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Time-Delay Discrimination Training with Multiple Distinctive-Feature Prompts: The Function of the Incorrect (S −) Prompt

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This study investigated to what extent discrimination learning through time delay of multi-stimulus distinctive-feature prompts is a function of the inclusion and configuration of the S− prompt. The study consisted of two experiments in which 4- and 5-year-old children participated. Experiment 1 consisted of two groups both of which were first trained to discriminate two color prompts, one (P+) for guiding attention to the distinctive feature of the correct stimulus and one (P−) for guiding attention to the distinctive feature of the incorrect stimulus. Then, one group was trained through time delay of a single prompt (P+), the other group through time delay of both prompts. Experiment 2 also used two groups. For one group, the conditions were the same as in Experiment 1, that is, discrimination training on two distinctive-feature prompts followed by time delay of both these prompts. The conditions for the other group were the same, except that now a distinctive-feature P+ and a nondistinctive-feature P− were used. The results of both experiments showed that most subjects did not learn the task unless two distinctive-feature prompts (P+, P−) were used. © 1988 Academic Press, Inc.

Much research on discrimination learning relates to errorless transition from prompted to nonprompted responding. A major technique that evolved from that research is time delay (Touchette, 1971). Although the procedure typically involves the use of a single unrelated prompt (e.g., a colored background for guiding the attention to the correct shape), time delay has been successfully used in establishing discriminations in a wide range

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of subject populations (Bradley-Johnson, Sunderman, & Johnson, 1983; Brown & Rilling, 1975; MacDonall & Marcucella, 1976; Touchette, 1971; Touchette & Howard, 1984). However, there are also studies in which the efficacy of this procedure was low (Aeschleman & Higgins, 1982; Saunders & Spradlin, 1985; Smeets & Lancioni, 1981; Smeets, Lancioni, & Striefel, in press; Smeets, Lancioni, Striefel, & Curfs, 1988; Spradlin, 1985), or it was demonstrated that it is the prompt rather than the delay that makes the procedure effective (MacCandless, Etzel, & LeBlanc, 1986).

The present study is the third in a sequence of studies concerned with identifying the mechanisms making time delay a powerful technique for teaching young children to discriminate complex visual stimuli. The central foci of this research are the number of prompts and the physical properties thereof. The two previous studies (Smeets et al., in press; Smeets et al., 1987) revealed two major findings. First, time delay of a single color prompt did not help subjects learn the task regardless of whether the prompt (P) directed attention to no feature, a nondistinctive feature, or to a distinctive feature of the S+ (Smeets et al., 1988). Second, time delay of multiple color prompts resulted in most subjects learning the task but only when distinctive-feature prompts were used, one (P+) for guiding the attention to the distinctive element of the S+ and one (P−) for guiding the attention to the distinctive feature of the S− (Smeets et al., in press). Although these findings were very encouraging, some mechanisms underlying the success of time delay of multi-stimulus distinctive-feature prompts remain unclear. First, the design of the initial study on time delay (Smeets et al., 1988) did not rule out that the superiority of multi-stimulus prompting over single-stimulus prompting was a function of the nature of the preceding training rather than of the inclusion of a second prompt (P−) per se. Time delay of multi-stimulus prompts was preceded by a training involving presentations of both color prompts (P+, P−) (prompt discrimination training). This training ensured that the subjects were responding to the relevant dimension (shape) of the P+. Time delay of single-stimulus prompts was preceded by a training in which the P+ was presented in isolation (prompt training). This training allowed subjects to respond to the irrelevant dimension (color) of the P+. Thus time delay of single-stimulus prompts could be as effective as time delay of multi-stimulus prompts if also preceded by a prompt discrimination training. Second, the demonstrated significance of the shapes and locations of multiple prompts (Smeets et al., in press) was based on systematic manipulations of these dimensions with both prompts concurrently. The design of that study did not allow any conclusions on the required dimensions of each prompt separately. Thus, it is possible that, when the P− is combined with a distinctive-feature P+, its configuration is relatively unimportant for establishing stimulus control transfer.

The present study investigated the extent to which the success of time delay of multi-stimulus distinctive-feature prompts is a function of the inclusion and configuration of the P−. The study consisted of two experiments. The types of subjects, stimulus materials, and training procedures were kept identical to those in the previous studies (Smeets et al., in press; Smeets et al., 1988).

EXPERIMENT 1

This experiment investigated whether time delay requires the inclusion of a P− after the children have been trained to discriminate the shapes of the color prompts (P+, P−). Specifically, the experiment assessed the effectiveness of two time-delay conditions through multiple comparisons ($N = 3$) across groups. One condition involved two distinctive-feature prompts (P+, P−), the other condition a single-stimulus prompt (P+ only). Following the screening of subjects (pretraining assessment) and their assignment to groups, the groups were randomly assigned to the experimental conditions. The first training was then initiated. Group 1 received time delay of single-stimulus prompts, Group 2 time delay of multi-stimulus prompts. Each time-delay training was preceded by a prompt discrimination training. Subjects who failed to learn the task through the least effective condition (time delay of single-stimulus prompts) were divided into two subgroups and were retrained (second training). One subgroup received time delay of single-stimulus prompts again while the other subgroup received time delay of multi-stimulus prompts. Subjects who had failed twice to learn the task through time delay of single-stimulus prompts were then trained (third training) through time delay of multi-stimulus prompts (see Table 1).

