This study examined the effects of a successive stimulus pairing procedure (respondent training) on formation of conditional discriminations and equivalence classes. Different training protocols (linear, many-to-one, one-to-many), and training and test arrangements (simultaneous, simple-to-complex) were used. A simultaneous protocol was used in Experiment 1. During training, adults were exposed to multiple random series of stimulus pairs. Stimuli of the same pair were presented one after the other (e.g., A1 arrow right B1, C1 arrow right B1, A2 arrow right B2, C2 arrow right B2, A3 arrow right B3, C3 arrow right B3). These series were followed by a match-to-sample test series involving symmetry probes (e.g., B-A, B-C) mixed with equivalence probes (A-C). Experiments 2 through 4 involved preschool children. Experiment 2 was a modified replication of Experiment 1 (Observing A arrow right B and C arrow right B. Testing A-B, C-B, A-C, and vice versa). Experiment 3 was the same except that a simple-to-complex protocol was used (e.g., training A arrow right B, testing A-B and B-A, training C arrow right B, testing B-C and C-B, and testing A-C and C-A). Experiment 4 was the same as Experiment 3 except that only symmetry and equivalence relations were tested (e.g., training A arrow right B, testing B-A, training C arrow right B, testing B-C, and testing C-A). Symmetry and equivalence were obtained most quickly with adults trained on simultaneous many-to-one protocols. With children, however, the simultaneous protocol was not effective. The simple-to-complex protocol produced much better results which were virtually the same for all training arrangements (linear, many-to-one, one-to-many).

Studies on stimulus equivalence have shown that, after being trained on multiple conditional discrimination tasks with common sets of stimuli, most verbal humans will conditionally relate all directly and indirectly linked stimuli to one another, irrespective of whether they are used as samples or as comparisons (see Barnes & Holmes, 1991; Hayes, 1991; Saunders & Green, 1992; Sidman, 1994). For example, after being trained to relate Samples A1 and A2 to Comparisons B1 and B2 (A1-B1, A2-B2) and to C1 and C2 (A1-C1, A2-c2), most subjects will, without further training, match all "1" and "2" stimuli with one another: B1-A1, B2-A2; C1-A1, C2-A2 (symmetry relations), and C1-A1, C2-A2 (combined symmetry and transitivity or equivalence relations). Similar findings have been obtained through training other tasks incorporating elements (if-then relations) of conditional discrimination tasks (Dube, Mcllvane, Mackay, & Stoddard, 1987; Lazar, 1977; Sidman, Wynne, Maguire, & Barnes, 1989; Sigurdardottir, Green, & Saunders, 1990; Vaughan, 1988). These and other related findings led Saunders and Green (1992, p. 239) to conclude that "class formation and perhaps equivalence class formation may be the product of any procedure that serves to partition a set of stimuli into subsets of stimuli that are substitutable for one another in certain contexts." (italics added). A similar conclusion was reached by Sidman (1994, p. 384), "An equivalence relation is
made up of pairs of events, with no restriction on the nature of the events that make up the pairs."

The empirical support for these conclusions, however, is very scarce and restricted to intellectually advanced populations. For example, in an effort to assess whether stimulus classes also emanate from simple discriminations, Smeets, Barnes, Schenk, and Darcheville (1996) trained children, high-functioning adults with mental retardation, and normal adults (college students) on a simultaneous discrimination task with A1 and A2. Responding to A1 (S+) was reinforced, responding to A2 (S-) was not reinforced (A1+/A2-). Then, the subjects received a series of simple discrimination probes with complex AB and BC stimuli, and single-element B and C stimuli. After showing transfer from A to B via AB and from B to C via BC (A1B1+/A2B2-, B1+/B2-, B1C1+/B2C2-, C1+/c2-), the subjects received conditional discrimination probes with A and B, B and C, and A and C stimuli (A-B, B-C, A-C, and vice versa). Most children and adults with mental retardation treated these probes as simple discrimination tasks and consistently selected the S+ stimuli (A1, B1, C1) irrespective of the samples. By contrast, all normal adults related the directly and indirectly paired stimuli of the same functions conditionally to one another (A1-B1-C1, A2-B2-C2). These and more recently obtained findings (Smeets & Barnes, 1995) suggest that simple discriminations lead to stimulus class formation in intellectually and educationally advanced persons but not in young normal children. Would the same apply to other nonmatch-to-sample procedures?

In a recent study we demonstrated that observation of sequentially presented stimuli (respondent training) can generate equivalence responding in normal adults (Leader, Barnes, & Smeets, 1996). In Condition 2 in this study, nine nonsense syllables were presented to the subjects in the form of six stimulus pairs: A1 arrow right B1, B1 arrow right C1, A2 arrow right B2, B2 arrow right C2, A3 arrow right B3, B3 arrow right C3 (we called this a linear sequence). The first stimulus of each pair was presented for 1 s (e.g., A1), the computer screen was then cleared for 0.5 s (the within-pair delay) and the second stimulus in the pair (i.e., B1) was presented for 1 s. The screen then cleared for 3 s (i.e., the between-pair delay) before the next stimulus pair was presented. All six stimulus pairs were presented 10 times in a quasi-random order across 60 trials. Subjects were then presented with a standard match-to-sample equivalence test that examined the six symmetry relations (i.e., B1-A1, B2-A2, B3-A3, C1-B1, C2-B2, C3-B3) and the three equivalence relations (i.e., C1-A1, C2-A2, C3-A3). Four out of five subjects demonstrated equivalence responding after two, three, five, or six exposures to the training and testing.

Present research addressed three major issues. First, the study examined whether respondent training (e.g., A arrow right B, C arrow right B) also produces conditional stimulus relations (A-B, B-A, C-B, B-C) and equivalence class formation (A-C, C-A) in young normal children. Second, variables that have been found to facilitate or suppress equivalence formation with standard match-to-sample procedures were examined. Some of these variables relate to the sample-comparison arrangements that are used for training. Three sample-comparison arrangements are distinguished:
linear (Train A-B and B-C. Test C-A), many-to-one (Train A-B and C-B. Test C-A), and one-to-many (Train B-A and B-C. Test C-A). Comparative studies by Saunders, Wachter, and Spradlin (1988) and Spradlin and Saunders (1986) reported that many-to-one training produces equivalence responding more readily than one-to-many training. Furthermore, recent studies have found that many-to-one training (relative to one-to-many) facilitates transfer in nonhuman subjects such as pigeons (see Urcuioli & Zentall, 1993; Urcuioli, Zentall, & DeMarse, 1995). The present study examined whether the facilitative or suppressive effects of these training arrangements are also evident with the respondent training procedure. Experiment 1 examined the outcome of many-to-one and one-to-many training with Irish adults as subjects. Experiments 2 to 4 examined the outcome of linear, many-to-one, and one-to-many training with 5-year-old Dutch children.

