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ERRORLESS LEARNING: REINFORCEMENT CONTINGENCIES AND STIMULUS CONTROL TRANSFER IN DELAYED PROMPTING

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Delayed prompting can produce errorless discrimination learning. There is inherent in the procedure a disparity in reinforcement density which favors unprompted over prompted responses. We used three schedules of reinforcement to investigate the impact of reinforcement probability on transfer of stimulus control. One schedule of reinforcement was equal prior to and following a prompt (CRF/CRF), the second favored unprompted responses (CRF/FR3), and the third favored responses following the prompt (FR3/CRF). Experimental questions concerned the probability of errors, the probability of transfer, and the rate of transfer in the context of delayed prompting. Transfer was accelerated when reinforcement probability favored anticipatory responding. The schedule that favored prompted responses did not prevent a shift to unprompted responding. Errors were infrequent across procedures. Reinforcement probability contributes to but does not entirely determine transfer of stimulus control from a delayed prompt.

DESCRIPTORS: fading, delay, prompts, schedules of reinforcement, retarded students

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To prompt an appropriate response, teachers of the handicapped routinely model a correct response, point to the correct choice, provide an added verbal stimulus, or use materials in which the correct choice is distinctive by virtue of its location, size, or color. Prompting is the substitution of an effective but inappropriate stimulus for an ineffective but appropriate one. Prompts are stimuli that control the desired behavior, but that are not functionally related to the task. Unfortunately, it is often the case that students who respond appropriately when prompted, founder when the prompt is removed. They evidence persistent dependence on stimuli not intrinsic to the task. Once correct responding has been initiated by prompting, the teacher's task is to maintain the response pattern while eliminating the prompt(s). Transfer of stimulus control from prompt to task-related stimuli is expected and relied on in virtually all instruction that uses stimuli extrinsic to the final performance.

Premature removal of a prompt can initiate persistent incorrect response patterns which preclude acquisition of the target repertoire (Sidman & Stoddard, 1966; Touchette, 1968). On the other hand, unnecessarily extended presentation of prompts may foster dependence in the form of persistent selective attention to stimuli supplied by the teacher. Applied research has not yet resolved the question of how to produce a successful transition from prompted to unprompted responding.

An ideal transition from prompted to unprompted responding will result in few or no errors. An error-free transition from instructional support to unassisted competence can be very important for the severely handicapped learner. Terrace (1966, pp. 316–317) noted that pigeons that were taught a discrimination by differential reinforcement emitted agitated, emotional behavior whereas pigeons that were taught the same discrimination without errors were calm and attentive. Informal observations and formal research suggest that the demands of learning by trial and error can provoke problem behavior including apathy, tantrums, aggression,

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and self-injury, sometimes severe (Carr, Newsom, & Binkoff, 1980; Weeks & Gaylord-Ross, 1981). Effective instruction demands an understanding of factors that encourage the emergence of appropriate stimulus control during training.

If a prompt is a stimulus that reliably controls a response, then the emergence of control by another stimulus associated with the prompt can be described as a transfer of control (Terrace, 1963; Touchette, 1971). There is an analogy between the transfer of stimulus control and the emergence of an operant response. In both cases the first instance can be encouraged by arranging the student's environment and history of reinforcement to improve the likelihood that the desired entity will emerge. Its occurrence, however, cannot be guaranteed. This topic has been discussed in depth by Skinner (1968, pp. 206–208) and by Ray and Sidman (1970, pp. 193–194). Applied practitioners have recourse to few options when they are faced with what Skinner called "the problem of the first instance." Data currently available are not sufficient to allow the selection of the best approach.

In this study, we examined the impact of schedules of reinforcement that would be expected to encourage and discourage the transfer of control from prompts to task-related stimuli. Reinforcement can and usually does maintain a stimulus-response relationship that already exists. It is less clear what influence reinforcement may have on the establishment of new stimulus-response relations or the transfer of control from prompts to task-related stimuli (Huguenin & Touchette, 1980).

Describing the conditions necessary to the transfer of stimulus control has been a more difficult task than devising procedures that produce transfer. To evaluate the impact of reinforcement on transfer it is necessary to use a paradigm that allows direct measurement of the point at which transfer occurs. Fading can produce errorless transfer of stimulus control, but the point of its occurrence is obscured. The string of correct responses that accompanies a successful fading procedure provides no information as to the point at which task-intrinsic stimuli acquired control. In contrast, delayed prompting (Touchette, 1971) can produce errorless learning and reveal the point of transfer. This technique allows the evaluation of differential consequences applied to prompted and unprompted responses.

In delayed prompting the discriminative stimuli are presented at the beginning of a trial. A prompt is provided after a delay. Responses occurring after the delay are presumed to be under the control of the added prompt. Response latencies shorter than the delay provide an indication that stimulus control has shifted from the prompt to the discriminative stimuli that precede it. There can be a substantial variation in reinforcement density per unit of time, dependent on whether correct responses precede or follow a delayed prompt. It is reasonable to postulate that an increase in reinforcement density, which results when correct responses anticipate the prompt, is a critical variable in producing and maintaining transfer of stimulus control.