Method

Much of the method was very similar to that in the previous two studies (Smeets et al., in press; Smeets et al., 1988). Therefore, only a brief synopsis is provided here. Procedures that were not used in the previous studies (i.e., wait-analysis test) are described in detail.

Subjects

Sixteen kindergarten students (eight boys and eight girls) between 4.58 and 5.92 years of age ($M = 5.22$) served as subjects. They were randomly divided into two groups of eight subjects with the restriction that the age and sex of each group was the same (see Table 1).

Stimulus Materials

The task stimuli were a septagon and an octagon. Both forms were drawn with light green ink (all lines 1 mm thick) on transparency sheets. The sheets covered and were attached to white background cards. The prompts were drawn with black ink (3 mm thick) on the background cards. The dimensions of the prompts (shape, size, location) were the same as those of the designated distinctive elements of the task stimuli. The stimulus materials showed (a) only the task stimuli, (b) only the prompts, or (c) the task stimuli with the prompts. Figure 1 shows the stimulus configurations for pretraining assessment, the prompt discrimination training, and for each time-delay condition when the task stimuli and prompt(s) appeared together.

Training

General. Sessions were conducted in a room of the school building, were scheduled once a day, five times a week, and lasted from 5 to 29 min (M = 5.22). Two adults participated, one as experimenter and one as reliability observer. The observer was present in the same room but unable to observe the experimenter's recordings.

A trial started when the experimenter presented a card while asking the subject to point to the correct stimulus ("Point to the correct picture."). Subjects were given 10 sec (pretraining assessment, prompt discrimination training) or 10 to 20 sec to respond (time-delay training).

Each correct response was followed by praise and the delivery of a token (colored bead). Incorrect responses were followed by no consequences. Invalid responses (e.g., looking at the experimenter while pointing or pointing to both stimuli) and no responses were followed by corrective feedback (e.g., "No! You should point to only *one* picture."). The tokens were exchanged for a sticker at the end of each session.

Pretraining assessment. This training consisted of five blocks of 12 trials, in each of which the experimenter presented the two task stimuli on a white background. Each block consisted of two demonstration trials in which the experimenter modelled the correct response followed by 10 trial-and-error trials in which no help was given. Four subjects of each group were assigned to point to the septagon, the others to the octagon. The training continued until a subject responded correctly on 9 out of 10 consecutive trial-and-error trials (task learned) or until the completion of the fifth block. Subjects were excluded from further participation if they (1) learned the task or (2) did not learn the task while (a) showing an ascending rate of correct responses or (b) making more than one invalid or no response in the final two blocks of trials. Subjects meeting any of these criteria were replaced by other subjects who also received this training first.

Prompt discrimination training. The training procedures were the same as for the pretraining assessment except that the experimenter now presented the prompts.

