An Analysis of the Role of Reinforcement Density in the Transfer of Stimulus Control in a Receptive Discrimination Task

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AN ANALYSIS OF THE ROLE OF REINFORCEMENT
DENSITY IN THE TRANSFER OF STIMULUS CONTROL IN
A RECEPTIVE DISCRIMINATION TASK

by

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Jane Stewart Howard

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INTRODUCTION

Procedures which facilitate the establishment of a specified stimulus-response relationship have long been of interest to behavior analysts. Beginning with those described by Terrace in 1963, procedures other than simple differential reinforcement of responses to the criterion stimuli have been developed. These procedures share the characteristic of transferring control of responding from an irrelevant stimulus or dimension to one which is critical to the criterion task. And, they have the common objective of minimizing the number of errors which occur during discrimination training. The emphasis on errorless acquisition derives its impetus from findings which demonstrate that errors during discrimination training coincide with poor retention of that discrimination and more troublesome acquisition of related tasks (Terrace, 1963a; 1963b).

The earliest and most well developed technique for errorless transfer of stimulus control is fading, which requires either a gradual increase or decrease in the value of some dimension of a stimulus in order to transfer control of responding to the critical aspects of the criterion S+. In general, fading procedures have been shown to have several advantages over simple differential reinforcement of responses to the criterion stimulus ("trial and error" methods).[1] For example, populations previously unsuccessful in

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[1]The results of fading investigations have not been unequivocal, however. Numerous studies have shown that transfer of stimulus control

acquiring certain discriminations (when trained with differential reinforcement procedures only) were later able to demonstrate acquisition of these same discriminations after exposure to fading procedures (e.g., Sidman & Stoddard, 1967).

Delayed prompting as first described by Touchette (1971) is another type of transfer of stimulus control procedure that is distinctively different from a fading procedure. The essential requirement in a delayed prompting procedure is that a prompt (e.g., an imitative prompt) is presented concurrently with the S+ (the S- stimulus or stimuli may or may not be present). As the number of discrimination training trials increases, so does the delay between the presentation of the S+ and the delivery of the prompt. Ultimately, the subject's behavior comes under the control of the S+ rather than the prompt; responding begins to precede the delivery of the prompt.

Touchette published the delayed prompting procedure in 1971 and described it as a technique which would be useful in basic research on stimulus control because it permits the direct measurement of the point of transfer; that is, the point at which responding is controlled by the relevant discriminative stimulus (S^D) rather than the stimulus which is irrelevant to terminal performance. Touchette noted that fading procedures do not permit the measurement of the point of

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has failed to occur under fading conditions and that acquisition of discrimination has been more effective with a "trial and error" procedure (e.g., Koegel & Rincover, 1976). These failures have been explained in terms of transfer of stimulus control to non-criterion related dimensions of the S+ and S- and are more likely to occur when the dimension which is manipulated is one that is not relevant to the criterion task. (See Schilmoeller, 1977 for further discussion.)

transfer--and such data are critical in determining which variables (historical, experimental, etc.) are relevant to the transfer of stimulus control (Touchette, 1971).

In addition to being useful in basic research, Touchette outlined the potential advantages of this technique when compared to a fading procedure. First, the delayed prompting procedure encourages the subject's responses to be controlled by the relevant S^D rather than the prompt because the relevant S^D temporally precedes the prompt. The notion is essentially that fading procedures, in some instances, may actually retard the acquisition of a new discrimination because they encourage the subject to continue under the control of the gradually disappearing prompt. This may be an acute problem when the prompt is non-criterion related. In addition, this procedure could prove most advantageous for stimulus-response relationships which would be cumbersome or impossible to teach with a fading program (e.g., teaching someone to say "cup" when presented with a cup).

The delayed prompting procedure has a number of other attractive features when compared with fading: (a) the delay procedure does not require the programmer to spend a great deal of effort modifying the training stimuli, as is the case with fading techniques. This reduced effort may encourage more effective (errorless) discrimination training, which might not occur if the only option for errorless programming consisted of a fading procedure. (b) Furthermore, it is not necessary that the individual who is training the discrimination have a sophisticated repertoire in order to produce errorless transfer, thereby increasing the number of individuals who could effectively teach with this procedure. (c) And finally, since it is possible to identify the exact moment when transfer of stimulus control has occurred, instructional time is spent teaching only those stimulus-response relationships which have not been acquired. Unless probes are used, fading procedures require the presentation of each and every set of stimuli--even if transfer occurs prior to the end of the program.

Delayed prompting was first used in the context of teaching a variety of visual discriminations to three retarded adolescents. Subjects were first taught to discriminate between a letter and its reversal. Initially the prompt (background of S^D illuminated red) was presented simultaneously with the S^D and S^Δ. Thereafter, each correct response increased the delay between the presentation of these stimuli and the red cue by .5 seconds (up to a maximum delay of 16 seconds). Each incorrect response decreased the delay by .5 seconds. (See Table I.) All subjects were able to perform this discrimination and its reversal; a line-tilt discrimination was also acquired (Touchette, 1971).[2]

This procedure has since been modified for use in applied settings. Probably the most critical adaptation concerns the maximum value of the delay, which has been fixed, rather than permitted to increase with each correct response. The optimal maximum value of

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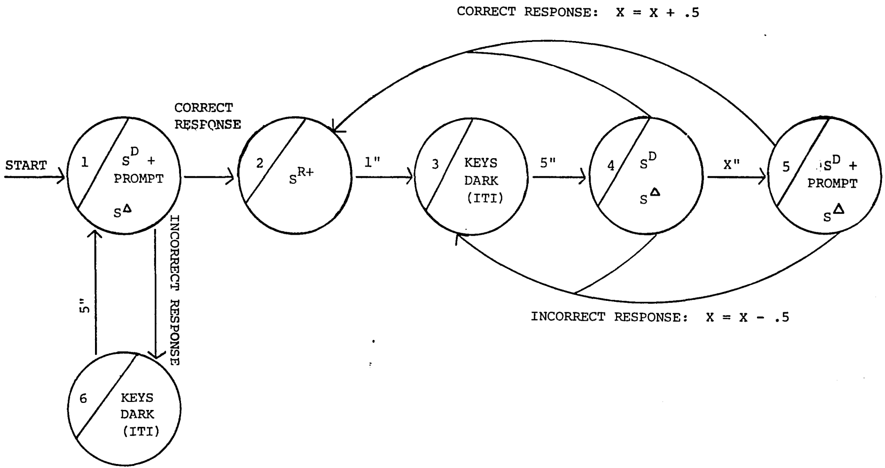
[2]Two of the three subjects readily learned the line-tilt discrimination. However, one subject did not even though the delay value reached 16 seconds. Subsequent to successful training with a fading program to teach this same line-tilt discrimination, this subject was able to perform this task with the delay procedure.

TABLE I. Original delayed prompting procedure as described by Touchette (1971). (Maximum value of x = 16.)