An analysis of procedural variables that affect transfer of stimulus control during errorless discrimination learning presents special problems in experimental design. More than one discrimination must be acquired under each condition to eliminate the possibility that the discriminative stimuli are the source of any variation observed. Rate of learning must then be determined within individuals. As is customary, this study includes a pretest to verify that each discriminative performance learned was not already in the student's repertoire. Evaluating the impact of the schedule of reinforcement on the point of stimulus control transfer requires a different reference. Uniform reinforcement of prompted and unprompted correct responses was used to teach a number of successive discriminations. These training sessions provided a referent for comparing the rate of learning under two disparate schedules of reinforcement subsequently used.

The experimental questions addressed here have both applied and theoretical significance. Will an exaggerated discrepancy in reinforcement probability favoring anticipatory responding produce more expeditious transfer? Conversely, will transfer be prevented if reinforcement density is higher for responses following a prompt? Is the probability of errors affected by the schedule of reinforcement? Are there uniform effects across severely retarded individuals?

METHOD

Students

Three students who had been diagnosed as severely retarded and who attended an educational center for multiply-handicapped children participated in this study. All were able to follow one-step verbal instructions such as "put your hands on the table" and "touch your nose."

Student 1 was 6-year-old boy with a Cattel estimated mental age of 2 years, 6 months. His verbal repertoire included some mands, tacts, and intraverbals. He could follow a few familiar two-step commands in the context of daily events, e.g., "go to the door and wait for me." He occasionally displayed self-abusive and aggressive behavior.

Student 2 was a 13-year-old girl diagnosed as having cerebral palsy and severe mental impairment. Her Leiter estimated IQ was 55. She had a very limited verbal repertoire, and she could not follow commands involving more than a single element. She was cooperative and displayed no deviant or disturbed behavior.

Student 3 was a 7-year-old boy whose Leiter estimated IQ was also 55. He could follow a few one-step commands in a familiar context. He was nonvocal, emitted unintelligible sounds, and communicated primarily through gestures. He was cooperative and displayed no deviant behavior in the educational center.

Setting

Data were collected at the training center that the students attended daily. The students sat in the work area to which they were normally assigned for instruction. Experimental sessions took place during school hours with other students present. The experimenter sat facing the student across a table set at a convenient height.

Training sessions were conducted 5 days a week and lasted for 20 to 30 minutes each. Tokens acquired during each training session were exchanged for a variety of toys, activities, and edible treats when a student had collected six tokens.

Discriminative Stimuli

All three students were taught developmentally appropriate visual discriminations. Four stimulus cards were placed before the students on each trial. The experimenter then instructed them to touch the card that had been designated S+. For example, a student might be shown cards containing the letters M, B, U, and L and instructed "point to B." The student then chose from among the four stimuli by touching a card. The positions of the S+ and three S− stimuli were varied unpredictably on each trial. Criterion for mastery of each discrimination task was nine correct unprompted responses within 10 consecutive trials in a single session.

Student 1 was presented with four letters of the alphabet on each trial. The letter designated S+ was held constant until it had been learned. Letters were assigned to three groups taking into account that each group should contain no two letters especially liable to visual confusion. For example, "M" and "W," "Q" and "O" were placed in different groups. Student 2 was more advanced, and was therefore taught to discriminate 19 four-letter words selected from the Popper word series and assigned to three groups as above. Student 3 learned to discriminate letters and numerals. Table 1 presents the stimuli used with each student during each of the three conditions of reinforcement.

The students were first taught to select a single stimulus within a group, with other stimuli in the group serving as S−. After the student was able to reliably select the first group member, that stimulus then served as S− during subsequent training on a random basis. No stimulus ever served as S− in a training condition other than the one to which it was originally assigned. The stimulus groups remained intact throughout training. Stimuli from one group were not interchanged with members of

Table 1

Training Stimuli and Schedules of Reinforcement in Effect

	Condition A (CRF/CRF)
S1	M B U T X L A Z
S2	long this good like cold from some
S3	M B U T L Z
	Condition B (CRF/FR3)
S1	S H K I O W P E G
S2	down ride away walk call play
S3	S H K O G V 4 5 7
	Condition C (VR3/CRF)
S1	N Q Y D F C R V J
S2	come make look jump stop help
S3	N Q Y D F R J 3 2 8

another group. A group of stimuli corresponded to each of the training conditions (see Table 1).

Pretest

Before each training condition the stimuli were presented to each student to determine whether or not the discriminations had already been learned. Four trials with each stimulus were presented. None of the students performed above the 50% level with any of the words, letters, or numerals. During pretest trials correct responses were reinforced with a token and verbal confirmation. Errors produced only the next trial. To ensure appropriate attention, these trials were interspersed with discrimination tasks already in the student's repertoire (e.g. "touch your ear"). Correct responses to these baseline tasks received verbal confirmation.

Schedules of Reinforcement

The independent variable in this study was the schedule of reinforcement provided for each of two classes of responses: (a) correct responses occurring prior to the prompt and (b) correct responses coinciding with or occurring after the prompt. Plastic tokens were delivered contingent on correct responses. Food, toys, and special privileges served to maintain the reinforcing function of the tokens. The three schedules of reinforcement were as follows.

Condition A. Correct responses both before and after the prompt were reinforced on a continuous reinforcement schedule (CRF/CRF).

Condition B. Correct responses that occurred before the prompt were reinforced on a continuous schedule while responses following the prompt were reinforced on a fixed ratio of 3 (CRF/FR3).