Time-delay training. The training procedures were the same for both

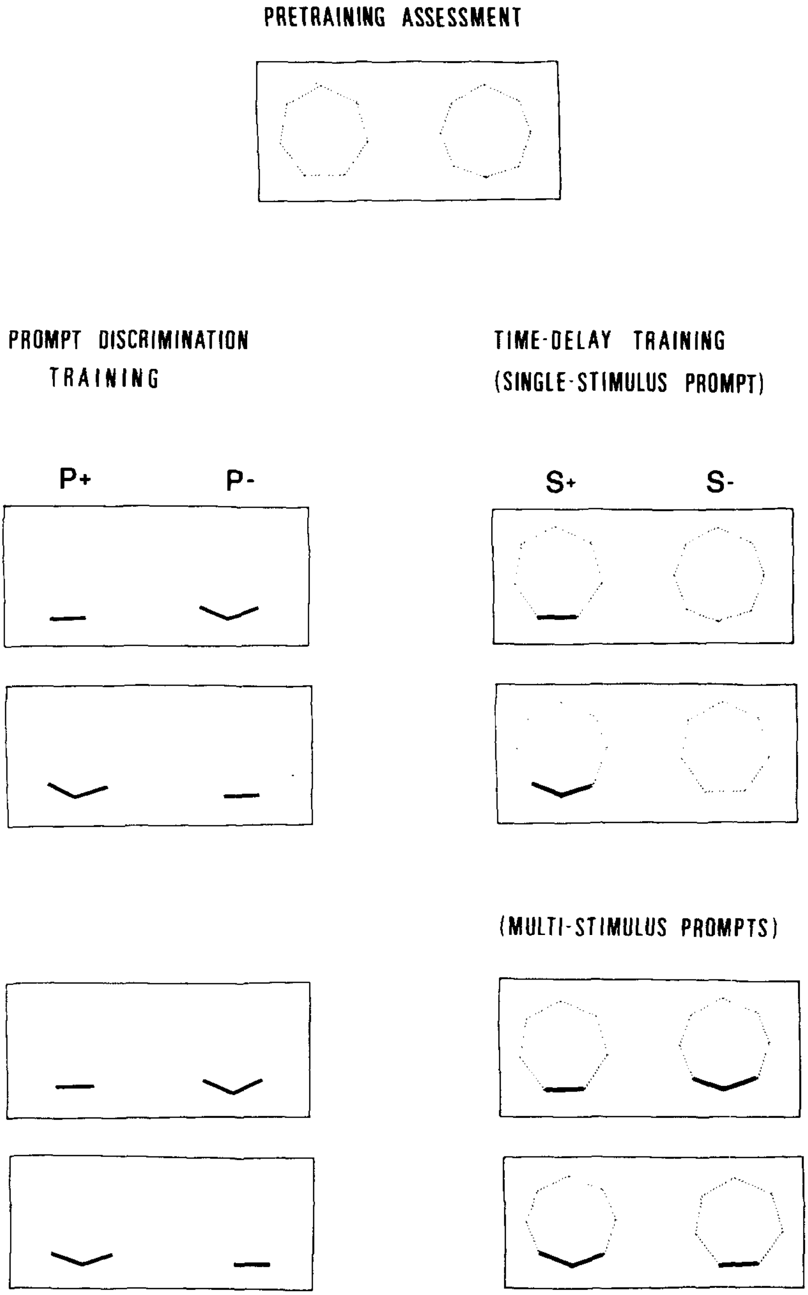

FIG. 1. Stimulus configurations used for pretraining assessment (upper center), prompt discrimination training (left column), and time-delay training when the cover card was not inserted (right column). The broken and solid lines indicate the colors green and black, respectively.

conditions. The training started with a simultaneous (0-sec delay) trial in which the experimenter presented the task stimuli together with the prompt(s). Subjects were given 10 sec to respond. A correct response resulted in the introduction of a 1-sec delay between the presentation of the task stimuli and the prompt(s) in the following trial. This was accomplished by the experimenter first inserting and then removing a white cover card between the transparency sheet (showing the task stimuli) and the background card [showing the prompt(s)]. Each correct response resulted in an increased delay of 1 sec on the next trial regardless of whether the response was made before (anticipatory response) or after the appearance of the prompt(s) (wait response). Incorrect anticipatory responses resulted in a decreased delay of 2 sec on the next trial. Incorrect responses in the presence of the prompt(s) (simultaneous trials, delay trials) resulted in two demonstration trials in which the experimenter modelled the correct response in the presence of the compound stimuli and a return to the beginning of the training sequence (simultaneous trial). The training continued until a subject made 9 correct anticipatory responses on a block of 10 trials or completed the 30th trial starting with the first simultaneous trial on which a subject responded correctly.

Wait-analysis test. This test was used for subjects who did not reach criterion performance in time-delay training while consistently making correct wait responses (i.e., correct wait responses on at least all final 10 trials). The test analyzed whether these responses were controlled by the prompt(s) (subject had not learned the task and waited for the appearance of the prompt[s] for guiding the correct response) or by the removal of the cover card (subject had learned the task but waited for a signal to respond). The test consisted of a sequence of 24 trials, 12 prompted trials randomly interspersed with 12 nonprompted trials. All trials involved the use of the cover card. In the prompted trials, this card was used with the time-delay cards (showing one or two prompts), while in the nonprompted trials, it was used with the pretraining assessment cards (showing no prompts). The procedures were the same as in time-delay training except that (a) the first trial (always a prompted trial) started with a 10-sec delay and (b) incorrect wait responses in the presence or absence of the prompt(s) resulted in the experimenter using the same delay for the following (prompted or nonprompted) trial. Control by the cover card was assumed when a subject consistently made correct wait responses on both types of trials. Control by the prompt(s) was assumed when a subject continued to make correct wait responses on the prompted trials while making correct and incorrect wait responses or no responses on the nonprompted trials.

Reliability

Reliability checks were made on 525 (23.6%) trials. Each trial, the experimenter and observer made two recordings, one of the type of response (i.e., whether it was a correct, incorrect, or invalid anticipatory or wait response, or no response) and one of the direction of response (i.e., whether the subject pointed to the left or right stimulus) (Smeets et al., in press; Smeets et al., 1988). The reliability on each measure was calculated by dividing the number of agreements by the number of agreements plus disagreements, times 100.

Results

The mean reliability measures on the type and direction of response were 99.2 and 99.0%, respectively. The pretraining assessment required four subjects (mean age = 5.33 years; range = 5.08–5.83 years) to be replaced by others. The major results of each (prompt discrimination and time delay) training are presented in Table 1.