Third, the study examined the effects of two training-and-test protocols on stimulus class formation. Three training-and-testing protocols are distinguished: simple-to-complex, simultaneous, and complex-to-simple. In the simple-to-complex protocol (Adams, Fields, & Verhave, 1993; Greenway, Dougher, & Wulfert, 1996; Lynch & Cuvo, 1995; Smeets, Schenk, & Barnes, 1995), each emergent relations test is introduced immediately after all of its prerequisite relations are established (first symmetry, then transitivity, then equivalence). The complex-to-simple protocol (Kennedy & Laitinen, 1988; MacDonald, Dixon, & LeBlanc, 1986, Spradlin & Saunders, 1986) is the same except that the order is reversed. The simultaneous protocol (Fields, Landon-Jimenez, Buffington, & Adams, 1995) involves massed training followed by massed testing. Adams et al. (1993) and Fields et al. (1995) demonstrated that the simple-to-complex protocol more often leads to the formation of equivalence classes than the simultaneous protocol (see also Stoddard & MacIlvane, 1986). Experiments 1 and 2 used the simultaneous protocol. Experiments 3 and 4 used the simple-to-complex protocol. Table 1 shows the basic training and test sequence for the many-to-one condition in each experiment.

**Experiment 1**

This experiment examined the efficacy of two respondent training arrangements (many-to-one and one-to-many) on the formation of equivalence relations in adults with the simultaneous protocol.

**Method**

**Subjects**

Ten students, 5 female and 5 male, of University College Cork served as subjects. Their ages ranged from 18 to 25 years. All subjects were experimentally naive, non-psychology majors, and they were randomly assigned to one of two experimental conditions (i.e., five in each condition). All subjects completed the experiment in one sitting which lasted from 25 to 90 min. Subjects were paid 5 pounds for their
participation.

**Apparatus**

Each subject was seated in a small experimental room, with an Apple Macintosh SE microcomputer, which displayed black characters on a white background. Stimulus presentation and the recording of responses were controlled by the computer. The Z, V, and M keys were marked with white paper dots to designate them as response keys. A pool of nine nonsense syllables (CUG, ZID, VEK, YIM, DAX, PAF, ROG, MAU, JOM) were randomly assigned to their respective roles as sample and comparison stimuli for each subject in the experiment.

**Procedure**

All subjects were seated in the experimental room and the instruction "Look at the screen" was presented on the computer screen. The experiment was divided into two stages: (a) respondent training and (b) equivalence testing.

Respondent training. Nine nonsense syllables were presented to the subjects in the form of six stimulus pairs. In the one-to-many condition, the stimulus pairs were designated: B1 arrow right A1, B1 arrow right C1, B2 arrow right A2, B2 arrow right C2, B3 arrow right A3, B3 arrow right C3. The first stimulus of each pair was presented for 1 s (e.g., B1), and the computer screen was then cleared for 0.5 s (within-pair delay). The second stimulus in the pair (i.e., A1 always followed B1) was then presented for 1 s and the screen was then cleared for 3 s (between-pair delay). Following the 3 s between-pair delay the next stimulus pair was presented (e.g., B3 arrow right A3). All six stimulus pairs were presented in this fashion, in a quasi-random order for 60 trials, the only constraint being that each stimulus pair was presented once in each successive block of 6 trials (i.e., each stimulus pair was presented 10 times). When all 60 trials had been presented (taking 5.5 min), the screen went blank for 5 s. The equivalence testing instructions then appeared immediately on the screen (see next section). The same procedure was employed in the many-to-one condition, except that the six stimulus pairs were: A1 arrow right B1, C1 arrow right B1, A2 arrow right B2, C2 arrow right B2, A3 arrow right B3, C3 arrow right B3.

Equivalence testing. During this stage subjects were presented with a standard, match-to-sample equivalence test that examined the six symmetry relations and the three equivalence relations. For one-to-many subjects the symmetry relations were A1-B1, C2-B2, A3-B3, C1-B1, A2-B2, and C3-B3, and the equivalence relations were A1-C1, A2-C2, and A3-C3. For the many-to-one subjects the symmetry relations were B1-A1, B1-C1, B2-A2, B2-C2, B3-A3, and B3-C3, and the equivalence relations were A1-C1, A2-C2, and A3-C3 (note, the tested equivalence relations were the same in both conditions). The equivalence test for both conditions (many-to-one, one-to-many) consisted of nine match-to-sample tasks. The sample was always presented in the center, top half of the computer screen (5 cm from the
upper edge). The three comparison stimuli appeared 1.5 s after the sample stimulus was presented; no overt observing response was required and the sample remained on the screen with the comparisons. The comparisons were presented in a line, 3 cm from the lower edge of the screen. The three comparisons appeared 6 cm to the right, 6 cm to the left, and directly below the sample. The location of the comparisons was counterbalanced across test trials. Subjects selected the left, middle, or right comparison by pressing the "Za", "V," or "M" keys, respectively. When a comparison had been selected, the screen cleared immediately and remained blank for 3 s. The next match-to-sample trial was then presented (no feedback was presented during the equivalence test).

Before subjects were exposed to the equivalence test the following instructions appeared on the computer screen (5 s after the last respondent training trial):

That is the end of the first stage of the experiment. In the next stage you must look at the nonsense syllable at the top, and then choose one of the three nonsense syllables at the bottom by pressing one of the marked keys on the keyboard. To choose the left syllable, press the marked key on the left. To choose the middle syllable, press the marked key in the middle. To choose the right syllable, press the marked key on the right. Press the space-bar twice to continue.

