthen the conclusion that the control was indeed relational, a final experiment was conducted that involved substitute samples as well as substitute comparison stimuli.

EXPERIMENT 4

The performances of 2 identity subjects and all 6 oddity subjects in Experiment 3 suggested control by the specific relations among non-identical samples and comparison stimuli. If

the selection (oddity subjects) or rejection (identity subjects) of nonidentical comparison stimuli indicates relational control between samples and comparison stimuli, then the presence of substitute sample stimuli should disrupt test performance. In Experiment 4, we asked whether consistent patterns of selection (oddity subjects) or rejection (identity subjects) would occur given the familiar comparison stimuli without the original samples (tests for comparison control). Test trials displayed A or B training stimuli, unfamiliar substitute color samples, and substitute form comparison stimuli. In addition, 2 new subjects were trained with the oddity procedure and were then given the tests for comparison and sample/S+ control.

METHOD

Subjects and Apparatus

Immediately following Experiment 3, 1 identity subject (TG) and 2 oddity subjects (GT and MC) participated in this experiment. Two naive male children (GA and LJ), aged 6 years 1 month and 5 years, also served. The apparatus was the same as in all previous experiments.

Procedure

Figure 10 depicts the test arrays used to assess control by A or B comparison stimuli. Test trials displayed familiar comparison stimuli, red (R) or green (G) samples, and novel

Fig. 8. Test results for identity subjects in Experiment 3. Bars show percentages of selecting substitute X or Y comparisons during tests for sample/S- control or identical Z comparisons during tests for generalized identity. (The absence of a bar reflects 0% selection of X or Y stimuli.) The 16 test trials (see Figure 5) were interspersed among 32 AA training trials (NC, TB, and FB) or 32 BB training trials (TK, CJ, and TG). Bars are arranged in the order tests were given (see Table 3).

substitute comparison stimuli. After oddity training and tests for comparison control, the 2 new subjects were also given tests for sample/S+ control. Table 4 shows the conditions given to each subject.

RESULTS

The new oddity subjects (GA and LJ) reached training criterion in six to seven sessions; their accuracy on the training trials remained high during testing (97 to 100%).

Table 3

Conditions for identity and oddity (*) subjects in Experiment 3. The A or B next to the parentheses indicates the stimulus set used during training; numbers within reflect sessions required to reach criteria. Test sessions for sample/S+ (ST/S+), sample/S- (ST/S-), and generalized (Gen.) control are listed in the order given. Figures 1, 2, and 5 show stimulus arrays given during the conditions. Test numbers in table and figures correspond.

NC	TB	TK	CJ	FB	TG
Trn A(1-5)	Trn A(1-5)	Trn B(1-5)	Trn B(1-5)	Trn A(1-6)	Trn B(1-5)
Test ST/S- Control:	Test ST/S- Control:	Test ST/S- Control:	Test ST/S- Control:	Test Gen. Identity:	Test ST/S- Control:
Test 1	Test 2	Test 3	Test 4	Test 1	Test 3
Test 2	Test 1	Test 4	Test 3		Test 4
Test 1	Test 2	Test 3	Test 4	Test ST/S- Control:	Test 3
Test 2	Test 1	Test 4	Test 3		Test 4
		Test 3	Test 4	Test 1	Test Gen. Identity:
		Test 4	Test 3	Test 2	Test 3
				Test 1	Test 4
				Test Gen. Identity:	Test 1
					Test 2
				Test 2	
				Test 3	
				Test 4

Fig. 9. Test results for oddity subjects in Experiment 3. Bars show percentages of selecting S+ comparisons during tests for sample/S+ control or nonidentical Z comparisons during tests for generalized oddity. The 16 test trials (see Figure 5) were interspersed among 32 AA training trials (NO, CC, and GT) or 32 BB training trials (SS, BK, and MC). Bars are arranged in the order tests were given (see Table 3).

Figure 11 shows that during the tests for control by comparison stimuli (horizontal bars), MC, an oddity subject from Experiment 3, continued to select the familiar comparison stimuli 100% of the time. Selection patterns for the other subjects were inconsistent during these tests. On tests for control by sample/S+

relations (diagonal bars), GA's selections of S+ comparison stimuli ranged from 66 to 94% and LJ's ranged from 56 to 75%.

DISCUSSION

The results strengthen the findings of specific relational control found in Experiment 3.

Table 3 (Continued)

NO*	CC*	SS*	BK*	GT*	MC*
Trn A(1-5)	Trn A(1-8)	Trn B(1-6)	Trn B(1-6)	Trn A(1-6)	Trn B(1-8)
Test ST/S+ Control:	Test ST/S+ Control:	Test ST/S+ Control:	Test ST/S+ Control:	Test ST/S+ Control:	Test Gen. Oddity:
Test 1	Test 2	Test 3	Test 4	Test 2	Test 3
Test 2	Test 1	Test 4	Test 3	Test 1	
Test 1	Test 2	Test 3	Test 4	Test 2	Test ST/S+ Control:
Test 2	Test 1	Test 4	Test 3	Test 1	
		Test 3	Test 4		Test 4
		Test 4	Test 3	Test Gen. Oddity:	Test 3
					Test 3
				Test 1	Test 4
				Test 2	
				Test 3	Test Gen. Oddity:
				Test 4	
					Test 4
					Test 1
					Test 2

Fig. 10. Major trial types used in Experiment 4 during unreinforced tests of comparison control. Each trio of stimuli depicts a sample (center) and two comparison stimuli (sides). Tests displayed red (R) or green (G) samples, familiar comparisons (Set A or B), and substitute comparisons (Set B or A) used only during these tests.