The data on the first training show that the prompt discrimination training resulted in most subjects reaching criterion performance with a minimum number (11 or 12) of trials. Time delay of single-stimulus and of multi-stimulus prompts resulted in two (25.0%) of the subjects of Group 1 and six (75.0%) of the subjects of Group 2 learning the target discrimination. Tocher's modification of the Fisher test, one-tailed, showed that this discrepancy was significant ($p < .05$). There were no indications for a superiority of the multi-stimulus prompt condition of both other measures, number of trials to criterion and percentage of correct responses. The performance of the subjects who failed to reach criterion was generally much lower. Their number of correct anticipatory responses on the final 10 trials varied from 0 to 7 ($M = 2.5$).

Subsequent response analyses suggested that the problems with transferring control differed across subjects. Two types of transfer were required to learn the task, transfer of prompt control across configurations (from the configuration used in prompt discrimination training to the much different configuration used in time-delay training) and transfer of stimulus control within configurations (from the prompt element of the compound stimulus to the distinctive feature of the S+). Transfer of prompt control failed to occur in two subjects, Subject 5 of Group 1 (3 incorrect wait responses) and Subject 11 of Group 2 (10 incorrect wait responses). Thus, for these two subjects the failure to learn could not be related to time delay but to other variables. Five other subjects, Subjects 2, 3, 4, and 6 of Group 1 and Subject 15 of Group 2, probably failed because of some inadequacies of the time-delay conditions preventing transfer of stimulus control to occur. Transfer of stimulus control also failed to occur with Subject 7 of Group 1 who made correct wait responses on the last 20 time-delay trials. During the subsequent test, he made 11 correct and 1 incorrect wait responses on the prompted trials, and 3 correct and 6 incorrect wait responses and 3 no responses on the nonprompted trials. These data suggest that his responses were not controlled by the task stimuli, but by the shape and/or color of the prompt.

TABLE 1

DESCRIPTIVE CHARACTERISTICS, CORRECT STIMULUS, AND PERFORMANCE FOR EACH SUBJECT IN EACH TRAINING SEQUENCE

					Prompt discrim.			Time delay		
Subjects	Sex	CA	S+	Training	Task learned	Number trials	Prompts	Task learned	Number trials	% Correct
Group 1										
S1	F	4.58	S	1	+	11	SS	+	24	86.4
S2	F	5.00	S	1	+	11	SS		33	77.2
S3	M	5.50	S	1	+	16	SS		30	76.7
S4	M	5.83	S	1	+	12	SS	−	30	70.0
S5	F	4.58	O	1	+	11	SS	−	33	63.0
S6	M	5.08	O	1	+	12	SS		30	73.3
S7	M	5.50	O	1	+	11	SS	− ( )	30	90.0
S8	F	5.75	O	1	+	11	SS	+	13	100.0
	$\bar{X}$ =	5.23								
Group 2										
S9	F	4.83	S	1	+	11	MS	+	24	83.3
S10	M	4.92	S	1	−	11	MS	+	25	100.0
S11	M	5.25	S	1	+	23	MS		33	28.6
S12	F	5.67	S	1	+	19	MS	−	27	77.8
S13	F	4.92	O	1	+	11	MS	+	15	92.3
S14	M	4.92	O	1	+	11	MS	−	27	81.5
S15	F	5.33	O	1	+	12	MS		33	65.5
S16	M	6.92	O	1	+	12	MS	+	21	81.0
	$\bar{X}$ =	5.19								
Group 1										
S2	F	5.00	S	2	+	11	SS	−	30	73.3
S4	M	5.83	S	2	+	11	SS		30	76.7
S6	M	5.08	O	2	+	11	SS		30	66.7
	$\bar{X}$ =	5.30								
S3	M	5.50	S	2	+	11	MS	+	12	100.0
S5	F	4.58	O	2	+	11	MS	−	30	65.4
S7	M	5.50	O	2	+	11	MS	(+)	30	100.0
	$\bar{X}$ =	5.19								
S2	F	5.00	S	3	+	11	MS	+	22	90.9
S4	M	5.83	S	3	+	11	MS		30	80.0
S6	M	5.08	O	3	+	11	MS		33	74.2
	$\bar{X}$ =	5.30								

Notes. S, septagon; O, octagon; SS, single-stimulus prompt; MS, multi-stimulus prompt. The plus and minus signs between parentheses indicate the results of the wait-analysis test on Subject 7. A (+) indicates that he had learned the task, a (−) indicates that he had not learned the task.

The results of the second training revealed that all (N = 6) subjects passed the prompt discrimination training errorlessly. All of them indicated (verbally or by demonstrating the correct response before the experimenter had the opportunity to model the response first) that they remembered the designated P+. The data on the subsequent time-delay conditions indicated that all three subjects (Subjects 2, 4, and 6) who were retrained with a single-stimulus prompt again failed to reach criterion performance (adequate transfer of prompt control but no transfer of stimulus control). Time delay of multi-stimulus prompts resulted in one subject (Subject 3) reaching and two subjects (Subjects 5 and 7) not reaching criterion performance. Their performance was very similar to that during the first training (time delay of single-stimulus prompts). Subject 5 again made several (N = 3) incorrect responses in the presence of the prompts, while Subject 7 did nothing but making correct responses in the presence of the prompts. However, in contrast to the first training when he consistently pointed to the center of the S+, Subject 7 now frequently pointed to the lower angle of that stimulus (octagon), thereby suggesting that his responses were controlled by the appropriate stimulus component and that he had learned the task. The results of the subsequent test confirmed this assumption. He consistently waited for the removal of the cover card and always responded to the S+, irrespective of the presence of the prompts.