The nine match-to-sample tasks were presented in a quasi-random order for 90 trials, the only constraint being that each task occurred once within each block of 9 trials (i.e., each match-to-sample task was presented 10 times; 60 symmetry test trials and 30 equivalence test trials). A consistency criterion was used that required each subject must choose the same but not necessarily correct comparison at least 9 times out of 10 on each of the 9 tasks (for ease of communication, "correct" will be used to describe responses that are in accordance with the symmetry and equivalence relations). This consistency criterion was used to control for the effects of inadvertent feedback provided by repeated training and testing (see Barnes & Keenan, 1993). If a subject produced an inconsistent performance (i.e., less than 9 out of 10 "same responses" on any of the tasks) they were reexposed to the entire experimental procedure again (i.e., respondent training and equivalence testing with the same instructions). If a subject did not produce a consistent performance by their fourth exposure to the entire experimental sequence, and their performance was less than 50% correct (i.e., the subject produced less than 45 correct responses), the performance was classified as inconsistent and the subject's participation in the study was terminated. If, however, a subject produced more than 50% correct responding on a fourth exposure to the equivalence test, additional exposures to the training and testing were provided until he or she either produced less than 50% correct or produced a consistent performance (with three comparison stimuli, 50% correct was 17 points above chance). This criterion thereby ensured that a subject who produced an inconsistent performance, which was considerably higher than chance, would not be prevented from retraining and retesting.
Results and Discussion

The percentage of correct responses on the symmetry and equivalence test trials for each individual exposure to the equivalence test for Subjects 1 to 10 are presented in Table 2. In the one-to-many condition, Subjects 1, 3, and 4 produced perfect symmetry and equivalence responding on either the second (3 and 4) or the third (1) exposure. Subject 2 produced an almost perfect performance on the second exposure. Subject 5 produced inconsistent and below 50% correct responding on the fourth exposure. In the many-to-one condition, Subjects 6 and 8 both produced perfect symmetry and equivalence responding on their second exposures, and Subject 7 was almost perfect on the second exposure. Subjects 9 and 10 both produced near perfect responding on their first exposures.

These data suggest that the many-to-one training facilitated equivalence responding more readily than the one-to-many training. Specifically, all five many-to-one subjects demonstrated equivalence on either their first or second exposure to the equivalence test, whereas four out of five of the one-to-many subjects produced equivalence on their second or third exposures to the test. These data are consistent with previous research (Saunders et al., 1988; Spradlin & Saunders, 1986). Interestingly, when the current data are compared with the results of a comparable linear training procedure (Condition 2) in the Leader et al. (1996) study, both one-to-many and many-to-one training appear to facilitate equivalence responding more readily than the linear procedure (A arrow right B, B arrow right C sequence). In the linear condition, subjects required between two and six exposures to the training and testing before passing the equivalence test. In view of this finding, the remaining three experiments using young children each compared the relative effects of linear, many-to-one, and one-to-many training protocols on equivalence responding.

Experiment 2

This experiment was a modified replication of Experiment 1 with preschool children.

Method

Subjects

Twelve normal 5-year-old preschool children served as subjects. They were divided into three groups of four subjects each. Table 3 shows the age (years and months) and sex of each subject.

Materials

The stimuli (3.0 x 3.0 cm) consisted of 10 (Greek) letters and symbols (see Figure 1). The stimuli are indicated by alphanumerical codes (e.g., X1, A2). The stimuli were presented on white cards (14.5 x 20.0 cm) covered by plastic transparencies to
prevent staining. Some cards, hereafter referred to as observation cards, showed two stimuli, one centered on the front side (e.g., A1) and one centered on the back side (B1). The other cards, hereafter referred to as matching cards, showed three stimuli, all presented on the front side: two horizontally aligned stimuli (e.g., B1 and B2) 9 cm apart, and one centered 3 cm below (A1).

Additional materials were a tray with beads and a standing (transparent) glass tube showing a mark. Filling the tube up to the mark required 50 beads.

**Sessions and Setting**

Sessions were conducted in a quiet room of the school building, once a day, 5 days a week, and lasted typically about 10 min. Three adults participated. One adult served as experimenter. The experimenter and subject were seated at the same table facing one another. The other adults served as reliability observers, one at a time. The reliability observer was present in the same room but situated such that she could clearly observe the stimuli and the subject’s responses, but not the experimenter’s data sheet.

**Trials, Response Recordings, and Contingencies**

Three types of trials were used: Respondent training trials, match-to-sample training trials, and match-to-sample test trials. A respondent training trial started with the experimenter showing both sides of an observation card, first the front side (e.g., showing A1) for about 1 sec (the experimenter counted silently "twenty-one") and then the back side (showing B1) for 1 sec. At that point, the experimenter recorded whether the subject had looked at both sides of the card and, without providing programmed consequences, initiated the next trial.

Two types of match-to-sample training trials were used: demonstration and no-help trials. A demonstration trial started with the experimenter presenting a matching card. She then pointed to the sample stimulus while saying, "If you see this, point to that" and pointed to the designated correct comparison. Then she requested the subject to do the same ("Now you do the same."). The no-help trials were the same but without instructions and modeling (the experimenter silently presented the cards). Responses on the match-to-sample training trials were scored correct, incorrect, or invalid. Correct and incorrect responses were defined as pointing to the designated correct or incorrect comparison. Invalid responses were recorded when a subject pointed to the sample, to both comparisons, or pointed to one comparison without looking at the materials. Correct responses were followed by verbal praise and the delivery of a token ("Good. Take a bead"). Incorrect responses were followed by verbal disapproval ("Wrong. No bead."). Invalid responses were followed by corrective feedback (e.g., "No! Don't look outside. Look at the pictures when pointing.").

The match-to-sample test trials were the same as the no-help training trials (silent...
presentation of matching cards) except that (a) responses consistent and inconsistent with the respondent or match-to-sample training were recorded correct and incorrect, respectively, and (b) no programmed consequences were used.

In addition to the nonverbal responses (looking at cards, pointing), the experimenter also recorded the subjects' verbal comments on the respondent training trials and on match-to-sample test trials involving stimuli that were used in respondent training.

**Training and Test Sequence**

The training and test sequence consisted of four steps. Steps 1 and 2 were directed at training and testing unrelated match-to-sample tasks with X and Y stimuli. Step 3 provided respondent training using A and B stimuli, and B and C stimuli. Step 4 assessed the emergence of conditional relations between directly and indirectly paired A, B, and C stimuli (A-B, B-C, A-C, B-A, C-B, and C-A; see Table 1). Three conditions were used: linear, many-to-one, and one-to-many. Each group (four subjects) received a different condition: linear condition (A arrow right B, B arrow right C), many-to-one (A arrow right B, C arrow right B), and one-to-many (B arrow right A, Barrow right C).

Step 1: Pretraining X-Y. This step aimed to establish an unrelated conditional discrimination task with X and Y stimuli, so that any "failures" during the critical match-to-sample probes in Step 4 could not be attributed to a lack of familiarity with the match-to-sample procedure.