CORRECT RESPONSE: X = X + .5
START
1
S^D + PROMPT
S^Δ
CORRECT RESPONSE
2
S^R+
1"
3
KEYS DARK (ITI)
5"
4
S^D
S^Δ
X"
5
S^D + PROMPT
S^Δ
INCORRECT RESPONSE: X = X - .5
INCORRECT RESPONSE
5"
6
KEYS DARK (ITI)

the delay has been suggested to be twice what it would require an individual who already has the discrimination, to perform it. This deviation from the original procedure stems from Touchette's subsequent observations that one cannot "force" the acquisition of some discrimination by continually increasing the value of the delay. Touchette found that "extreme" delay values produce two undesirable patterns of performance: either (a) high error rates, or (b) a tendency to wait, and never anticipate the prompt.[3] Setting a fixed value of the delay may also have another advantage. "Streamlining" the procedure may make it more likely that it will be implemented, and with a minimal number of errors on the part of the trainer.

Another modification is the inclusion of a "time out" period as a consequence for incorrect responses. During "time out" the trainer looks away and does not attend to the subject's behavior for a short period of time (e.g., Johnson, 1978). In addition, there has been some variability in the delay value for the trial following an incorrect response. Some researchers decrease it as in the original version of this procedure (e.g., Striefel, Bryan & Aikens, 1974); but in at least one other study the delay appears to have remained constant (e.g., Johnson, 1978).

Subjects are taught to wait for the fixed delay by one of two procedures: (1) by presenting the prompt and the relevant S^D simultaneously and then gradually increasing the delay with each correct response to its maximum value (e.g., Striefel, et al., 1975) or (2)

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[3]Personal communication, March, 1978.

first teaching an "impossible" discrimination (e.g., Johnson, 1978).[4] The "impossible" discrimination approach might involve presenting the subject with two or more blank cards and instructing the subject to point to the correct card. Thus, the subject can only make a correct response by waiting for the prompt (e.g., the trainer pointing to one of the cards chosen at random). With this procedure, the delay between the trainer's instruction ("point to the correct card") and the prompt is gradually increased to the maximum value of the delay that will be used to teach the criterion discrimination.

Only a handful of studies have been published since 1971 which have made use of this transfer of stimulus control procedure. Striefel and his colleagues have used this procedure to teach instruction-following behavior to retarded subjects (Striefel, Bryan & Aikens, 1974; Striefel et al., 1975). Johnson (1978) has used the delay procedure to teach discriminations among flashcards of geometric shapes, pictures of animals, and numerals to a multiply-handicapped adolescent. All of these studies could be described as applied in that their main focus has been to teach a specific set of stimulus-response relationships rather than investigate some of the variables relevant to this particular procedure's effectiveness in producing transfer. This latter type of study would be of theoretical interest with potential applications for the applied area.

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[4]Touchette notes that after a subject has been taught a number of discriminations with the delayed prompting procedure it may be unnecessary to gradually increase the delay each time a new discrimination is presented. This is probably also the case with the "impossible" discrimination approach for teaching waiting behavior. Personal communication, March, 1978.

In some ways, describing the nature of transfer of stimulus control has been a more difficult task than the application of procedures which produce transfer. For example, the two sequential stages involved in transfer of stimulus control with fading were identified long after that procedure had become widely used in applied settings. It has been established that responses during fading procedures are controlled only by the prompt until the intensity of that stimulus is reduced, at which time the prompt and the relevant S^D begin to exercise joint control (stage 1). During the final phase, responding appears to be controlled only by the relevant S^D to the exclusion of the prompt (Fields, Bruno & Keller, 1976). These authors have interpreted transfer during fading in terms of attenuation of the control exerted by the blocking stimulus (the prompt). Attenuation of stimulus blocking is accomplished by adjusting some physical characteristic of the prompt. In the delayed prompting procedure, the blocking stimulus does not seem to be attenuated in the same way as the "intensity" of the prompt remains unaltered; yet, transfer of control still occurs.

Perhaps a critical variable in producing this transfer is the higher reinforcement density for responses made prior to the prompt. If so, acquisition of a discrimination would be related to the discrepancy in the reinforcement density for responses that occur prior to the prompt and responses which are controlled by the prompt. It might be possible to increase the effectiveness of this procedure by presenting more frequent reinforcement for responses prior to the prompt, relative to the frequency of reinforcement for responses which occur after the prompt. The result would be an even greater discrepancy in the reinforcement density than if both types of responses were reinforced on the same schedule of reinforcement. If such an effect were found, it would be useful information for those working in the applied area.

On the other hand, can the delay procedure be rendered less effective by increasing the frequency of reinforcement for responses controlled by the prompt relative to the schedule of reinforcement for responses which anticipate the delivery of the prompt? Such a procedure would have the effect of making the reinforcement density for responses before and after the prompt less disparate.

Such questions about the role of reinforcement density and the effectiveness of this procedure have some theoretical significance related to the process underlying transfer of stimulus control. A strictly operant interpretation might suggest that the manipulation of reinforcement density should produce changes in discrimination acquisition. A contrasting point of view, based on elicitation theory, describes transfer of stimulus control as primarily a respondent process (Denny & Adelman, 1955). Therefore, within a given range, manipulation of the reinforcement density should neither facilitate nor impede the transfer of stimulus control. An equally conservative view of the role of reinforcement in the transfer of stimulus control has been expressed by Ray and Sidman (1970). As these authors indicate, the role of reinforcement in maintaining behavior is better understood than its role in producing new stimulus-response relationships. However, given that a controlling relation exists between a stimulus and response, the characteristics of the consequence delivered contingent upon the observation of that controlling relation should determine its future probability of occurrence.

The purpose of this research is to test for the presence of a functional relationship between reinforcement density, as determined by the schedule of reinforcement, and the transfer of stimulus control with the delayed prompting procedure.

METHOD

Subjects

The subjects were two multiply-handicapped students at the Kalamazoo Valley Multihandicapped Center. S1 was six-years-old, male, and diagnosed as emotionally-impaired and mentally retarded; and, was observed to have a number of disruptive and inappropriate behaviors (e.g., aggression, self-abuse, etc.), and a history of seizures. This subject was token trained prior to the study and had also learned to point to a specified numeral (1, 2, or 3) with the delayed prompting procedure. Reinforcement during the acquisition of these discriminations consisted of one token for each correct response.

S2 was female, thirteen-years-old and labeled mentally retarded and diagnosed as having cerebral palsy. She was confined to a wheel chair and lacked adequate gross and fine motor skills. S2 was token trained just prior to the study and received tokens only during experimental sessions, but not for academic work during non-experimental sessions. Prior to the study, she had no exposure to the delayed prompting procedure.

Setting and Apparatus

The study was conducted at the Kalamazoo Valley Multihandicapped Center during school hours. Each subject sat at the desk which had been assigned to him or her and at which all academic instruction took place during the school day. Sessions took place in a classroom with other students present and working. During these sessions, the experimenter sat facing the subject.

Apparatus consisted of tokens, data sheets, a stop watch, flash cards of the training stimuli, and a variety of "back-up" reinforcements.