The results of the third training show that only one subject (Subject 2) learned the task through time delay of multi-stimulus prompts. The two subjects (Subjects 4 and 6) who failed to learn the task were adequately controlled by the designated prompts but did not shift their responses from these prompts to the corresponding task stimuli.

Discussion

The results of this experiment revealed that, after being trained to discriminate a color prompt of the same shape as the distinctive element of the S+, subsequent progressively delayed presentations of only that prompt did not result in most subjects learning the target discrimination. Instead, the data showed that, as has been repeatedly demonstrated before (Smeets et al., in press; Smeets et al., 1988), the inclusion of a second (P−) prompt was a necessary condition for time delay to establish the discrimination.

While these findings answered one question, they also raised another one. Why did most subjects of Group 1 fail to learn the task? It could be that the shape of the P+ controlled these subjects' responses in the condition in which they were trained (prompt discrimination training) but not in the other condition when much different configurations were used (time delay). If so, time delay including a P− of any shape, not necessarily the same as the distinctive feature of the S−, might be sufficient to maintain the control of the shape of the P+. If not, the inclusion of a P− of a specific shape, that is, the same shape as the distinctive feature of the S−, might be a necessary condition for the subjects to compare the critical components of both task stimuli.

EXPERIMENT 2

This experiment investigated whether the efficacy of time delay of multi-stimulus distinctive-feature prompts is a function of the shape of the P−. Two conditions were used. Each condition consisted of prompt discrimination training and time delay training. Both conditions included two color prompts, a distinctive-feature P+ (same shape as the distinctive feature of the S+) and a P−. Under one condition, hereafter referred to as the "Matching P−" condition, the P− had the same shape (line, angle) as the distinctive feature of the S−, while under the other condition, hereafter referred to as the "Nonmatching P−" condition, it had a different shape. It was expected that the efficacy of the Matching P− condition would be superior to that of the Nonmatching P− condition. This hypothesis was based on the assumption that, during time delay, the Nonmatching P− would only insure the continued control of the shape of the P+, while the Matching P− would do the same *and* direct the subjects' attention to the distinctive feature of the S−.

Method

The procedures (pretraining assessment, prompt discrimination training, time-delay training, wait-analysis test, reliability assessment) and design were the same as in Experiment 1. The stimulus configurations for the prompt discrimination training and time-delay training under the Matching P− condition were the same as for the multi-stimulus distinctive-feature prompts condition in Experiment 1. The stimulus configurations for the Nonmatching P− condition (prompt discrimination training, time-delay training) were the same as for the Matching P− condition, except that the shapes of the P− for the septagon and octagon consisted of a vertical line and an X, respectively. The total length, width, and color of these prompts were identical to those (line, angle) under the Matching P− condition. Figure 2 shows the stimulus displays for the Nonmatching P− condition when the correct stimulus appeared on the left.

Sixteen 4- and 5-year-old kindergarten students (eight boys and eight girls) from another school served as subjects. Following pretraining assessment, they were divided into two groups which were randomly assigned to the experimental conditions. Group 1 received the Nonmatching P− condition, Group 2 the Matching P− condition. The age and sex of each

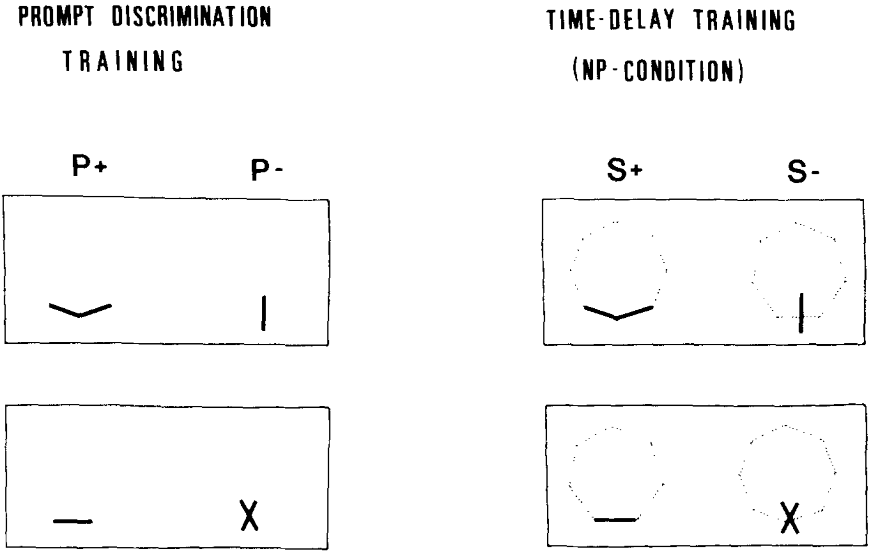

FIG. 2. Stimulus configurtions used for the prompt discrimination training and time-delay training ("Nonmatching P−" condition).

group are listed in Table 2. The same adults participated as experimenter and reliability observer. Reliability checks were made on 568 (28.8%) trials.