Condition C. Correct responses that occurred before the prompt were reinforced on a fixed ratio of 3 and responses after the prompt on a continuous schedule of reinforcement (FR3/CRF).

General Procedure

A trial began when the experimenter gestured toward the array of four stimulus cards and said "look here." When the student looked toward the cards, the experimenter said "point to (letter or word)." Initially, the experimenter pointed to the correct card simultaneously with the verbal instruction to point to the letter or word. Tokens were delivered according to the reinforcement schedule in effect. All correct responses throughout the study were followed by a verbal confirmation "right" or "good." Four consecutive correct responses produced a 0.5-second increase in the delay between the verbal instruction and the prompt, up to a maximum of 5 seconds for Students 1 and 3, and 8 seconds for Student 2. Student 2 was permitted a longer delay because of her poor fine motor coordination.

If the student did not respond before the predetermined delay, the experimenter pointed to the correct card. If the student made a response before the delay was reached, the prompt was not delivered on that trial. Incorrect responses always received the same consequence. The experimenter said "no," removed the cards from the desktop, and looked away from the student for 10 seconds. Two consecutive incorrect anticipations resulted in the delay being decreased to the shorter of the latencies emitted by the student in these two trials. Subsequent correct responses produced an increase in the delay value of 0.5 until the value at which the errors occurred was equaled. The increment rule previously in effect was then reinstated, and four consecutive correct trials were required to increase the delay value 0.5 seconds. The delay following errors was reduced to reinstate appropriate stimulus control, because the purpose of this study was to assess the impact of schedules of reinforcement on the transfer of control from an essentially error-free baseline of prompted responses. Criterion for mastery of each discriminative performance was nine correct, unprompted trials out of 10 within a single session. Figure 1 contains a flowchart of events during a training session.

The 0.5-second delay increment was chosen originally (Touchette, 1971) because it provided several exposures to the prompt prior to the delay value exceeding the student's normal response latency. In a nonautomated field setting, a half second is the smallest interval value that an experimenter or teacher can use. The presence of auditory or visual time signals offered a potential distraction to both the teacher and student. Prior to the study the experimenters practiced with a stopwatch until accurate 1-second counts were achieved using the familiar silent verbal aid "one Mississippi, two Mississippi . . ." This covert verbal pacing aid was the basis for timing the delivery of the prompt. Keeping track of a half second was achieved by acting before the verbal pacing aid was completed. The 0.5-second unit occurs only once during the final count of odd valued delays. It does not occur at all in even valued delays.

To increase the probability of the students' discriminating the several schedules of reinforcement, the color of the mat on which the cards were placed, the background color of the cards themselves, and the color of the tokens dispensed were changed for each condition.

Condition A (CRF/CRF) exemplifies the most common version of delayed prompting where the probability of reinforcement is equivalent whether a correct response precedes or follows the prompt. Acquisition under condition A served as a standard for comparing the relative efficacy of condition B, which favored anticipatory responding, and condition C, which favored responding following the prompt. All the stimuli assigned to condition A were learned first by all students. Following acquisition of six to eight condition A discriminations, stimuli associated with conditions B and C were presented in alternation. Acquisition of discriminations under each of these two experimental conditions went on simultaneously. This approach allowed evaluation of conditions B and C in a within-subjects design with minimal contamination as a result of sequence. This type of design has been called "multielement" (Sidman, 1960; Ulman & Sulzer-Azaroff, 1975) or "alternating treatments" (Barlow & Hayes, 1979).

Random order test. Following acquisition of all discriminations associated with a particular schedule of reinforcement, a test was conducted to determine whether the verbal stimuli spoken at the outset of each trial had acquired control over the student's card selection. The S+ stimuli were the letters, words, or numerals learned under the prevailing contingency of reinforcement. The stimulus designated S+ was now changed on every trial. To be correct, students had to respond on the basis of the name of the stimulus spoken by the experimenter. This requirement was not in force during original training where a single stimulus remained as S+ until criterion was reached. The contingencies in effect during test trials were the same as those during criterion trials with the following exception. The delay value was not shortened following an incorrect response nor was the trial presented again. The pointing prompt was presented if the student failed to respond prior to the maximum delay value permitted for that student during training (5 seconds for Students 1 and 3, 8 seconds for Student 2). Each discriminative stimulus in the group was presented five times in a randomized sequence of 20 trials.

Generalization test. When all three sets of discriminative stimuli under all three contingencies of reinforcement had been acquired, a generalization test session was conducted. Reinforcement contingencies, card color, mat, and tokens for the generalization session were those that had been present during baseline condition A (CRF/CRF). This meant that discriminative stimuli learned under conditions B and C were presented with colored cards, mats, and tokens different from those in training. Any one of these changes might have been sufficient to disrupt performance, even though