Procedure

Independent variable. The independent variable in this experiment was the schedule of token reinforcement for each of the two types of correct responses: (1) R_1 - correct responses which anticipate the delivery of the prompt, and (2) R_2 - responses which coincide with or occur after the delivery of the prompt. There were three values of the independent variable and they were as follows: (1) Condition A: Both R_1 and R_2 responses were reinforced on a continuous reinforcement schedule consisting of one token for each correct response. (2) Condition B: R_1 type responses were reinforced on a CRF schedule of reinforcement (one token delivered for each correct response), and R_2s on a fixed ratio (FR3) schedule of reinforcement (one token). (3) Condition C: R_1s were reinforced on an FR3 schedule of reinforcement (one token) and R_2s were maintained on the CRF schedule of reinforcement.

Discrimination tasks. Both subjects were taught a series of "receptive" discrimination tasks which required a pointing response. Training stimuli were presented on flash cards placed on the desk in front of the subjects. All trials, both review and training, consisted of the presentation of four flash cards--the S^D and three S^Δ stimuli. The position of the S^D and the specific S^Δ stimuli were randomly varied for each trial.

S1 was required to point to (touch) a letter of the alphabet during each trial. Only one letter discrimination was trained at a time. No new discriminations were presented until the current one had been learned. The twenty-six letters of the alphabet were divided into three groups on a somewhat random basis; i.e., in those cases where two or more letters within a single grouping shared similar topographies, the experimenter would randomly assign one of those letters to another group. For example, the letters "M" and "W" were placed into different groups by the experimenter.

S1 was first trained to discriminate the initial letter in each grouping with the other letters within that group serving as S^{Δ} stimuli. After reaching criterion for the first discrimination task within that group, that letter served as S^{Δ} on a random basis during subsequent training within that condition. No letter ever served as S^{Δ} for training and review trials for a different condition. That is, a letter assigned to Condition A training would never serve as S^{Δ} for discrimination training during Conditions B and C.

S2 was trained to discriminate nineteen four-letter words which were selected from the Popper word series and randomly assigned to one of three word groupings. After reaching criterion for the first word discrimination within that condition, that word served as S^{Δ} on a random basis during subsequent training within that condition. No word ever served as S^{Δ} for training and review trials for a different condition. As was the case with S1, S2 was never presented with a new word discrimination until the current one had been acquired. (See Table II for ordering and grouping of tasks for both subjects.)

TABLE II. Order of training stimuli and contingencies in effect during training.

TABLE II

ORDER OF TRAINING STIMULI AND CONTINGENCIES IN EFFECT DURING TRAINING

		S1	S2
Condition	Task #	Letter	Word
	1	M	long
	2	B	this
	3	U	good
A	4	T	like
	5	X	cold
	6	L	from
	7	A	some
	8	Z	
	1	S	down
	2	H	ride
	3	K	away
B	4	I	walk
	5	O	call
	6	W	play
	7	P	
	8	E	
	9	G	
	1	N	come
	2	Q	make
	3	Y	look
C	4	D	jump
	5	F	stop
	6	C	help
	7	R	
	8	V	
	9	J	

Experimental design. This experiment utilized a multi-element design (Ulman & Sulzer-Azaroff, 1975). Following stabilization of the number of errors emitted during the acquisition of a new discrimination under Condition A contingencies, subjects were exposed to Conditions B and C on an alternating basis within two daily sessions. The condition in effect for the first session was alternated across experimental days.

In order to increase the probability of the subjects discriminating the different sets of reinforcement contingencies, different stimuli were associated with each of the three different conditions. Different colored mats were placed on top of the subjects' desks, with the training stimuli placed on top of these backgrounds. In addition, different colored flashcards and tokens were used during each condition. The colors of the mat, tokens, and flashcards associated with each condition were reversed for S1 and S2.

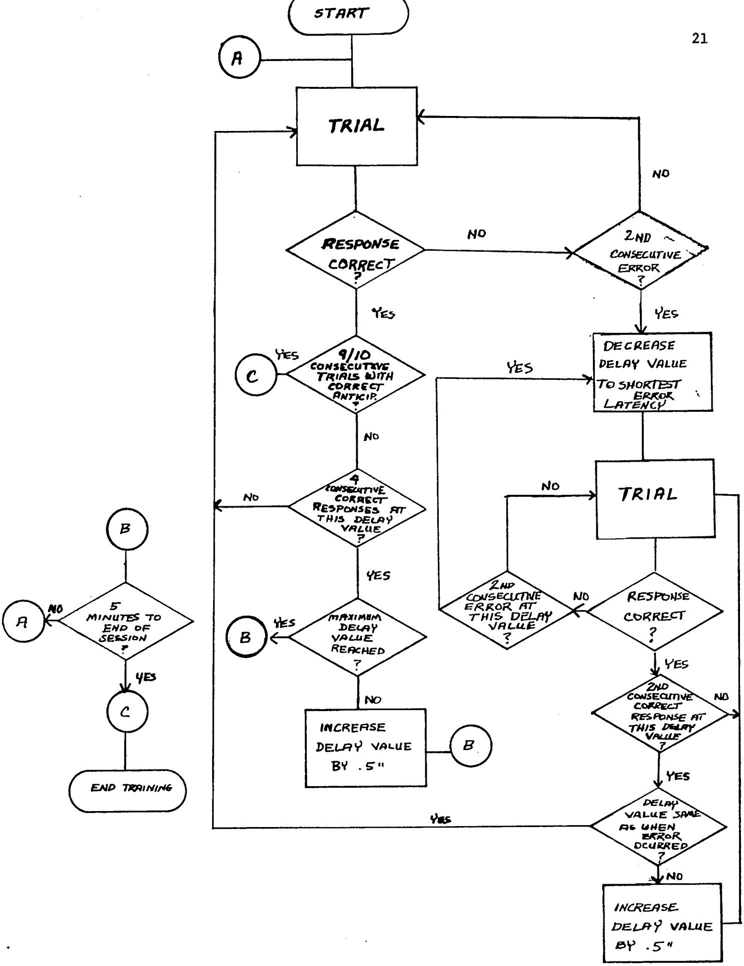
Training sessions. Sessions were conducted daily, for either four or five days a week and lasted for 20-30 minutes each. Tokens were exchanged during the session for a variety of edibles or activities selected by each subject. The amount of time required for token exchange and to consume the edibles or activities was not included as part of the session time. Subjects exchanged when they had accumulated six tokens.