Results and Discussion

The reliability measures on the type and directionality of response were above 98.3% (M = 99.1). The pretraining required seven subjects (mean age = 5.22 years; range = 4.83–5.75) to be replaced by others. The results of the experimental conditions are presented in Table 2.

The data of the first training show that the subjects had no difficulties with the prompt discrimination training. The subsequent time-delay training resulted in three subjects of Group 1 (Nonmatching P− condition) and six subjects of Group 2 (Matching P− condition) learning the task. Although this difference was not statistically significant (Fisher test), the data are consistent with those obtained in Experiment 1 of this study and those in previous studies (Smeets et al., in press; Smeets et al., 1988). The conditions did not differentially affect the efficiency of learning (number of trials to criterion, percentages of correct responses). The subjects who did not learn the task made 0 to 5 correct anticipatory responses on the final 10 time-delay trials (M = 2.9). One of these subjects (Subject 9 of Group 2) evidenced inadequate prompt control. The other six subjects

TABLE 2

DESCRIPTIVE CHARACTERISTICS, CORRECT STIMULUS, AND PERFORMANCE FOR EACH SUBJECT IN EA
TRAINING

						Prompt discrim.		Time delay		
Subjects	Sex	CA	S+	Training	P-	Task learned	Number trials	Task learned	Number trials	Cor
Group 1										
S1	F	4.75	S	1	NM	+	11		30	70
S2	F	5.08	S	1	NM	+	12	+	34	97
S3	M	5.33	S	1	NM	+	11		30	71
S4	M	5.75	S	1	NM	+	11		30	70
S5	M	4.58	O	1	NM	+	12		30	76
S6	M	5.08	O	1	NM	+	11	+	18	94
S7	F	5.42	O	1	NM	+	17	+	31	79
S8	F	5.58	O	1	NM	+	11		30	73
	$\bar{X}$ =	5.20								
Group 2										
S9	F	5.00	S	1	M	+	12		30	63
S10	M	5.33	S	1	M	+	12	+	27	85
S11	F	5.75	S	1	M	+	17	+	19	89
S12	M	5.00	S	1	M	+	19		30	82
S13	M	4.67	O	1	M	+	11	+	18	81
S14	F	5.17	O	1	M	+	11	+	12	100
S15	F	5.83	O	1	M	+	11	+	23	91
S16	M	5.42	O	1	M	+	11	+	22	95
	$\bar{X}$	5.27								
Group 1										
S1	F	4.75	S		NM	+	11		30	70.
S8	F	5.58	O	2	NM	+	11	+	25	84.
	$\bar{X}$ =	5.17								
S3	M	5.33	S	2	M	+	11	+	14	100.
S4	M	5.75	S	2	M	+	11	+	11	100.
S5	M	4.58	O	2	M	+	11	+	15	100.
	$\bar{X}$ =	5.22								
S1	F	4.75	S	3	M	+	11	+	16	100.

Note. S, septagon; O, octagon; M, matching P- prompt, NM, non-matching P- prompt.

(Subjects 1, 2, 3, 4, and 8 of Group 1 and Subject 12 of Group 2) probably failed due to inadequate stimulus and/or temporal conditions of the time-delay procedures.

The results of the second and third training revealed that all subjects who had once or twice failed to learn the task under the Nonmatching P – condition reached criterion under the Matching P – condition without making errors and with a minimum of trials ($M = 14$; range = 11–16). By contrast, the second implementation of the Nonmatching P− condition resulted in one subject failing to learn the task (adequate prompt control), while the other subject made errors and needed about the same number of trials as most subjects who learned the task during the first training.

GENERAL DISCUSSION

The present study assessed whether the previously reported success of time delay of multi-stimulus distinctive-feature prompts (Smeets et al., in press; Smeets et al., 1987) was a function of the P−. In essence, the question raised here was whether the discrimination learning through time delay was only a matter of learning which element of the S+ to respond to or also which element of the S− not to respond to. The designs of the two previous studies did not rule out that, after they had been trained to discriminate the shape of the distinctive-feature P+ (prompt discrimination training), the delayed presentation of only that prompt or in combination with a stimulus unrelated P− would have been sufficient for most children to learn the discrimination. Present findings provide sufficient evidence to reject these possibilities and show that two distinctive-feature prompts were necessary, one for each stimulus. Thus, the answer to the above question would be that for most children the discrimination learning was not simply a matter of learning to respond to the distinctive element of the S+, but also of learning not to respond to the distinctive element of the S−.