Two blocks of 20 match-to-sample training trials were used. Each block started with four demonstration trials in which X1 and X2 served as samples and Y1 and Y2 as comparisons (X1-Y1, X2-Y2). Following the completion of the fourth trial, the experimenter said, "Let's see if you can do it also without me helping you." and then presented 16 no-help trials on the same task. Fifteen correct responses on 16 no-help trials were required.

Step 2: Testing X-Y and Y-X. This step examined whether the subjects continued the trained X-Y performance accurately (a) without programmed consequences and (b) when the sample-comparison functions of the X and Y stimuli were reversed. The step consisted of two blocks of test trials (Blocks 1 and 3) and two blocks of training trials (Blocks 2 and 4). Each test block consisted of 16 trials: 8 X-Y trials quasi-randomly mixed with 8 Y-X trials. Each training block consisted of six X-Y trials.

Immediately before the introduction of each test block, the experimenter removed the bead containers from the table and said, "Now we are going to play the game without me telling you whether you are right or wrong. Also you won't get any beads. Later on, we are going to play the game with beads. Do your best." The experimenter then presented the first test trial and refrained from any communication
until the completion of the final test trial of that block.

Immediately before the introduction of a training block, the experimenter placed the bead containers on the table and said, "Now you can earn beads again." If during the training trials of this or any following step the collected beads reached the mark (50 beads), the experimenter stopped the session, allowed the subject to exchange the beads for a preselected picture (e.g., soccer player, animal, cartoon character), and resumed the session. Subjects who responded correctly on 7/8 XY trials and 7/8 Y-X trials of a test block and on 5/6 (X-Y) trials of the following training block proceeded to Step 3.

Step 3: Respondent training (A arrow right B, Barrow right C). This step allowed the subjects to observe stimulus pairs in a fixed temporal order. Four trial blocks were used: Two blocks with respondent training trials (Blocks 1 and 3) and two blocks with X-Y training trials (Blocks 2 and 4; same as in Step 2). For Subjects 1 and 2 of the linear condition, each respondent training block consisted of a random sequence 5 A1 arrow right B1, 5 A2 arrow right B2, 5 B1 arrow right C1, and 5 B2 arrow right C2 trials. Subjects 3 and of this condition received the same trials except that in the B arrow right C trials, B1 preceded C2 and B2 preceded C1 (5 B1 arrow right C2 and 5 B2 arrow right C1 trials). The procedures for both other conditions were the same except that, (a) in many-to-one, the C stimuli preceded the B stimuli (A arrow right B, C arrow right B), and (b) in one-to-many, the B stimuli preceded the A stimuli (B arrow right A, B arrow right C).

Immediately before the introduction of each respondent training block, the experimenter told the subject that she was going to show him/her pictures and asked the subject to watch these pictures carefully. Before starting a trial, the experimenter waited until she had the subject's attention (i.e., looked at the experimenter) or prompted the subject's attention with a mild cough or saying the subject's name. At that point the experimenter presented the two stimuli (e.g., A1 arrow right B1), recorded whether the subject had looked at both stimuli, and presented the next trial. Furthermore, to promote the subject's attention, the experimenter checked on every fifth trial whether the subject had looked at both stimuli during each of the five preceding trials. If so, she removed all stimulus cards, complimented the subject for his/her on-task behavior, and gave a token ("You are doing very well. Take a bead."). Criterion was reached if a subject (a) looked at both stimuli on 36/40 respondent training trials (Blocks 1 and 3 combined) and (b) responded correctly on 11/12 X-Y training trials (Blocks 2 and 4 combined).

Step 4: Testing equivalence relations (A-B-C). This step assessed whether the respondent training led to the emergence of conditional relations between the directly and indirectly paired stimuli and was always conducted immediately after Step 3 (same session). Step 4 consisted of six blocks of trials. Block 1 consisted of four respondent training trials, two with A and B stimuli and two with B and C stimuli. Block 2 consisted of 14 test trials: 1 X-Y and 1 Y-X trial, followed by a random sequence of 2 A-B, 2 B-A, 2 B-C, 2 C-B, 2 A-C, and 2 C-A trials. Block 3
consisted of six X-Y training trials. Blocks 4, 5, and 6 were the same as Blocks 1, 2, and 3, respectively. Thus, the subjects received a total of 28 match-to-sample-test trials: 2 X-Y, 2 Y-X, 4 A-B, 4 B-A, 4 B-C, 4 C-B, 4 A-C, and 4 C-A trials.

All subjects received at least two runs on Steps 3 and 4 (Step 3, Step 4, Step 3, Step 4). After the second run, the number of correct A-B, B-A, B-C, C-B, A-C, and C-A responses in both runs were calculated. Subjects were excused from further participation if they had responded correctly on \( \leq 7 \) of 8 trials on each match-to-sample task (A-B, B-A, B-C, C-B, A-C, C-A). Otherwise, the subjects received a third run on Steps 3 and 4 at which point the experimenter checked whether the subject's performance in Runs 2 and 3 met the above criteria. If not, the subjects received a fourth and final run on Steps 3 and 4. At the end of the final run, the experimenter presented each subject again a C-A trial and asked the subject why she or he had pointed at the selected comparison ("Why did you point to this?").

Reliability

Reliability checks were made on 480 observation trials (20.8%), 372 training trials (24.1%), and on 312 test trials (20.3%). The experimenter and observers were always in agreement.

Results

All subjects learned the X-Y task in 20 to 40 trials (M = 26.7) in Step 1, and they continued to respond accurately on this task and on its symmetrical counterpart (Y-X) under nonreinforced conditions in Steps 2 through 4. All subjects required four runs on Steps 3 and 4. Table 3 shows the results of the conditional discrimination probes at the completion of Runs 2, 3, and 4. Overall, the data show that respondent training did not reliably produce conditional relations between directly and indirectly paired stimuli. Three subjects (3, 8, and 11) did not relate any of the designated stimuli conditionally to one another. Two other subjects (7 and 9) demonstrated evidence of a unidirectional conditional relation between directly paired stimuli on one occasion but not on subsequent occasions. Six subjects (1, 2, 4, 5, 6, 12) demonstrated bidirectional conditional A-B or B-C relations, two of whom (1 and 5) also demonstrated unidirectional relations between B and C stimuli. Only Subject 10 demonstrated bidirectional conditional relations between all directly and indirectly paired stimuli, thereby documenting the formation of two stimulus equivalence classes (A1-B1-C1, A2-B2-C2). None of the subjects, including Subject 10, provided a helpful verbal account for their performance (shrugging shoulders, "I guessed," "Because," "Don't know").