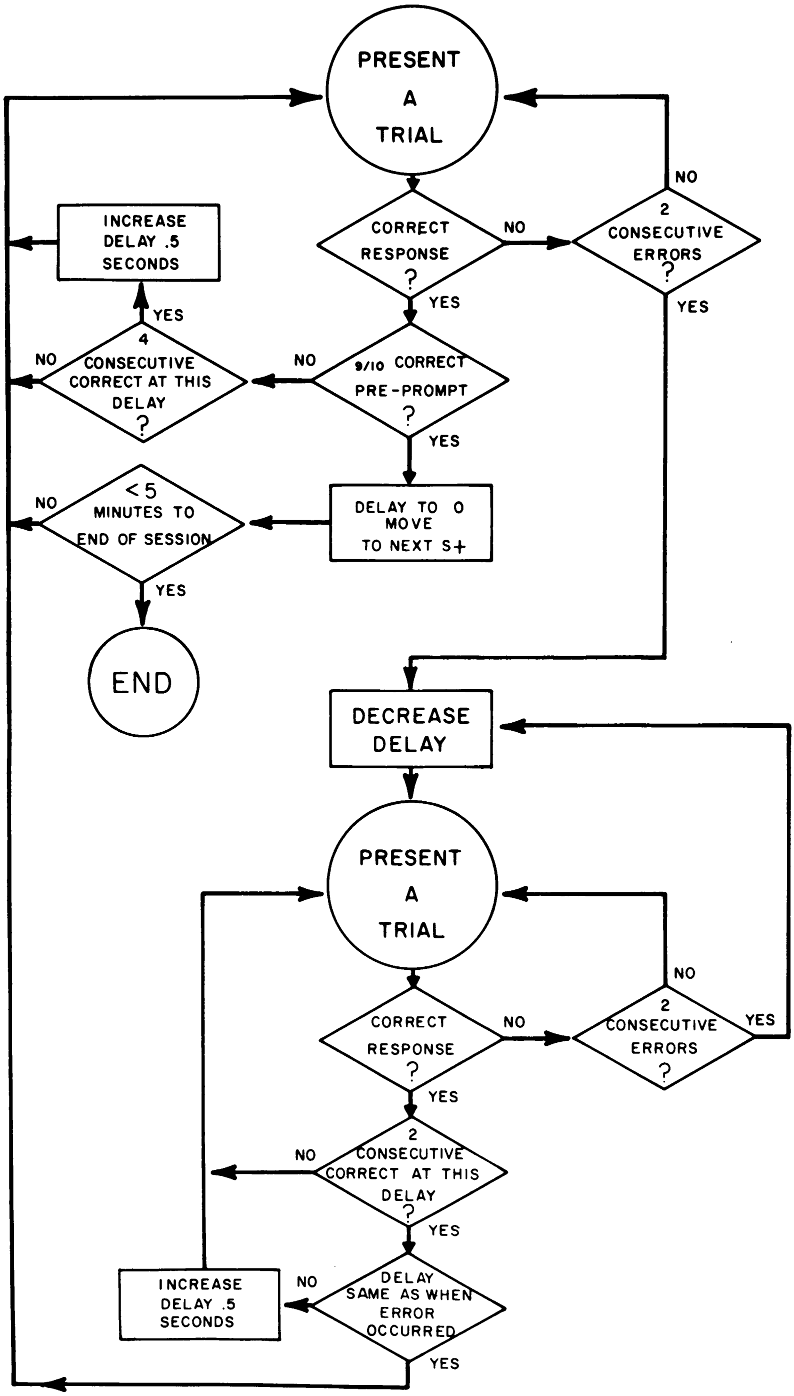

Figure 1. Flowchart analysis of a training session.

the stimuli changed were not directly relevant to the discrimination. Changing all three elements simultaneously was most likely to decrease accuracy. In addition, all three groups of stimuli were combined so that some or all of the S− stimuli on each trial had never previously been seen in combination with the S+ presented. Each stimulus served as S+ three times during the session. The prompting conditions in effect were the same as those for the random order test.

Data Collection and Reliability

The data collected on each trial specified the type of response as follows: (a) correct preprompt, (b) incorrect preprompt, (c) correct postprompt, (d) incorrect postprompt. Responses coinciding with the moment of prompting were treated as postprompt responses, but were identified in the data record as simultaneous.

Reliability checks occurred approximately once every 15 sessions. To ensure independence of observation, the experimenter did not consequate the child's responses during reliability checks until the second observer silently signaled that the response had been recorded. One of the four response categories inevitably occurred on each trial. Agreements were trials in which both experimenter and observer identified the outcome as falling in the same category. Disagreements were trials in which observer and experimenter recorded different categories. Percentage agreement equaled the total agreements divided by the sum of agreements plus disagreements multiplied by 100. Interobserver reliability ranged from 88% to 100% over 11 reliability check sessions involving all three students. The overall mean was 94.5%.

RESULTS

Accuracy During Training

All three students responded at high levels of accuracy across experimental conditions. Students' mean correct responses across conditions A, B, and C, respectively, were as follows: Student 1—91%, 97%, 92%; Student 2—99%, 89%, 100%; Student 3—98%, 99%, 99%. Overall response accuracy averaged 96% and was uniformly high. Variation was insufficient to reveal any functional relationship between the accuracy of responding and the contingencies of reinforcement in effect.