Each trial began with the experimenter pointing to each one of the four stimulus cards, saying "look here", and then pointing towards the experimenter's eye. When the subject made eye contact, the experimenter provided the verbal instruction (e.g., "point to A"). Initially the delivery of the prompt (which consisted of the experimenter pointing to the correct card) and the verbal instruction occurred simultaneously. All correct responses, regardless of whether an R_1 or R_2 or what condition was in effect were followed by verbal praise (e.g., "right", or "good, you pointed to A"). Depending upon which condition was in effect, a token was or was not delivered. Thereafter, four correct and consecutive responses (R_1s and/or R_2s) increased the delay between the delivery of the verbal instruction and the imitative prompt by .5 seconds--up to a maximum of five seconds for S1 and eight seconds for S2. (S2 was permitted a longer delay value because of her slow and awkward fine motor coordination.) If the subject did not make a response before the delay value was reached, the experimenter pointed to the correct stimulus card. If the subject made a response before the delay value was reached, the prompt was not delivered for that trial. All incorrect responses, regardless of which value of the independent variable was in effect, were followed by the experimenter saying "no", removing the training stimuli from the desk and looking away from the subject and ignoring his or her behavior for ten to fifteen seconds. Two consecutive, incorrect anticipations resulted in the value of the delay being decreased to the shortest latency emitted by the subject during these two trials. The correct responses at this reduced delay value increased the delay by .5 seconds (up to a maximum of five seconds for S1 and eight seconds for S2). This same contingency was in effect until the value of the delay equalled that which was in effect when the errors occurred. When this value was reached, four correct, consecutive trials were again required to increase the delay value by .5 seconds. Criterion for mastery of each discrimination task was nine correct anticipations on ten consecutive trials (within a single session).

Five review trials occurred at the end of each training session. During review trials, the S^Ds were letters previously learned under that condition (the letter that was currently being trained did not serve as S^D during any of these trials). Each acquired discrimination was, therefore, reviewed a minimum of once every few sessions. The same contingencies for R_1s and R_2s were in effect during review trials as were in effect during training. Incorrect responses were followed with a "time out" procedure, as previously described, but the delay value for the next trial was not shortened; nor was that trial re-presented. Failure to make a response within the time period specified by the maximum delay value for that subject, resulted in the trainer pointing to the correct stimulus card. (See Table III for flowchart of training session.)

Initial baseline. Prior to each condition, a pretest was given to determine if the subjects could discriminate one or more letters or words within that group. Each letter or word served as S^D for four trials (presented randomly). If the subject performed this discrimination on three of these four trials, the letter was considered learned and training would not have occurred for that particular discrimination task. (However, neither subject made three correct responses to any of the training stimuli during any of the three pretests.) If the subject made less than three correct responses then training was conducted with that stimulus. No consequence followed errors during

TABLE III: Flowchart of training sessions.


START
A
TRIAL
RESPONSE CORRECT ?
NO
2ND CONSECUTIVE ERROR ?
NO
YES
DECREASE DELAY VALUE TO SHORTEST ERROR LATENCY
YES
9/10 CONSECUTIVE TRIALS WITH CORRECT ANTICIP. ?
YES
C
NO
4 CONSECUTIVE CORRECT RESPONSES AT THIS DELAY VALUE ?
NO
YES
MAXIMUM DELAY VALUE REACHED ?
YES
B
NO
INCREASE DELAY VALUE BY .5"
B
TRIAL
NO
2ND CONSECUTIVE ERROR AT THIS DELAY VALUE ?
NO
RESPONSE CORRECT ?
YES
2ND CONSECUTIVE CORRECT RESPONSE AT THIS DELAY VALUE ?
NO
YES
DELAY VALUE SAME AS WHEN ERROR OCCURRED ?
YES
NO
INCREASE DELAY VALUE BY .5"
B
5 MINUTES TO END OF SESSION ?
NO
A
YES
C
END TRAINING

these trials; nor were any prompts delivered. Correct responses were reinforced with praise and the delivery of a token, regardless of which condition was to be in effect for that group of tasks during training. In order to ensure continued attention to the experimenter and maintain control over the subject's attending behavior, these pretest trials were interspersed with discrimination tasks that were already in the subject's repertoire (e.g., "point to your nose"). Correct responses to these types of tasks were followed by the delivery of praise only (no tokens).

Review sessions. Following acquisition of all of the discriminations associated with a particular reinforcement contingency, review sessions were conducted. Each discrimination task that was learned under that condition was randomly presented for five trials. The reinforcement contingencies and stimulus conditions were identical to those present during training. Incorrect responses were followed by a "time out" procedure, as previously described, but the delay value for the subsequent trial was not affected; nor was the trial represented. Failure to make a response within the time period specified as the maximum delay value for that subject resulted in the imitative prompt being presented. Because of the length of time that elapsed between the completion of Conditions A and B for S1 and termination of Condition C, a second set of review sessions were conducted for this subject when Condition C was terminated.

A final review was also scheduled for both subjects when all three sets of discrimination tasks had been acquired. The stimulus conditions and reinforcement contingencies in effect during this final review were those associated with Condition A. Thus, those tasks which had been learned under Conditions B and C were tested with different colored flashcards, mats, and tokens than those present during their acquisition. Each discrimination task was presented three times and the S^{Δ}s for each trial sometimes consisted of letters or words which had been learned under contingencies different than those that had been in effect during training for the S^{D}.

Data collection and reliability. The following data were collected for each trial during a session: (1) response latency, and (2) type of response: whether the response was (a) a correct anticipation, (b) an incorrect anticipation, (c) correct and occurred simultaneously with the delivery of the prompt (R_2), (d) an incorrect response which occurred simultaneously with the prompt, (e) a correct response which occurred after prompt delivery (R_2), or (f) an incorrect response which occurred after the prompt was delivered.

Reliability checks were made approximately once every 15 sessions. Four reliability checks were made during sessions with S1 with the inter-observer agreement ranging from 88% to 100%, and averaging 96%. Three reliability checks were made during sessions with S2, averaging 93%, with a range from 89% to 100%. In order to ensure independence of observation, the experimenter-trainer did not consequate the subjects' responses (deliver token, praise, or remove the stimulus cards) on these trials, until the second observer signalled that he or she had recorded the response as one of the six types described above. No reliability checks were made on the subjects' latencies.

RESULTS

Trials to Criterion

Figures 1 and 2 show the number of trials to criterion for both subjects for each discrimination task. For S1, the number of trials to criterion during Condition A ranged from 20 to 65 and averaged 37. During Condition B, the number of trials ranged from 12 to 25, with an average of 17. The average number of trials to criterion during Condition C ranged from 15 to 65 with an average of 38. S2 averaged 34 trials to criterion during Condition A, with a range from 28 to 47. Data for Condition B varied between 17 and 25 trials with an average of 22. For Condition C, the average was 30 trials to criterion with a variability from 20 to 44 trials. It is interesting to note that the high amount of variability in trials to criterion shown in Conditions A and C does not appear in Condition B for either subject.

In general, the data show that the number of trials to criterion during Condition B was much less for both subjects when compared to the data from Conditions A and C. With the exception of the first discrimination task under Conditions B and C for both subjects and one Condition C task for S2, the number of trials to criterion for Condition B tasks was always less than the lowest number of trials to criterion for any task under either Condition A or C contingencies. The data also indicate that Condition C contingencies did not result in an increase in the number of trials to criterion, when compared with data from Condition A. Approximately the same number of trials

FIGURE 1: Total number of trials to criterion for each discrimination task for S1 under Conditions A, B, and C.