Discussion

In essence, the results of Experiment 2 did not even approximate the data of the many-to-one and one-to-many conditions used in Experiment 1 of the present study, and of the linear condition used in the previous study (Leader et al., 1996). This
failure could not be attributed to lack of attention during respondent training (all subjects always looked at both stimuli presented during each respondent training trial).

The erratic and "chance level" performance by most children could have resulted, at least in part, from the simultaneous protocol. If correct, respondent training should yield more conditional stimulus relations and equivalence classes with the simple-to-complex protocol. Alternatively, the probe performances could indicate that young children (a) find it difficult to derive conditional stimulus relations from nonmatch-to-sample tasks (see also Smeets & Barnes, 1995; Smeets et al., 1996), or (b) like mentally retarded adults, do not easily acquire conditional discriminations through observational learning (MacDonald et al., 1986). If correct, the respondent training procedure is bound to fall even if a simple-to-complex protocol is used. This issue was addressed in Experiment 3.

**Experiment 3**

This experiment examined whether respondent training would yield a higher frequency of emergent conditional discriminations when a simple-to-complex protocol is used.

**Method**

*General*

Twelve new 5-year-old preschool children participated. Their age and sex are listed in Table 4. The subjects were divided into three groups of four subjects. Each group received a different respondent training protocol (see below). The experimenter, stimulus materials, instructions, and contingencies were the same as in Experiment 2. Two new adults served as reliability observers.

*Training and Test Sequence*

Five steps were used (see Table 1). Steps 1 and 2 were the same as in Experiment 1: training on the X-Y conditional discrimination task in Step 1, and testing on X-Y and Y-X in Step 2.

In Step 3, the subjects received respondent training with sequentially presented A and B stimuli, A arrow right B (linear and one-to-many) or B arrow right A (many-to-one) immediately followed by conditional A-B and B-A discrimination probes. Six trial blocks were used. Block 1 consisted of 10 respondent training trials. Block 2 consisted of match-to-sample test trials: two trials with X and Y stimuli (1 X-Y and 1 Y-X trial) followed by eight trials with A and B stimuli (four A-B trials quasi-randomly mixed with four B-A trials). Block 3 consisted of six X-Y match-to-sample training trials. Blocks 4, 5, and 6 were the same as Blocks 1, 2, and 3,
respectively. Criterion was reached if a subject (a) looked at both stimulus presentations on 18/20 respondent training trials and (b) responded correctly on \(<=1/8\) A-B and \(>=1/8\) B-A trials, or on \(>=7/8\) A-B and \(>=7/8\) B-A trials. Two runs were allowed.

Step 4 was the same as Step 3, except that (a) each respondent training block consisted of 10 B arrow right C trials (linear and one-to-many) or 10 C arrow right B trials (many-to-one), and (b) each test block consisted of 1 X-Y, 1 Y-X, 4 B-C, and 4 C-B trials. Subjects who demonstrated criterion performance in Steps 3 and 4 proceeded to Step 5. Other subjects were eliminated from further participation.

Step 5 examined whether the subjects conditionally related the indirectly paired stimuli with one another: A-C and C-A. Again, six blocks were used. Block 1 consisted of four respondent trials: two A arrow right B and two B arrow right C trials (linear), two A arrow right B and two C arrow right B trials (many-to-one), or two B arrow right A and two B arrow right C trials (one-to-many). Block 2 consisted of 10 match-to-sample test trials: 1 X-Y and 1 Y-X trial followed by 4 A-C trials quasi-randomly mixed with 4 C-A trials. Block 3 consisted of six X-Y match-to-sample training trials (same as in Steps 3 and 4). Blocks 4, 5, and 6 were the same as Blocks 1, 2, and 3, respectively. Criterion performance was set at: (a) observing both stimuli on 7/8 respondent training trials, and (b) responding correctly on \(<=1/8\) A-C trials and on \(<=1/8\) C-A trials, or on \(>=7/8\) A-C and on \(>=7/8\) C-A trials. Two runs were allowed. At the end of Step 5, the experimenter gave each subject the opportunity to respond on a probe trial and asked why she or he had pointed to the selected comparison.

Reliability

Reliability checks were made on 236 respondent training trials (49.2%), 256 match-to-sample training trials (25.7%), and on 320 match-to-sample test trials (28.3%). The experimenter and observers disagreed on one (respondent training) trial.

Results

All subjects learned the pretrained conditional discrimination task in about the same number of training trials (Range: 20-40, M = 30.0) and looked at both stimuli of almost all (99.2%) respondent training trials. Except for Subjects 2 and 8 (see below), none of the subjects made any task-related comments during the respondent training and the match-to-sample tests. Table 4 shows the conditional discrimination performances emanating from respondent training. The data show that the simple-to-complex arrangement was far more effective in generating conditional discrimination performances than the simultaneous arrangement used in Experiment 2, even though the number of allowed respondent trials with A and B stimuli (N = 48), and B and C stimuli (N = 48) was 50% lower than in Experiment 2 (96 respondent training trials with A and B stimuli, and 96 trials with B and C stimuli). Only one subject (4) failed to relate any of the directly paired stimuli conditionally to
one another. Another subject (12) demonstrated bidirectional relations between the paired A and B stimuli but failed to match the B and C stimuli with one another. A third subject (6) matched the nonpaired A and B stimuli, and the paired B and C stimuli with one another. His performance on the A-C and C-A probes was consistent with that on the preestablished conditional discrimination tasks (A-B, B-A, B-C, C-B). The other nine subjects (75.0%, three of each condition), matched all directly paired A, B, and C stimuli with one another (A-B, B-C, and vice versa). Seven of these subjects (77.8%), three linear subjects, three many-to-one subjects, and one one-to-many subject, also matched the indirectly paired A and C stimuli with one another (A-C, C-A).

As in Experiment 2, none of the subjects' verbal reports provided a helpful explanation for their performance ("Don't know," "Just because," "Because that is right"). Interestingly, these explanations were also provided by Subjects 2 and 8 who repeatedly named the stimuli during respondent training and even stated the correct sequential order in which the stimuli of each pair had been presented. For example, during C-,B respondent training with Subject 8, C2 (*[This character cannot be represented into ASCII Text]*) was presented immediately before B1(*[This character cannot be represented into ASCII Text]*) and C1 (*[This character cannot be represented into ASCII Text]*) immediately before B2 (*[This character cannot be represented into ASCII Text]*)). Whenever C2 appeared, Subject 8 repeatedly said, "Now comes arrows." and when C1 appeared, "Now comes music." Interestingly, when questioned at the end of Step 4, Subject 4, who failed to relate any of the directly paired stimuli to one another, spontaneously named the A arrow right B and B arrow right C stimulus pairs in the correct temporal order (e.g., "First comes ... [named B1], then comes ... [named C1]").