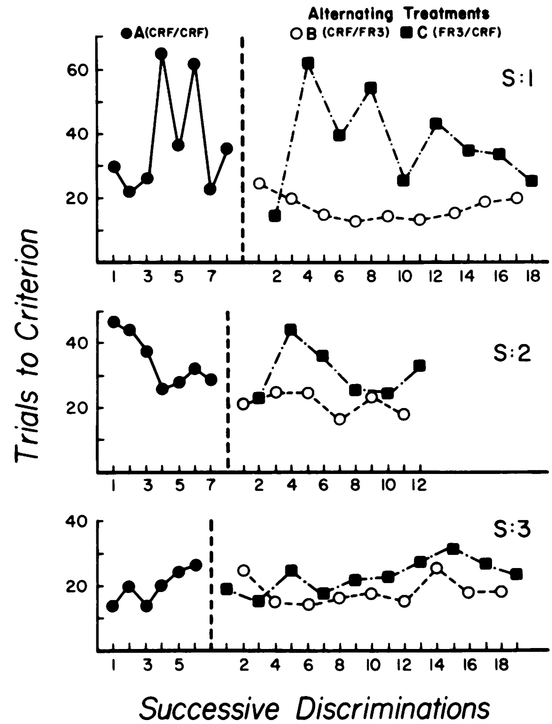

Figure 2. Trials to criterion under the three experimental conditions. Each point represents a discrimination taught.

Trials to Criterion

Figure 2 shows the number of trials to criterion for each discrimination, by student. Student 1 averaged 37 trials to criterion (range = 22–65) during condition A (CRF/CRF). During condition B (CRF/FR3) he averaged 17 trials (range = 14–25). In condition C (FR3/CRF) his average was 38 (range = 15–62). Student 2 presented a similar pattern with an initial average of 35 during condition A (range = 26–47). Her average during condition B was 21 (range = 17–25). Condition C produced an average of 31 trials to criterion (range = 23–44). Student 3 produced a more uniform result. During condition A he averaged

20 trials to criterion (range = 17–27). During condition B his average was 18 (range = 14–25). During condition C his average was 23 (range = 15–31).

These data reveal that fewer trials were required to reach criterion during condition B (CRF/FR3) for all three students. There is, however, some overlap in all cases. For Student 3 the difference between conditions B and C is minimal. It is interesting to note that condition B reduced the number of trials to criterion relative to condition A for Students 1 and 2, but there was a failure of reciprocity. In no case did condition C (FR3/CRF) prolong acquisition relative to condition A (CRF/CRF). Student 3 acquired discriminations in all three conditions at near the minimal (14) number of trials to criterion. A criterion run required 10 trials, and the first four trials were prompted at zero delay precluding correct responses in anticipation of the prompt. For this student, condition A produced an intermediate value with condition B slightly lower and C slightly higher. The trends here are the same as those for Students 1 and 2 but the variation is so small as to suggest no important difference among the three conditions.

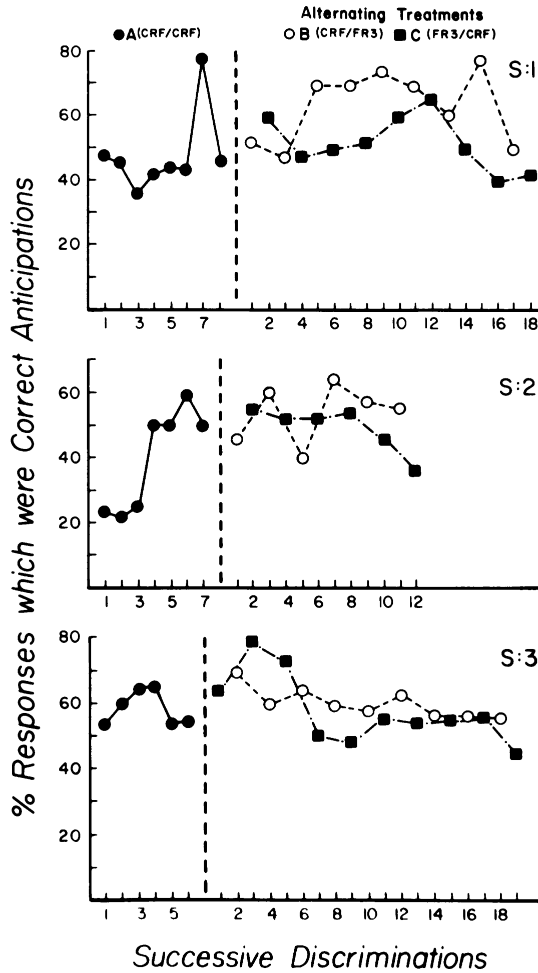

Figure 3. Percentage of responses that were correct anticipations under the three experimental conditions.

Preprompt Responses

Given the overall high percentage of correct responses, the remaining issue of interest is the proportion of those responses that preceded and followed the prompt. The number of correct anticipatory responses was limited by the criterion for acquisition. Large numbers of correct preprompt responses could occur only if a mixture of pre- and postprompt responses persisted long after the initial appearance of anticipatory responding. Such was not the case. There was no major difference in the scatter of anticipatory responses across treatments. Figure 3 shows that Student 1 exhibited a comparable proportion of preprompt responses during conditions A and B, with a larger proportion during condition C. Students 2 and 3 showed little difference across conditions. Inspection of these data reveals overlapping distributions, suggesting no clinically important difference among the three contingencies. There is only a weak suggestion that condition C (FR3/CRF) lowered the probability of anticipatory responses, despite a 3 to 1 disparity in reinforcement probability favoring postprompt responses.

Responses following or simultaneous with the presentation of the prompt were classified as prompt controlled. In the absence of any significant number of errors, prompt-controlled responses necessarily constitute the inverse of preprompt responses. The observations stated earlier therefore apply to this class of responses as well.