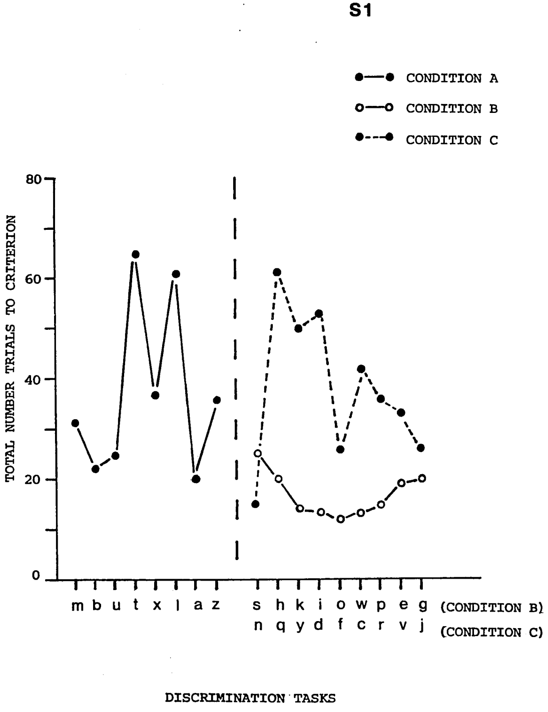
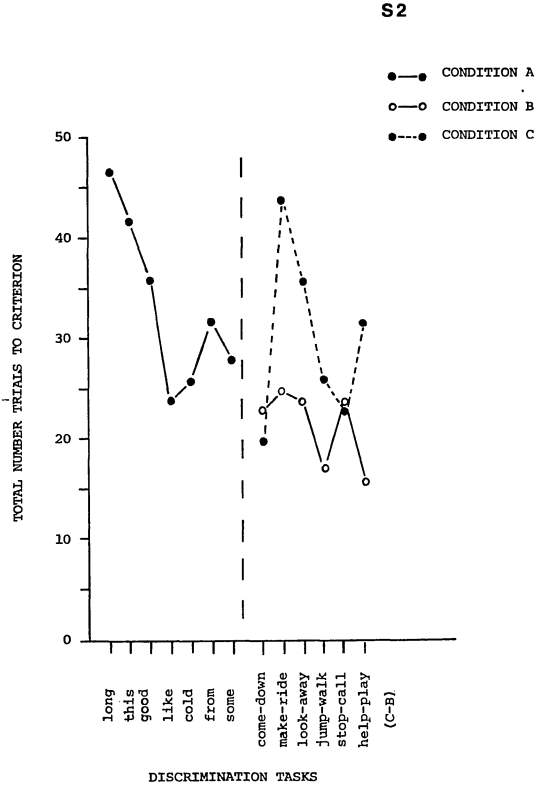

S1
CONDITION A
CONDITION B
CONDITION C
TOTAL NUMBER TRIALS TO CRITERION
80
60
40
20
0
m b u t x l a z
s h k i o w p e g (CONDITION B)
n q y d f c r v j (CONDITION C)
DISCRIMINATION TASKS

FIGURE 2. Total number of trials to criterion for each discrimination task for S2 under Conditions A, B, and C.


S2
CONDITION A
CONDITION B
CONDITION C
TOTAL NUMBER TRIALS TO CRITERION
50
40
30
20
10
0
long
this
good
like
cold
from
some
come-down
make-ride
look-away
jump-walk
stop-call
help-play
(C-B)
DISCRIMINATION TASKS

to criterion were required under Conditions A and C contingencies. These general trends are more apparent in Figure 3A which shows the average number of trials to criterion for each of the three conditions.

The last four discrimination tasks under Condition C contingencies for S1 were acquired in the absence of any Condition B sessions. (The lower number of trials to criterion during Condition B resulted in that condition being terminated first.) And, the number of trials to criterion for these tasks appears to have been decreasing, which might suggest that either the presence of Condition B may have been critical to observing the higher number of trials to criterion under this condition or that the effect of Condition B contingencies was a transient one. However, it is not possible to determine which of these factors, or what additional ones may have been responsible for this effect.

Percentage Correct

The percentage of correct responses during the acquisition of each discrimination for S1 and S2 is shown in Figures 3 and 4, respectively. These data have been pooled across all three types of correct responses: anticipations, simultaneous, and prompt-controlled (occur after delivery of prompt). The percentage of correct responses was quite high for both subjects across all conditions. For S1, the percentage of correct responses averaged 91 for Condition A with a range from 80% to 100%. During Condition B, the percentage correct ranged from 92 to 100 with an average of 97%. With Condition C contingencies in effect, the average percent correct was 92 with a range

FIGURE 3. (A) Average number of trials to criterion for S1 and S2 during Conditions A, B, and C. (B) Percentage of correct anticipations for S1 and S2 during Conditions A, B, and C. (C) Percent prompt-controlled responses for S1 and S2 during Conditions A, B, and C. (D) Percent correct simultaneous responses for S1 and S2 during Conditions A, B, and C.

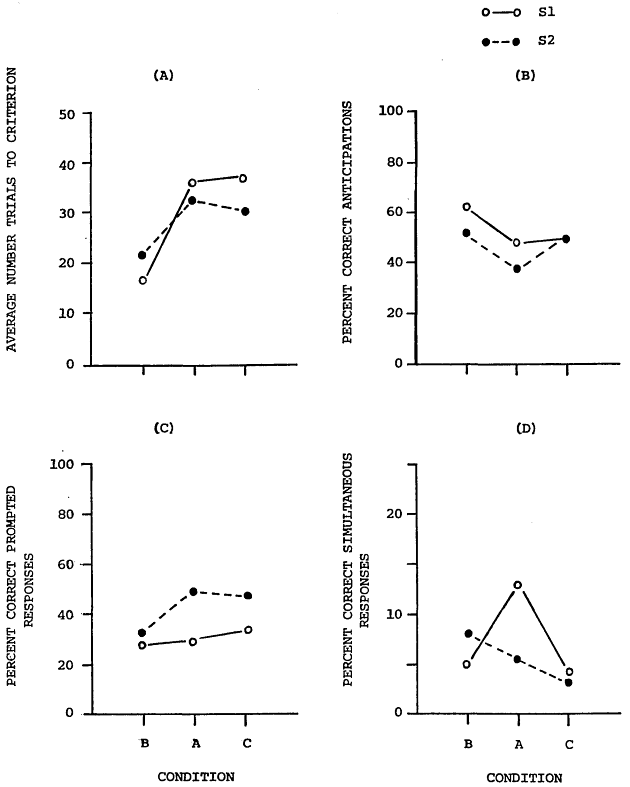

S1
S2
(A)
AVERAGE NUMBER TRIALS TO CRITERION
50
40
30
20
10
0
(B)
PERCENT CORRECT ANTICIPATIONS
100
80
60
40
20
0
(C)
PERCENT CORRECT PROMPTED RESPONSES
100
80
60
40
20
0
B
A
C
CONDITION
(D)
PERCENT CORRECT SIMULTANEOUS RESPONSES
20
10
0
B
A
C
CONDITION

FIGURE 4. Percentage of correct responses for S1 across Conditions A, B, and C, for each discrimination task.