**Discussion**

The results of Experiment 3 showed that, after being successfully trained on an X-Y matching task, most children acquired conditional stimulus relations from respondent training with a simple-to-complex protocol. In fact, most (31/40) of these conditional relations (77.5%) required only one run of respondent training in Step 3 (20 A arrow right B or B arrow right A trials) and in Step 4 (20 B arrow right C or C arrow right B trials). In 23 instances, subjects showed already perfect conditional discrimination performance after the first block of 10 respondent training trials. These findings suggest that, after being pretrained on an unrelated arbitrary matching task and using a simple-to-complex protocol, simply observing sequentially presented stimuli rapidly produces conditional stimulus relations in young normal children.

Seven of the nine subjects (77.8%) who demonstrated conditional stimulus relations between directly paired A and B stimuli and between B and C stimuli also showed conditional stimulus relations between indirectly paired A and C stimuli. Both subjects who failed on the A-C and C-A tests were of the one-to-many condition. This finding is consistent with the data reported in Experiment 1 of this study (adults
data) and those reported by others (Saunders et al., 1988; Spradlin & Saunders, 1986).

**Experiment 4**

This experiment examined whether the results in Experiment 3 could have been facilitated by the fact that some of the match-to-sample probes involved stimulus presentations of the same direction as in the respondent training. For example, after receiving A arrow right B respondent training (linear, many-to-one), subjects received both A-B and B-A conditional discrimination probes. The A-B probes might be considered to be of the same direction as the temporal sequence in which the A and B stimuli were presented during respondent training and hence easier to establish than the symmetrical counterparts (B-A). Although the subjects' performances in Experiment 3 did not seem to be affected by directionality of the stimulus relations, the presence of "same-directionality" probes could have facilitated the performance on "opposite-directionality" or symmetry probes. Would the subjects' performances be the same as in Experiment 3 if only symmetry probes were used (same procedure as used in Experiment 1)?

**Method**

Twelve new 5-year-old preschool children served as subjects. Their sex and age are shown in Table 5. The subjects were divided into three groups of four subjects each. One group was assigned to the linear condition, one to the many-to-one condition, and one to the one-to-many condition. The procedures were the same as in Experiment 3 (see Table 1) except that (a) in Steps 3 and 4, all "same-directionality" probes were replaced by "opposite-directionality" probes, and (b) in Step 5, the A-C probes were replaced by C-A probes. Thus, the numbers of "opposite-directionality" probes in Steps 3 and 4, and of C-A probes in Step 5, were twice as high as in Experiment 3 (e.g., 16 C-A test trials in Step 5 versus 8 A-C and 8 C-A trials in Step 5 of Experiment 3).

Reliability checks were made on 232 respondent training trials (30.1%), 168 matching-to-sample training trials (17.4%), and on 280 matching-to-sample test trials (24.0%). The experimenter and observers always agreed.

**Results and Discussion**

All 12 subjects learned the X-Y pretraining tasks in 20 to 40 trials (M = 26.7) and observed both stimuli during all respondent training trials. Except Subject 7, all subjects remained silent during the respondent training. During the respondent training trials (C arrow right B) of Step 4, this subject observing the first stimulus consistently said, This goes with," then waited for the second stimulus and said, "that!" These verbalizations were not observed during the subsequent B-C probes. Table 5 shows the results on the match-to-sample test trials in Steps 3, 4, and 5.
contrast to Experiment 3, all 12 subjects matched the directly paired stimuli (A and B, and B and C) with one another. Nineteen of these performances (79.2%) were already demonstrated during the first run of a step (after 20 respondent training trials).

Seven subjects (58.3%), one linear, two many-to-one, and all four one-to-many subjects, demonstrated criterion performance on the C-A probes (14/16 match-to-sample trials correct). Although this percentage is lower than that reported in Experiment 3 (77.8%), it should be noted that the accuracy of all four linear subjects improved substantially in the second run of Step 5. Thus, it seems plausible that all these subjects would have benefited from a third run. Moreover, the performance of two of these subjects in the second run (Subject 3: 12/16 C-A responses correct; Subject 4: 13/16 C-A responses correct) was well above chance level (p < .05, Binomial test). Thus when we consider these two performances as "successes," the total number of subjects demonstrating the designated C-A relations (N = 9) would be higher than in Experiment 3 (N = 7) and the proportion (75.0%) about the same as in Experiment 3 (77.8%).

The subject's verbal explanations were not much different as in Experiments 2 and 3. None of the subjects, including Subject 7, provided any helpful reports on their performance (shrugging shoulders, "Because it is right," "Don't know," "Because you changed the pictures").

In essence, Experiment 4 showed that, even though only symmetry probes were used, respondent training always led to conditional stimulus relations between directly paired stimuli. This finding suggests that the formation of conditional stimulus relations in Experiment 3 was not facilitated by the use of "same-directionality" match-to-sample probe trials. However, the data were inconsistent with those of Experiments 1 and 3 in that the many-to-one condition produced less equivalence relations than the linear and one-to-many conditions.

**General Discussion**

The present findings demonstrated that respondent training or the observation of sequentially presented stimuli not only is a powerful procedure for establishing conditional relations and stimulus classes in adults but also in young children. Using a simultaneous protocol in Experiment 1, many-to-one and one-to-many respondent training resulted in 9 of 10 adults matching the directly and indirectly paired stimuli with one another. In Experiments 3 and 4, in which a simple-to-complex protocol was used, 21 of 24 children (87.5%) matched all directly paired A and B, and B and C stimuli with one another. Of those 21 subjects, 16 (76.2%) also matched the indirectly paired A and C stimuli with one another. The efficacy and efficiency of respondent training with these youngsters is particularly noteworthy in view of the repeated negative results of previous attempts to establish conditional discriminations and stimulus classes with this age group through other nonmatch-to-sample tasks (Smeets & Barnes, 1995; Smeets et al., 1996; but see Schenk, 1995).
The present findings may also be of practical relevance for teaching arbitrary conditional discriminations to young or difficult-to-teach individuals some of whom fall to learn these tasks with standard match-to-sample training procedures (Saunders & Spradlin, 1989; Smeets & Striefel, 1994; Zygmont, Lazar, Dube, & McEvane, 1992). However, the negative results of Experiment 2, in which the simultaneous protocol was used, (a) suggest that the significance of present findings should not be overstretched, (b) raise questions as how well respondent training holds up when a complex-to-simple protocol (Train A-B and B-C; Test C-A before B-A and C-B) is used, and (c) call for future studies to improve the efficacy of the simultaneous protocol; this might be achieved by interspersing the match-to-sample test trials (e.g., B-A, C-B, C-A) among respondent training trials (A arrow right B, B arrow right C).