Present data may also extend the validity of previously reported findings on extra-stimulus distinctive- and nondistinctive-feature prompts. Studies on prompt fading have shown that prompts indicating only the location of the S+ or a nondistinctive feature thereof usually don't help subjects learn the discrimination (Egeland, 1975; Etzel & LeBlanc, 1979; Guralnick, 1975; Koegel & Rincover, 1976; Lancioni & Smeets, 1986; Rincover, 1978; Schreibman, 1975; Schreibman, Charlop, & Koegel, 1982; Schwartz, Firestone, & Terry, 1971; Smeets, Lancioni, & Hoogeveen, 1984a; Wolfe & Cuvo, 1978). Present findings suggest that this also applies to the P−. Experiment 2 showed that when the shape of the P− matched the correct location but not the shape of the distinctive feature of the S−, most children of Group 1 did not learn the task. However, the proportion of children (40.0%) that learned the task under that condition was higher than that (18.2%) under the control condition (Group 1) in Experiment 1 or under any of the control conditions of the two previous studies (Smeets et al., in press; Smeets et al., 1988). Moreover, the data of Experiment 2 also showed that in contrast to Experiment 1, all children who had failed to learn the task under the Nonmatching P− condition learned the task under the Matching P− condition with a minimum of trials and without making any error. Although it is possible that these children were more task oriented or advanced than their counterparts in Experiment 1, the unrelated P− may have guided the attention to the location of the critical element of the S− which is more than no guidance at all.

Previous research suggests that it is easier to devise procedures that produce transfer than to identify conditions necessary for transfer (Touchette & Howard, 1984). An even more difficult enterprise may be to uncover how these conditions produce transfer. The present study succeeded in identifying one of these conditions. It did not identify how the P− contributed to transfer. Additional research is needed to better understand the flow of events that constitute transfer of stimulus control. First, more information is needed on the breadth of transfer. Was transfer restricted to one set of stimuli (i.e., from the P+ prompt to the S+) or did it occur in both sets (i.e., also from the P− to the S−)? If double transfer occurred, how did the transfer across negative stimuli (from the P− to the S−) contribute to the transfer across positive stimuli (from the P+ to the S+)?

Second, anecdotal observations suggested that an adequate account of transfer requires a more accurate and comprehensive description of task-related responses such as visual scanning (e.g., Stella and Etzel, 1979, 1986) and the locus of pointing responses (e.g., Lipsitt, 1961; Murphy & Miller, 1959; Weise & Bitterman, 1951). The experimenter observed that visual scanning could occur before the onset or near the completion of the pointing responses. In the latter case, scanning typically occurred when incorrect pointing responses were made. The experimenter noted that just before completing these responses, the subjects came to a momentary halt, looked at both stimuli and then, instead of pointing to the other stimulus (S+), searched for and subsequently pointed to an element of the S− of the same shape (line, angle) and about the same orientation (oblique) and location (near the bottom) as the distinctive element of the S+. The experimenter also observed that some subjects pointed consistently to the center of the stimuli. Other subjects consistently pointed to the correct and/or incorrect elements (lines, angles) of the stimuli or pointed to the center when preempting the prompts while pointing to the critical feature in the presence of the prompts. Although these individual differences were probably also controlled by other variables (e.g., the reinforcement history during pretraining assessment), a detailed analysis of the (visual, manual) responses would be functional for making a more accurate and valid assessment of the adequacy of the prompts and the process of transfer. The variations and shifts of the locus of response may also call for a differentiation between lack of transfer and restricted transfer. As has been implied above, some subjects who did not reach or had difficulties reaching criterion performance frequently pointed to a feature (line, angle) of either stimulus (S+, S−) very similar in orientation and location to that of the critical feature of the S+. These observations suggest that (a) the task required transfer of at least two stimulus dimensions, shape *and* orientation, and (b) for some subjects, the progressively delayed presentations of the prompts might have been sufficient to learn to respond to the programmed dimension (shape) but not to the equally important nonprogrammed dimension (orientation) of the critical element. Similar observations were made in a previous study on fading in which transfer sometimes occurred to other than the programmed features of the task stimuli (Smeets, Lancioni, & Hoogeveen, 1984b). Referenced and other related questions are currently under investigation.

REFERENCES

Aeschleman, S. R., & Higgins, A. F. (1982). Concept learning by retarded children: A comparison of three discrimination learning procedures. *Journal of Mental Deficiency Research*, **26**, 229–238.

Bradley-Johnson, S., Sunderman, P., & Johnson, C. M. (1983). Comparison of delayed prompting and fading for teaching prschoolers easily confused letters and numbers. *Journal of School Psychology*, **21**, 327–335.

Brown, C. H., & Rilling, M. H. (1975). Stimulus delay and the reduction of errors in the transfer of stimulus control. *Animal Learning and Behavior*, **3**, 21–27.

Egeland, B. (1975). Control by stimulus features during fading. *Journal of Applied Psychology*, **60**, 533–536.