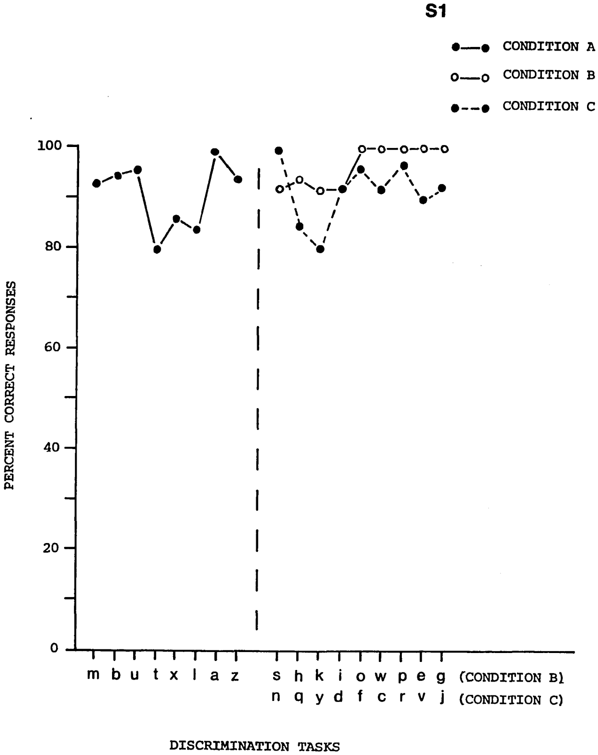
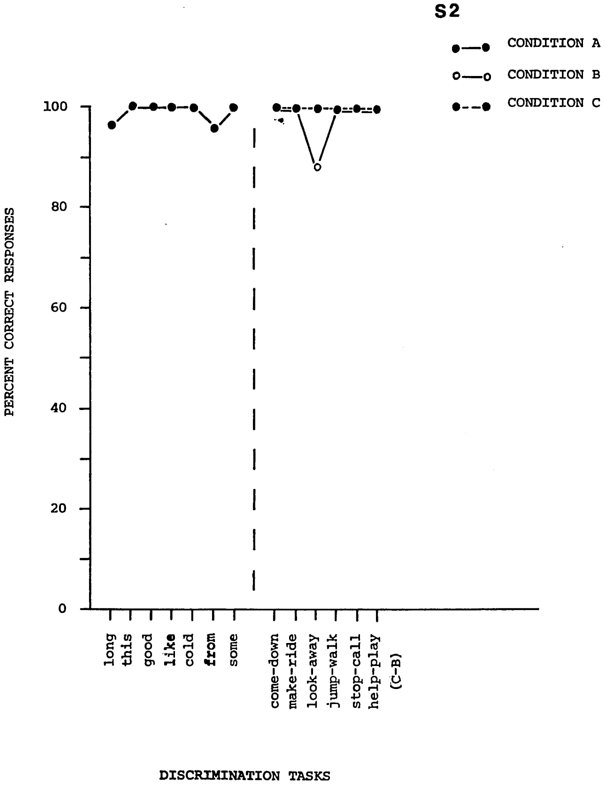

S1
CONDITION A
CONDITION B
CONDITION C
PERCENT CORRECT RESPONSES
100
80
60
40
20
0
m b u t x l a z
s h k i o w p e g (CONDITION B)
n q y d f c r v j (CONDITION C)
DISCRIMINATION TASKS

FIGURE 5. Percentage of correct responses for S2 across Conditions A, B, and C, for each discrimination task.


S2
CONDITION A
CONDITION B
CONDITION C
PERCENT CORRECT RESPONSES
100
80
60
40
20
0
long
this
good
like
cold
from
some
come-down
make-ride
look-away
jump-walk
stop-call
help-play
(C-B)
DISCRIMINATION TASKS

from 80 to 100. Thus, percentage correct data were virtually identical for Conditions A and C with an average of 91 or 92, while percentage correct under Condition B appeared to increase--reaching 100% for five of the nine discrimination tasks.

The percentage correct for S2 under Condition A averaged 99% with almost no variability. All discrimination tasks under Condition C contingencies were acquired with 100% accuracy; the same is true for Condition B discrimination tasks, with the exception of one which was learned with 89% of the subject's responses being correct.

In summary, despite the data from S1, it is difficult to identify a functional relationship between percentage correct and the three different reinforcement contingencies in effect, as percentage correct was high for both subjects under all conditions.

Response Types

Given the high percentage of correct responses, only data from the three correct types of responses are presented below.

Correct anticipation. Figures 6 and 7 show the percentage of total responses during each discrimination task that were correct anticipations for S1 and S2, respectively. These data were calculated by dividing the total number of correct anticipations observed during each discrimination task by the total number of responses emitted during acquisition. For S1, the percent of correct anticipations during Condition A averaged 40 and ranged from 36% to 80%. Under Condition B, this percentage rose to an average of 63% with a range from 47% to 75%. The average percent of correct anticipations under Condition

FIGURE 6. Percentage of S1's responses which were correct anticipations during discrimination acquisition for Conditions A, B, and C.

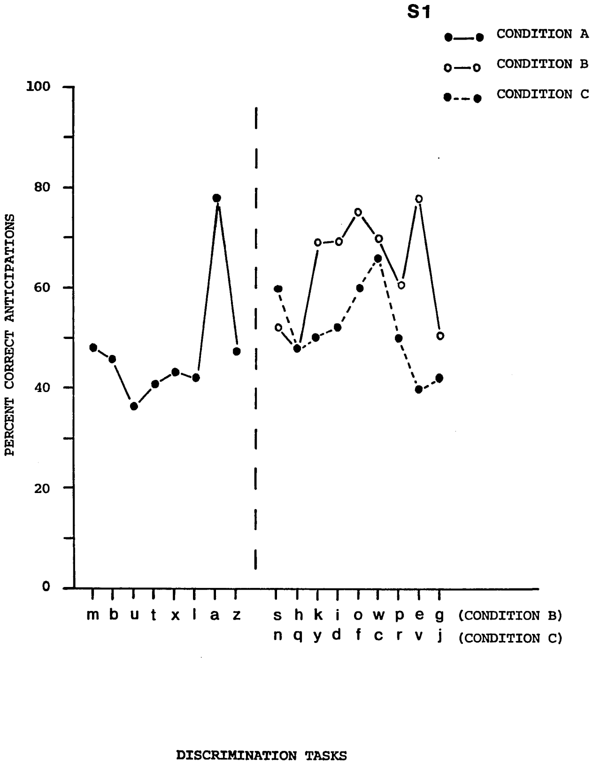
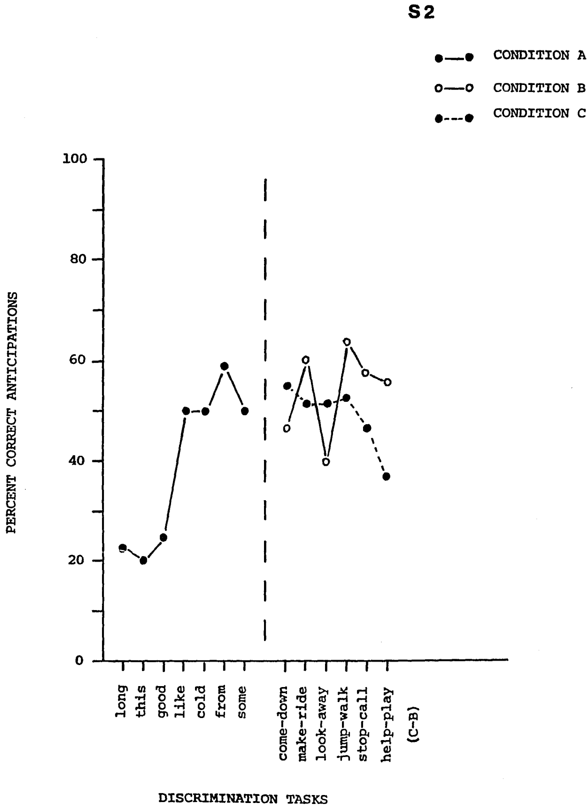