Moreover, the success of respondent training in Experiments 3 and 4 (simple-to-complex protocol) may have been facilitated by the fact that same-pair stimuli were presented on a same card. Although all cards were of the same physical dimensions (color and form) and were also used in Experiment 2 (simultaneous protocol), the systematic turning of cards (a typical feature of many commercially available memory games) may have encouraged the children to relate stimuli on the same card conditionally to one another. Thus, it remains to be demonstrated if the results of Experiments 3 and 4 would be the same if same-pair stimuli were presented on separate cards or, as in Experiment 1, on a computer screen.

None of the children provided helpful information on the variables controlling their (un)systematic performance on the conditional discrimination probes. This finding is rather surprising especially for the few children who labeled the stimuli, indicated the temporal relations, or expressed "go with" relations between same-pair stimuli during respondent training. This finding might indicate that (a) children of this age level still have to learn how to verbally express conditional relations between indirectly paired stimuli, and/or (b) the question ("Why did you point to this one?") was inadequate for extracting this information.

The results did not permit firm conclusions with regard to the superiority of any respondent training procedure (linear, many-to-one, one-to-many), at least, not for both populations. The data of Experiment 1 together with Condition 2 (linear) of the Leader et al. (1996) study clearly show that for the adults, the many-to-one protocol was superior over one-to-many protocol which, in turn, was superior over the linear protocol, both in terms of the numbers of subjects demonstrating equivalence (many-to-one: 5; one-to-many: 4; linear: 4), and the numbers of runs required for establishing conditional relations between directly paired stimuli (many-to-one: M = 1.0, no Range; one-to-many: M = 1.75, Range 1-2; linear: M = 2.75, Range 2-5) and between indirectly paired stimuli (many-to-one: M = 1.4, Range 1-2; one-to-many: M = 2.0, Range 1-3; linear: M = 4.0, Range 2-6). In contrast, Experiments 3 and 4 showed that the three protocols were equally effective in establishing conditional relations between directly paired stimuli (7/8 children in each condition) and between indirectly paired stimuli (linear: 6, many-to-one: 5, one-to-many: 5). Perhaps this inconsistency should have been expected. Consider the following
arguments and analyses.

First, although the linear, many-to-one, and one-to-many respondent training conditions were designed to be analogues of the same three match-to-sample training arrangements, current research conducted at Cork suggests that respondent training is a more effective procedure for establishing equivalence classes than match-to-sample training. Given this difference, and perhaps others to be discovered, we should not be surprised if using different training arrangements with the respondent procedure produces outcomes different from those produced using the same arrangements with match-to-sample.

Second, in the present and the previous study (Leader et al., 1996), the probes assessing conditional relations between directly paired stimuli were presented together with (Experiments 1 and 2) or before those assessing conditional relations between indirectly paired stimuli (Experiments 3 and 4). These procedures permitted that the conditional relations between indirectly paired stimuli did not result from the training arrangements per se (linear, many-to-one, one-to-many), but from the conditional relations established through training and testing (see also Saunders & Green, 1992; Saunders, Saunders, Williams, & Spradlin, 1993; Sidman, 1994). In all three conditions, the symmetry tests formed protocols opposite to those used during training: another linear protocol (B-A, C-B) in the linear condition (A arrow right B, B arrow right C), a one-to-many protocol (B-A, B-C) in the many-to-one condition (A arrow right B, C arrow right B), and a many-to-one protocol (A-B, C-B) in the one-to-many condition (B arrow right A, B arrow right C). Although test responses were not followed by scheduled consequences, the relations established during symmetry probes could have facilitated or suppressed the formation equivalence (A-C) relations. Thus, even if many-to-one training did produce stimulus classes more readily than one-to-many training, one could not tell whether the equivalence relations were derived from the training protocol, the test protocol, or both. For example, after receiving many-to-one respondent training (A arrow right B, C arrow right B), Subject 8 in Experiment 1 (see Table 1) responded 93% correct on the B-C and B-A tasks, and 30% correct on the A-C task during the first run; and 100% correct on all tests during the second run. The performance on the A-C task in the final run could be based on the additional repeated respondent training alone (many-to-one), or on the tested and obtained conditional stimulus relations (fitting the one-to-many protocol). The situation becomes even more complex in Experiments 2 and 3 in which the conditional stimulus relations were tested bidirectionally. In three conditions (linear, many-to-one, one-to-many), the subjects received A-B, B-A, B-C, C-B probes simultaneously with (Experiment 2) or before the A-C and C-A probes (Experiment 3). These probe arrangements permitted the subjects to base their A-C and C-A performances on the tested A-B and B-C relations (linear), C-B and B-A relations (linear), A-B and C-B relations (many-to-one), or on B-A and B-C relations (one-to-many). Note that this situation is very much the same when conditional relations are trained with match-to-sample procedures in accordance with a simple-to-complex or simultaneous protocol. After being trained on A-B and B-C tasks (linear protocol), subjects receive B-A and C-B tests before or concurrently with C-
A tests.

The performance on the latter test may be based on the trained relations (A-B, B-C; linear), or combinations of tested and/or trained stimulus relations fitting the linear protocol (B-A [tested] and C-B [tested]), the many-to-one protocol (A-B [trained] and C-B [tested]), or the one-to-many protocol (B-A [tested] and B-C [trained]).

The issue of whether equivalence formation can or should be affected by the training protocols has been under debate for about a decade. Theoretically, there are no compelling reasons for such an effect, and there are sufficient studies showing that, with humans, one-to-many training can be highly effective (Barnes, Browne, Smeets, & Roche, 1995; Barnes, McCullagh, & Keenan, 1990; Devany, Hayes, & Nelson, 1986; Sidman & Tailby, 1982) and many-to-one very ineffective (Saunders et al., 1993). Yet, the two studies by Saunders et al. (1988) and Spradlin and Saunders (1986) indicating superiority of many-to-one over one-to-many have received considerable attention (Barnes, 1994; Hayes, 1992; Sidman, 1994). However, questions about the appropriate methodology for measuring these effects have not been addressed.