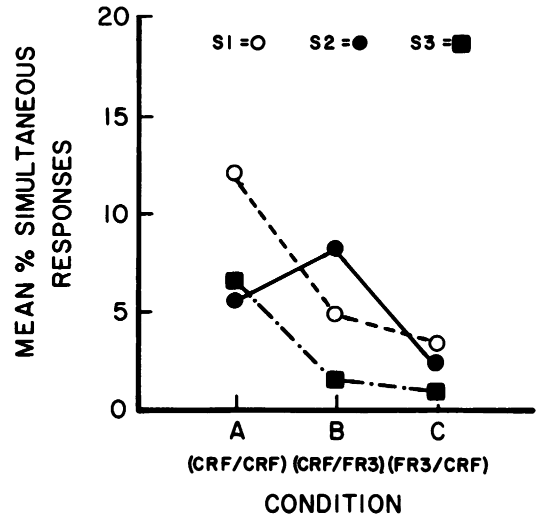

Figure 4. Mean percentage of responses occurring simultaneous with the presentation of the prompt, under conditions A, B, and C.

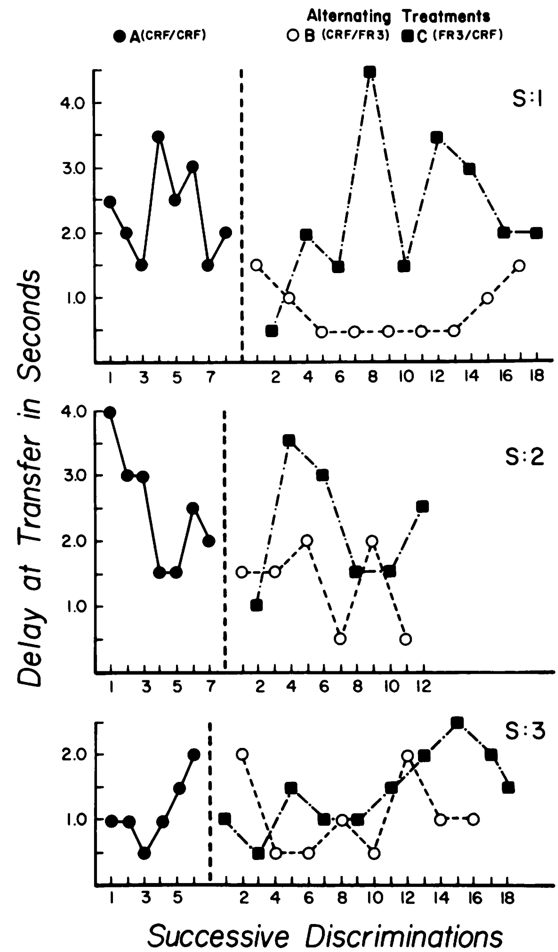

Figure 5. The delay in effect on the first of the 10 consecutive trials that defined the transfer of stimulus control under conditions A, B, and C.

Simultaneous Responses

Correct responses that occurred in very close proximity to the delivery of the prompt were treated as prompt controlled, in terms of consequences, but were recorded separately as simultaneous responses. It is impossible to determine whether these responses were emitted in response to the early stages of the teacher's prompt or on the basis of the discriminative stimuli alone. Figure 4 shows that simultaneous responses were infrequent, ranging from 1.3% to 12% with an overall mean of 5% and a mean of less than 4% during conditions B and C.

Delay in Effect at Transfer

Figure 5 shows the delay values in effect during the first of the 10 consecutive trials that defined the transfer of stimulus control. For Student 1, delay values at which transfer series were initiated were much lower during condition B than during conditions A or C. Condition C (FR3/CRF) produced the greatest variability. Students 2 and 3 again exhibited overlapping distributions with initiation points generally lowest during condition B (CRF/FR3). It is interesting to note that Student 2's delay value never approached the maximum (8 s), an unexpected outcome in view of her substantial movement impairment. Data collected prior to this study, using familiar objects as discriminative stimuli, suggested that minimum response latencies for this student were between 3 and 4 seconds. Student 3 anticipated at delays of 2 seconds or less in all but one instance. There is heavy overlap in Student 3's data across conditions A, B, and C.

Table 2
Percentage of Correct Responses During Post Acquisition Tests

	Verbal control test			Generalization test		
	A (%)	B (%)	C (%)	A (%)	B (%)	C (%)
S1	68	64	93	74	78	96
S2	86	90	90	80	90	97
S3	10	60	20	06	41	32

Testing for Verbal Control and Generalization

In verbal control tests the stimulus designated correct was changed on every trial, making it necessary for the child to respond on the basis of the experimenter's naming the correct choice. Test sessions included all of the discriminative stimuli taught under one of the three experimental conditions. Generalization sessions used stimuli from all three conditions ignoring the groupings in which they were originally taught. This meant that the discriminative stimuli were juxtaposed with novel S− stimuli. The question was whether accurate responding would persist when the stimulus presentations were not exactly as they had been during training. The percentages of correct preprompt responses during both types of sessions are shown in Table 2. The data are virtually idiosyncratic. Each of the students tested produced a different pattern of competency. Student 2 alone responded with high (80% or above) accuracy across all tests. Student 1 was uniformly above chance, but performed with high accuracy only with group C stimuli. Student 3 achieved accuracy above 50% only with group B stimuli. All three students designated familiar objects named by the experimenter during pretesting. This skill was uniformly present across students. Learning of auditory-visual correspondences during the study, however, was not uniform. Student 3 learned little or nothing, Student 2 learned nearly everything, and Student 1 fell in between. All three displayed similar profiles of accuracy at the end of training under the generalization test conditions.