The selection patterns indicating sample/S– control in identity and sample/S+ control in oddity were apparently not based on control by comparison stimuli alone. Oddity Subjects GA and LJ were also tested with sample/S+

stimulus arrays. Performances generally did not show strong control by sample/S+ relations. Error patterns established during prior testing, however, may well have interfered with their subsequent performance (cf. Stoddard & Sidman, 1971).

GENERAL DISCUSSION

The present study represents a first step toward identifying the conditions under which human identity and oddity performances are controlled by general relations, specific relations, or both. The performances found in Experiments 1 through 3 replicate previous demonstrations of generalized control in identity and oddity (Levin & Maurer, 1969; Saunders & Sherman, 1986; Scott, 1964; Sherman et al., 1970). Further, Experiments 1 and 2 support the earlier observation of control by general, but not by specific, stimulus relations with humans (Stoddard, 1968). However, control by general and specific relations is not necessarily mutually exclusive. In Experiment 3, the performances of 2 identity subjects and all 6 oddity subjects suggested control by specific stimulus relations. In addition, selected subjects also showed control by the general relations among stimuli. The finding of control by specific relations replicates, in part, earlier studies of identity matching (Dixon & Dixon, 1978;

Table 4

Conditions for identity and oddity (*) subjects in Experiment 4. The A or B next to the parentheses indicates the stimulus set used during new subject's training; numbers within reflect sessions to reach criteria. Test sessions for comparison (CO) and sample/S+ (ST/S+) control are listed in the order given. Figures 5 and 10 show stimulus arrays given during these conditions. Test numbers in table and figures correspond.

TG	GT*	MC*	GA*	LJ*
Test CO	Test CO	Test CO	Trn A(1–7)	Trn B(1–6)
Control:	Control:	Control:		
Test 3	Test 1	Test 3	Test CO	Test CO
Test 4	Test 2	Test 4	Control:	Control:
Test 3	Test 1	Test 3	Test 2	Test 4
Test 4	Test 2	Test 4	Test 1	Test 3
			Test 2	Test 4
			Test 1	Test 3
			Test ST/S+	Test ST/S+
			Control:	Control:
			Test 1	Test 3
			Test 2	Test 4
			Test 1	Test 3
			Test 2	Test 4

Fig. 11. Test results for Experiment 4. Subjects TG, GT, and MC participated in Experiment 3 prior to this experiment. GA and LJ were taught oddity prior to testing. Bars show percentages of selecting substitute comparisons (TG), or familiar A or B comparisons (all oddity subjects) during tests of comparison control and tests of sample/S+ control. The 16 test trials (see Figures 5 and 10) were interspersed among 32 AA training trials (GT and GA) or 32 BB training trials (TG, MC, and LJ). Bars are arranged in the order tests were given (see Table 4).

Dixon et al., 1983) and extends the analysis to children's oddity performance.

If one assumes that a subject is capable of acquiring either generalized or specific relations, perhaps it is not surprising to find generalized rather than specific control. Learning a single relation seems to require less effort than does learning several specific relations. Consequently, it was interesting to find children who displayed both kinds of control simultaneously (Experiment 3). Also interesting was that generalized control developed with only minimal training (a single set of two stimuli).

The lack of consistent control by sample/S- relations in identity contrasts sharply with the remarkably clear findings of Dixon and Dixon (1978). The lack of sample/S+ control in oddity following AA/BB training (Experiments 1 and 2) also requires clarification. Several procedural differences between this study and previous ones should be examined systematically. By themselves or collectively, factors such as the preliminary verbal instructions, the number of training trials, the kinds of consequences used during training, and the contingencies operating during testing may have influenced performance.

The ability to learn both positive and negative relations among samples and comparison stimuli is considered to be critical to the formation of generalized identity and oddity re-

lations. Generalized control occurs when a subject learns which comparison stimulus to select in the presence of a given sample and which comparison not to select. This conceptualization has emphasized the role of control by specific relations, either as an outcome performance (Dixon & Dixon, 1978) or as a training variable (Urcuioli, 1977; Urcuioli & Nevin, 1975). But, as shown in the present study, generalized control does not always translate into control by specific sample-comparison relations. Moreover, training specific relations is not necessarily a sufficient precondition for the emergence of generalization (Santi, 1982; Urcuioli, 1977; Urcuioli & Nevin, 1975).

Perhaps too much emphasis has been placed on the separate functions of samples and comparison stimuli in attempts to account for generalized control. As Cumming and Berryman (1965, p. 286) suggested, identity-matching and oddity performance may be based on the entire sample-comparison stimulus array. Identity and oddity arrays may function as a "unitary discriminative stimulus." The stimulus configuration itself controls responding (cf. Carter & Werner, 1978). But with humans, such control is obviously not restricted to specific stimulus configurations. Generalized control suggests that any unitary discriminative function is unrestricted; it is shared by any stimulus array that conforms to identity or oddity configurations.

Additional research is needed to clarify the relationship, if any, between specific and generalized sample-comparison relations. The difficulties in producing specific control in the present study suggest that, for humans, this source of control may be exhibited only under special circumstances. The ability to treat various identity and oddity arrays as unitary discriminative stimuli may, however, be related in some distant way to specific relational control. When children display specific control in the laboratory, test conditions may tap an important ability developed outside the experimental setting—the ability to discriminate both correct and incorrect stimulus selections in a variety of contexts. To produce generalized control in subjects who do not show it readily (e.g., pigeons), an effective tactic might combine the learning set approach (Holmes, 1979) with explicit training on positive and negative sample-comparison relations (Santi, 1982; Urcuioli, 1977; Urcuioli & Nevin, 1975).

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