The position taken here is that the differential effects of training protocols can be measured only with a complex-to-simple arrangement (e.g., Train B-A and B-C. Test C-A before A-B and C-B) because it prevents subjects from deriving the stimulus class relations from other stimulus relations obtained through testing (A-B, C-B). This arrangement was used by Spradlin and Saunders (1986) and by Saunders et al. (1988). Both these studies used mentally retarded adults as subjects. In the first study (Spradlin & Saunders, 1986), two subjects (Experiment 3) were trained with a one-to-many protocol (A-B, A-C, A-D, A-E) and three subjects (Experiment 4) with a many-to-one protocol (B-A, C-A, D-A, E-A). Then they received stimulus class probes. The data convincingly demonstrated superiority of many-to-one over one-to-many: All three many-to-one subjects demonstrated stimulus class development whereas both one-to-many subjects did not. At that point, the subjects also received symmetry probes followed by additional stimulus class probes (note that at this point a simple-to-complex protocol is used). From the way stimulus equivalence is formalized (Sidman & Tailby, 1982; Sidman, 1994) the symmetry probes were necessary indeed. But did these probes also measure symmetry? Not necessarily. Symmetry tests implied that the designated relations were derived from previously trained relations between two directly linked stimuli (Train B-A, Test A-B). The design, however, permitted the "symmetry" relations to be derived from the trained relations and from the tested stimulus class relations (e.g., C-A [trained], C-B [tested], therefore A-B). Although this may not have occurred in all subjects, the gradually improving "symmetry" performance of many-to-one subject JB could point in this direction. The interaction between stimulus class and symmetry probes and vice versa is very apparent in the study by Saunders et al. (1988). Six mentally retarded persons were used. In Phase 1, three subjects received one-to-many training(A-B, A-C, A-D, A-E) and three subjects many-to-one training(B-A, C-A, D-A, E-A). After training, the subjects received stimulus class probes (B-C, D-B, B-E,
C-D, C-E, D-E, and vice versa) before receiving symmetry probes (one-to-many: B-A, C-A, D-A, E-A; many-to-one: A-B, A-C, A-D, A-E), followed again by stimulus class probes, and so forth. All three many-to-one subjects and only one one-to-many subject eventually demonstrated stimulus class formation. Based on these findings the authors concluded that "the two types of procedures may not be equally effective in creating equivalence classes." (Saunders et al., 1988, p. 112). However, only one of these four subjects (many-to-one subject BD) demonstrated evidence of stimulus class formation before the symmetry probes were introduced. Thus, it can be reasonably assumed that, for the other three subjects (two many-to-one subjects and one one-to-many subject), class formation was not based on the trained relations alone but on combinations of trained and tested stimulus relations (e.g., for a many-to-one subject, the performance on the D-B could be based on the trained D-A and tested A-B relations [linear protocol]). Clearly, therefore, these complex issues will require careful and systematic experimental analysis before we can judge the relative effectiveness of the various protocols in producing derived stimulus classes.

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Table 1 Training (Many-to-One) and Test Sequence in Experiments 1-4

Legend for Chart:

A - Experiment 1
B - Experiment 2
C - Experiment 3
D - Experiment 4

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## Table 2 Percent Correct on 60 Symmetry and 30 Equivalence Test Trials per Exposure

Legend for Chart:

A - Successive Exposures; Subj
B - Successive Exposures; 1 Sym
C - Successive Exposures; 1 Equiv
D - Successive Exposures; 2 Sym
E - Successive Exposures; 2 Equiv
F - Successive Exposures; 3 Sym
G - Successive Exposures; 3 Equiv
H - Successive Exposures; 4 Sym
I - Successive Exposures; 4 Equiv

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## Table 3 Sex, Age, and Number of Correct Conditional Discrimination Responses for Each Subject During Runs 1 and 2 (2), 2 and 3 (3), and 3 and 4 (4) of Step 4 in Experiment 2

Legend for Chart:

A - Subjects
B - Sex
C - Age
D - Tasks and Runs; A-B 2
E - Tasks and Runs; A-B 3
F - Tasks and Runs; A-B 4
G - Tasks and Runs; B-A 2
H - Tasks and Runs; B-A 3
I - Tasks and Runs; B-A 4
J - Tasks and Runs; B-C 2
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Note. The maximum number of correct responses is 8. The bold numbers indicate emergent conditional discrimination (criterion) performances consistent with respondent training.

Table 4 Sex, Age, and Number of Correct Conditional Discrimination Responses for Each Subject in Experiment 3

Tasks and Runs

Legend for Chart:

A - Subjects
B - Sex
C - Age
D - Step 3: A-B 1
E - Step 3: A-B 2
F - Step 3: B-A 1
G - Step 3: B-A 2
H - Step 4: B-C 1
I - Step 4: B-C 2
J - Step 4: C-B 1
K - Step 4: C-B 2
L - Step 5: A-C 1
M - Step 5: A-C 2
N - Step 5: C-A 1
O - Step 5: C-A 2

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Note. The maximum number of correct responses is 8. The bold numbers indicate emergent conditional discrimination (criterion) performances consistent with respondent training.

Table 5 Sex, Age, and Number of Correct Conditional Discrimination Responses for Each Subject in Experiment 4

Tasks and Runs

Legend for Chart:
A - Subjects
B - Age
C - Sex
D - Step 3: A-B 1
E - Step 3: A-B 2
F - Step 3: B-A 1
G - Step 3: B-A 2
H - Step 4: B-C 1
I - Step 4: B-C 2
J - Step 4: C-B 1
K - Step 4: C-B 2
L - Step 5: C-A 1
M - Step 5: C-A 2

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Note. The maximum number of correct responses is 16. The bold numbers indicate emergent conditional discrimination (criterion) performances consistent with respondent training.

DIAGRAM: Figure 1. Stimuli used in Experiments 2, 3, and 4.

**References**


BARNES, D., BROWNE, M., SMEETS, P.M., & ROCHE, B. (1995). A transfer of functions and a conditional transfer of functions through equivalence relations in
three- to six-year-old children. The Psychological Record, 45, 405-430.


LEADER, G., BARNES, D., & SMEETS, P.M. (1996). Establishing equivalence relations by using a respondent-type training procedure. The Psychological Record,


By PAUL M. SMEETS, Leiden University and GERALDINE LEADER and DERMOT BARNES, University College Cork