DISCUSSION

A disparity in reinforcement density is inherent in delayed prompting. Unprompted responses are closer to the trial initiation, and prompted responses can occur only after the delay has timed out. This means that when the schedule of reinforcement is the same for prompted and unprompted responses, the actual density of reinforcement over time is higher when a response precedes the prompt. Instead of waiting for the prompt, the student can respond right after a trial has been initiated and get reinforced a lot sooner. The disparity can be very large when long delays are used. Delay values have ranged as high as 30 seconds in laboratory studies (Touchette, 1971) but shorter delays are typically used in clinical applications, as they were in this study.

Something about inserting a delay prior to the presentation of a prompt encourages transfer of stimulus control. It is not yet clear whether the delay of reinforcement that accompanies post-prompt responding is responsible for transfer or whether the shift in control is provoked by a pairing of prompt and task stimuli, which approximates the Pavlovian paradigm (Denny & Adelman, 1955; Johnson, 1981). If contrast in reinforcement density provokes transfer, the rate of transfer should be sensitive to manipulations of contingencies that alter reinforcement density. On the other hand, reinforcement might serve only to maintain responding. If reliable sequential pairing of task stimuli and prompt is sufficient to provoke a shift in stimulus control, we would expect altered reinforcement contingencies to have limited impact on the rate of transfer.

In this study, we compared the impact of three schedules of reinforcement on rate of transfer and frequency of errors during discrimination learning by delayed prompting. One schedule (CRF/CRF) was a standard for comparison, representing the most commonly used parameters of equal consequences for correct responses preceding and following a prompt. The second schedule (CRF/FR3) exaggerated the disparity of reinforcement in favor of correct responses prior to the prompt. The third schedule of reinforcement (FR3/CRF) provided a higher probability of reinforcement for responses following the prompt. The discriminative stimuli, instructional prompts, and setting were appropriate to the behavioral ecology of severely handicapped adolescents.

The first question was whether learning would occur under all three schedules and whether errors would or would not occur. Surprisingly, all three experimental conditions produced successful transfer from the visual prompt (teacher's pointing) to the discriminative stimuli (cards containing letter, words, or numbers), and error rates were uniformly low. Students 1, 2, and 3 were correct on more than 90% of all trials across conditions. Altered contingencies of reinforcement affected the tendency to wait for or anticipate a prompt in some cases, but they did not significantly alter the probability of error. This finding is an important one because low error rates are highly desirable in teaching the learning handicapped (Reese, Howard, & Rosenberger, 1977; Sidman & Stoddard, 1966; Touchette, 1968), and a procedural variant that traded earlier transfer for more errors would be contraindicated.

Was there any difference in how quickly transfer occurred? Figures 2 and 5 indicate that condtion B, which favored anticipatory responding (CRF/FR3) produced earlier transfer from prompt to task stimuli in Students 1 and 2. Student 3 also tended to initiate anticipatory responding earlier when the CRF/FR3 schedules were in effect, but the difference was so small as to be of no practical importance. Student 1, who was the slowest to anticipate under the equal probability schedule (condition A), was the most dramatically affected when contingencies favored anticipatory responding (condition B). Student 2 also required more trials to criterion and longer delays prior to transfer when the probability of reinforcement was equal and when contingencies favored waiting for the prompt (condition C). The impact of the disparate schedules was intermediate for Student 2. She was more dramatically affected than Student 3, but less so than Student 1. Student 3 had the fewest trials to criterion, and transferred most rapidly under condition A. His pattern of transfer was minimally affected by conditions B and C. Student 3 showed the same tendencies as the other two individuals. He transferred most rapidly when contingencies favored responses preceding the prompt, and he transferred a bit more slowly when contingencies favored responses following the prompt.

The rate of transfer can be accelerated by disparate response consequences favoring responding before the prompt. In order for improvement to occur, however, there must be room for that improvement. Student 3 learned rapidly and efficiently under condition A and could therefore improve very little under condition B. Students 1 and 2 learned less efficiently under condition A, and had more room for improvement. It was surprising to find that the accelerated transfer under the CRF/FR3 schedule was not accompanied by an increase in "guessing" or incorrect anticipatory responses.

Some factors limiting the generality of these statements should be noted. The sample of subjects was small and not homogeneous, but this is typical of the severely handicapped. The sequence of experimental events was fixed, so that each student was initially exposed to the "traditional" procedure based on identical schedules of reinforcement. This provided a basis for comparing the conventional procedure's outcome with that of the two subsequent training conditions. Condition A, however, contaminated conditions B and C by giving all students an immediate prior history that might have been relevant. The results of procedures B and C show that condition B accelerated transfer, whereas condition C reversed this effect in an alternating treatments design. This outcome makes it clear that the differences between conditions B (CRF/FR3) and C (FR3/CRF) were not due solely to increased exposure to stimuli, procedures, or consequences.