Etzel, B., & LeBlanc, J. (1979). The simplest treatment alternative: The law of parsimony applied to choosing appropriate instructional control and errorless learning procedures for the difficult to teach child. *Journal of Autism and Developmental Disorders*, **9**, 361–382.

Guralnick, M. J. (1975). Effects of distinctive feature training and instructional technique on letter and form discrimination. *American Journal of Mental Deficiency*, **80**, 202–207.

Koegel, R. L., & Rincover, A. (1976). Some detrimental effects of using extra stimuli to guide learning in normal and autistic children. *Journal of Abnormal Child Psychology*, **4**, 59–71.

Lancioni, G. E., & Smeets, P. M. (1986). Procedures and parameters of errorless discrimination training with developmentally impaired individuals. In N. R. Ellis and N. W. Bray (Eds.), *International review of research in mental retardation* (Vol. 14, pp. 135–164). New York: Academic press.

Lipsitt, L. B. (1961). Simultaneous and successive discrimination learning in children. *Child Development*, **32**, 337–347.

MacCandless, Etzel, B. C., & LeBlanc, J. M. (1986, May). *The delayed prompt with complex discriminations*. Paper presented at the Association of Behavior Analysis Convention, Milwaukee, WI.

McDonall, J., & Marcucella, H. (1976). Cross-modal transfer of stimulus control in the albino rat: A stimulus delay procedure. *Animal Learning and Behavior*, **4**, 341–346.

Murphy, J. V., & Miller, R. E. (1959). Spatial contiguity of cue, reward, and response in discrimination learning by children. *Journal of Experimental Psycholgy* **6**, 485–489.

Rincover, A. (1978). Variables affecting stimulus fading and discrimination responding in psychotic children. *Journal of Abnormal Psychology*, **87**, 541–553.

Saunders, R. R., & Spradlin, J. E. (1985, May). *A systematic analysis of transfer of control in the delayed prompt procedure*. Paper presented at the Association of Behavior Analysis Convention, Columbus, OH.

Schreibman, L. (1975). Effects of within-stimulus and extra-stimulus prompts on discrimination learning in autistic children. *Journal of Applied Behavior Analysis*, **8**, 91–112.

Schreibman, L., Charlop, M. H., & Koegel, R. L. (1982). Teaching autistic children to use extra-stimulus prompts. *Journal of Experimental Child Psychology*, **33**, 475–491.

Schwartz, S. H., Firestone, I. J., & Terry, S. (1971). Fading techniques and concept learning in children. *Psychonomic Science*, **25**, 83–84.

Smeets, P. M., & Lancioni, G. E. (1981). The efficacy of three procedures for teaching easy and difficult discriminations in severely retarded adolescents. *Behavior Research of Severe Developmental Disabilities*, **2**, 191–201.

Smeets, P. M., Lancioni, G. E., & Hoogeveen, F. R. (1984a). Using stimulus shaping and fading to establish stimulus control in normal and retarded children. *Journal of Mental Deficiency Research*, **28**, 207–218.

Smeets, P. M., Lancioni, G. E., & Hoogeveen, F. R. (1984b). Effects of different stimulus manipulations on the acquisition of word recognition in trainable mentally retarded children. *Journal of Mental Deficiency Research*, **28**, 109–122.

Smeets, P. M., Lancioni, G. E., & Striefel, S. (in press). Discrimination training through time-delay of multi-stimulus prompts: The shapes and locations of the prompts. *The Psychological Record*.

Smeets, P. M., Lancioni, G. E., Striefel, S., & Curfs, P. G. M. (1988). Establishing a difficult discrimination through time-delay: Some critical dimensions of prompts. *Journal of Experimental Child Psychology*, **45**, 280–302.

Spradlin, J. E. (1985, May). *A systematic analysis of transfer of control in the delayed prompt procedure*. Paper presented at the Association of Behavior Analysis Convention, Columbus, OH.

Stella, M. E., & Etzel, B. C. (1979, April). *Manipulation of visual orientation on correct (S+) stimuli during acquisition*. Paper presented at the Meeting of the Society for Research in Child Development, San Francisco, CA.

Stella, M. E., & Etzel, B. C. (1986). Stimulus control of eye orientation: Shaping S+ only versus shaping S− only. *Analysis and Intervention in Developmental Disabilities*, **6**, 137–153.

Touchette, P. (1971). Transfer of stimulus control: Measuring the moment of transfer. *Journal of the Experimental Analysis of Behavior*, **15**, 347–354.

Touchette, P. E., & Howard, J. S. (1984). Errorless learning: Reinforcement contingencies and stimulus control transfer in delayed prompting. *Journal of Applied Behavior Analysis*, **17**, 175–188.

Weise, P., & Bitterman, M. E. (1951). Response selection in discrimination learning. *Psychological Review*, **8**, 185–195.

Wolfe, V. F., & Cuvo, A. J. (1978). Effect of within-stimulus and extra-stimulus prompting on letter discrimination by mentally retarded children. *American Journal of Mental Deficiency*, **83**, 297–307.

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