S1
CONDITION A
CONDITION B
CONDITION C
PERCENT CORRECT ANTICIPATIONS
100
80
60
40
20
0
m b u t x l a z
s h k i o w p e g (CONDITION B)
n q y d f c r v j (CONDITION C)
DISCRIMINATION TASKS

FIGURE 7. Percentage of S2's responses which were correct anticipations during discrimination acquisition for Conditions A, B, and C.


S2
CONDITION A
CONDITION B
CONDITION C
PERCENT CORRECT ANTICIPATIONS
100
80
60
40
20
0
long
this
good
like
cold
from
some
come-down
make-ride
look-away
jump-walk
stop-call
help-play
(C-B)
DISCRIMINATION TASKS

C was 50% and varied from 39% to 67%. For S2, the average percent of responses which were correct anticipations was 40% for Condition A, 55% for Condition B, and 50% for Condition C. The variability of percent correct anticipations was from 22% to 50% for Condition A, 48% to 65% for Condition B, and 38% to 55% for Condition C. The percentage of correct anticipations for S2 increased with repeated exposure during Condition A and suggests that there was a "learning to learn" phenomenon occurring. This was not the case for S1 and was probably due to the subject's previous exposure to the delayed prompting procedure. It is interesting to note, however, that both subjects were beginning to show a steady decrease in the percentage of responses which were correct anticipations under Condition C contingencies.

In general, the percentage of correct anticipations was related to the reinforcement density available for that response. This relationship is most apparent in Figure 3B which shows the average percent of correct anticipations under each condition for both subjects. During Condition B, which was most favorable to correct anticipations, the percentage of S1's responses which were correct anticipations (63%) was considerably higher when compared with the data from Conditions A and B. During these latter two conditions, the percentage of responses which were correct anticipations was approximately the same (48 and 52 for Conditions A and C, respectively). For S2, the percentage of responses which were correct anticipations was considerably higher during Condition B (55%) when compared to Condition A (40%), but only somewhat higher when compared to Condition C (50%). Given the decreasing trend for this type of response during Condition C (as shown in Figure 7), it is possible that the difference observed between Conditions B and C would have been greater if more discrimination tasks had been presented. It is not clear why the percentage of correct anticipations during Condition C was higher than that observed during Condition A for both subjects--even though Condition C provided for a lower density of reinforcement for correct anticipations.

Prompt-controlled responses. The percentage of correct responses which occurred after the delivery of the prompt for each discrimination task is shown in Figures 8 and 9 for S1 and S2, respectively. The average percent of S2's responses which occurred after the delivery of the prompt was 28% for Condition B, 31% for Condition A, and 36% for Condition C. The range in the percentage of this type of response was 15% to 40% during Condition A, 21% to 45% during Condition B, and 26% to 52% during Condition C. The average percent of S2's responses which were prompt-controlled was 35% (with a range of 25% to 44%) during Condition B, 52% (with a range of 19% to 79%) during Condition A, and 47% (with a range of 42% to 60%) during Condition C. Figure 6 shows that initially the percentage of responses which were prompt-controlled during Condition A was quite high (79% to 66%) but gradually decreased with repeated exposure to the delayed prompting procedure. In addition, this same figure indicates that the percentage of S2's responses which were prompt-controlled was steadily decreasing during Condition B and beginning to increase under Condition C. If additional discrimination tasks had been presented during Conditions A and C, it is likely, or at least possible, that S2's data

FIGURE 8. Percentage of responses which were prompt-controlled for S1 across Conditions A, B, and C, for each discrimination task.

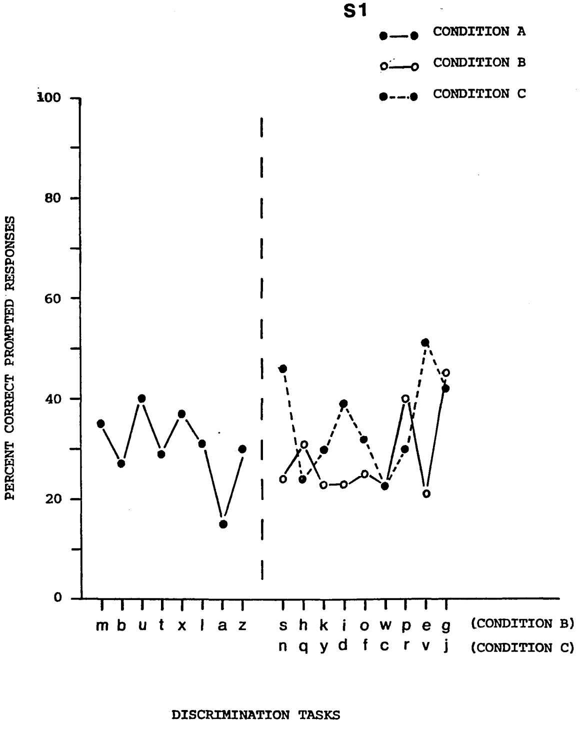
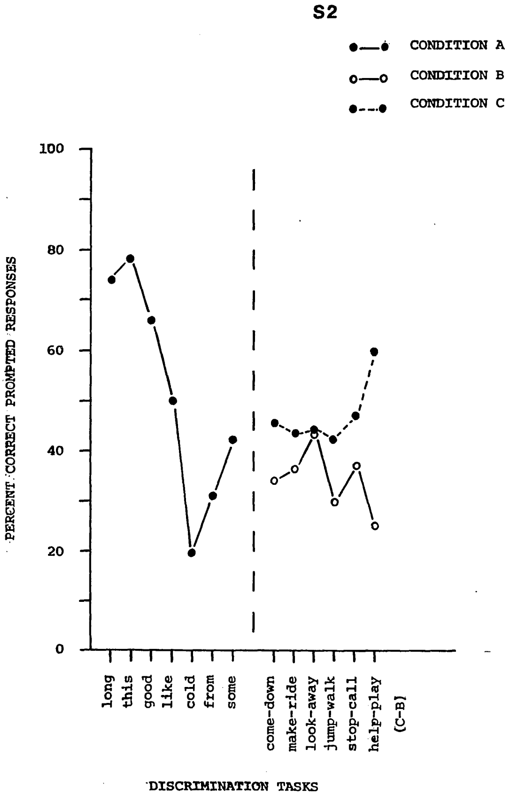

S1
CONDITION A
CONDITION B
CONDITION C
PERCENT CORRECT PROMPTED RESPONSES
100
80
60
40
20
0
m b u t x l a z
s h k i o w p e g (CONDITION B)
n q y d f c r v j (CONDITION C)
DISCRIMINATION TASKS

FIGURE 9. Percentage of responses which were prompt-controlled for S2 across Conditions A, B, and C, for each discrimination task.