Surprisingly, condition C produced acquisition data that strongly resembled those obtained during original training with nondisparate consequences. Considering only Students 1 and 2, where variability was evident, the number of trials to criterion during condition C averaged 34.5, and during condition A averaged 36.2. Student 3 transferred in a similar course regardless of the schedule of reinforcement. The failure of condition C to prevent or seriously inhibit transfer in any student suggests that reinforcement probability is only one factor influencing the course of discrimination learning by delayed prompting.

Condition B was superior in facilitating original discrimination learning, but condition C produced the best posttraining accuracy in Students 1 and 2. The mean numbers of trials to acquisition were virtually identical for conditions A and C, again ruling out greater exposure as an explanation for the verbal control test and generalization scores. Student 3 evidenced little control by any of the verbal stimuli during random order tests. This result was unanticipated, and it was not possible to carry out manipulations necessary to determine its origins post hoc.

All three students had previously evidenced some receptive language competence. Each had been tested, and was able to comply with simple requests involving familiar objects and body parts (e.g. "Hands down please, touch your shoe . . ."). They were under the control of common verbal stimuli at the outset of the study. The verbal requests that accompanied the visual discriminations established in the course of the study did not acquire reliable control of responding. This stimulus-response relation, not explicitly trained, was not spontaneously available. Few assumptions of incidental learning are reliably validated among the severely learning handicapped. Each individual must be tested to determine what, if any, learning has occurred beyond that which was programmed (Marholin & Touchette, 1979; Rincover & Koegel, 1975). Desirable controlling relations can emerge spontaneously following training of related discriminations (Sidman, 1971; Spradlin, Cotter, & Baxley, 1973) but most must be directly taught (Stokes & Baer, 1977). It has been suggested that generalization and incidental learning following errorless discrimination acquisition may be a special case (Terrace, 1964; Schilmoeller, Schilmoeller, Etzel, & LeBlanc, 1979). There are, however, only the most preliminary data available on this subject.

In addition to providing an observable indication of the transfer of stimulus control, current evidence suggests that many instructional goals can be achieved by inserting a delay prior to the delivery of stimulus that controls the behavior of interest. The objective of delaying the prompt is to shift control from stimuli supplied by the instructor to stimuli inherent in the task. The classroom is only one possible setting. Halle, Marshall, and Spradlin (1979) used a 15-second prompt delay to provoke verbalizations from severely retarded children waiting to be served at a lunch counter. They used the delay interval to bring behavior that they knew to be available to the trainees under the control of its natural precursors. Those authors emphasized the stimulus function of the delay interval, which constituted an avoidable time-out prior to being served lunch. It appears, however, that the delay of reinforcement is not exclusively responsible for stimulus control transfer in this paradigm. Practical applications of delayed prompting need not await a complete functional analysis of transfer among sequenced stimuli.

The essence of delayed prompting is that a stimulus that controls the response of interest (a prompt) is presented concurrently with the task-related stimuli. A delay is then interposed between the presentation of the task and the onset of the prompt. Stimulus materials do not appear to be critical and there is no need to develop elaborate, subtle, and sometimes unique graduated changes necessary to effective fading (Etzel, LeBlanc, Schilmoeller, & Stella, 1981). A number of studies have shown that this approach can teach useful discriminations to handicapped and young unimpaired children (Johnson, 1978; Smeets & Striefel, 1976; Stremmel-Campbell, Cantrell, & Halle, 1977; Striefel, Bryan, & Aikins, 1974; Striefel, Wetherby, & Karlan, 1976). Parametric studies have until now been conducted only with lower organisms (Brown & Rilling, 1975; MacDonall & Marcucella, 1976).

Etzel and LeBlanc (1979) suggested that fading is a more powerful instructional approach than delayed prompting. Although this may be the case, there is little evidence currently available one way or the other. A recent study by Bradley-Johnson, Johnson, and Sunderman (1983) failed to substantiate this assertion in teaching readily confused letter discriminations to preschool children. Each technique has been shown to produce errorless learning under some circumstances, and each should be considered as an alternative when the other fails.

The decision of whether to apply disparate or uniform consequences to pre- and postprompt responses is a practical one. This study shows that providing higher reinforcement probability for anticipatory responses can produce more rapid transfer of stimulus control. The drawback in application is that the procedure is more complex when different schedules of reinforcement apply to responses before and after the prompt. The alternative of using uniform consequences for all correct responses does not prevent or seriously retard transfer of stimulus control, although more trials and longer delays will result in some cases.

Students should be given an opportunity to respond prior to prompting (Hart & Risley, 1975; Halle, Baer, & Spradlin, 1981). We suggest that there is more to delayed prompting than offering an opportunity to respond. Pausing prior to delivering a prompt defers reinforcement of prompt-controlled behavior. We suggest that there is more to delayed prompting than a differential in reinforcement density favoring responses that precede the prompt. In this study, when the probability of reinforcement was three times as high for responses following the prompt, students still reliably shifted to responding prior to the prompt. This is a shift in stimulus control that occurred *despite* the schedule of reinforcement. It is reasonable to assert, given these data, that response consequences only partially determine the transfer of stimulus control in this paradigm. Transfer appears to be provoked whenever a suitable noncontrolling stimulus is reliably followed by a controlling stimulus.

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