S2
CONDITION A
CONDITION B
CONDITION C
100
80
60
40
20
0
PERCENT CORRECT PROMPTED RESPONSES
long
this
good
like
cold
from
some
come-down
make-ride
look-away
jump-walk
stop-call
help-play
(C-B)
DISCRIMINATION TASKS

would have displayed the same functional relationship between prompt-controlled responses and reinforcement contingencies as did the data from S1.

Figure 3C shows the average percentage of prompt-controlled responses emitted during discrimination tasks under each condition. In general, these data show a functional relationship between the occurrence of this type of response and the reinforcement density available for prompt-controlled responses. Both subjects tended to emit a higher percentage of prompt-controlled responses under Condition C, which favored prompt-controlled responses, and a lower percentage of this response type during Condition B, which favored correct anticipatory responses.

Correct simultaneous responses. The percentage of correct simultaneous responses across all discrimination tasks is shown for S1 (Figure 10) and S2 (Figure 11). S1's data show that 13% of the responses emitted were of this type during Condition A, with a range of 5% to 23% across discrimination tasks. The average for this subject was 5% and 4% for Conditions B and C respectively. (The percentage of correct simultaneous responses ranged from 0% to 16% for Condition B and from 0% to 17% for Condition C.) In general, the percentage of correct responses decreased from Condition A to Conditions B and C, and was approximately identical for these latter two conditions. The percentage of responses which were correct and simultaneous appeared to be related to the amount of exposure to the delayed prompting procedure, rather than the particular reinforcement contingencies in effect. For S2, the percentage of correct, simultaneous responses

FIGURE 10. Percentage of responses which were correct and simultaneous with prompt delivery across Conditions A, B, and C, for each discrimination task.

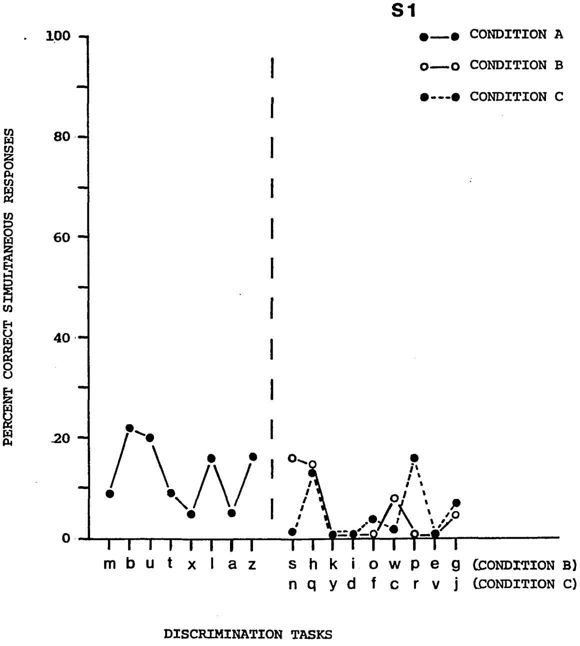
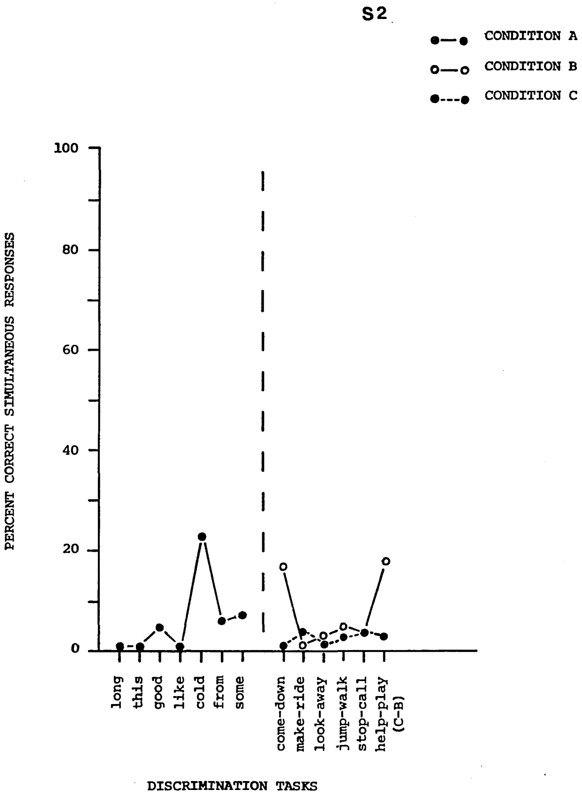

S1
CONDITION A
CONDITION B
CONDITION C
PERCENT CORRECT SIMULTANEOUS RESPONSES
100
80
60
40
20
0
m b u t x l a z
s h k i o w p e g (CONDITION B)
n q y d f c r v j (CONDITION C)
DISCRIMINATION TASKS

FIGURE 11. Percentage of responses which were correct and simultaneous with prompt delivery across Conditions A, B, and C, for each discrimination task.


S2
CONDITION A
CONDITION B
CONDITION C
PERCENT CORRECT SIMULTANEOUS RESPONSES
100
80
60
40
20
0
long
this
good
like
cold
from
some
come-down
make-ride
look-away
jump-walk
stop-call
help-play
(C-B)
DISCRIMINATION TASKS

was 8% during Condition B (with a range of 0% to 19%), 6% during Condition A (with a range of 0% to 23%), and 3% during Condition C (with a range of 0% to 5%). This subject's data would indicate a functional relationship between percentage of correct, simultaneous responses and conditions. The two general trends described for both subjects can be seen most clearly in Figure 3D.

However, it must be pointed out that all inter-observer disagreements during reliability checks occurred when one observer identified a given response as prompt-controlled and the second observer classified the same response as simultaneous. For this reason, these data must be viewed somewhat critically. In addition, the contingencies in effect for simultaneous responses may have been somewhat in conflict. Given that correct, simultaneous responses were subject to the same contingencies that were in effect for prompt-controlled responses, it is reasonable to expect that such responses would show the same functional relationship as that shown in Figures 8 and 9 for prompt-controlled responses. However it is also possible that a moderate number of responses which were actually anticipatory--but happened to coincide with the delivery of the imitative prompt--occurred, especially during Condition B when anticipatory responses were more favorably reinforced than either prompt-controlled or simultaneous responses.

In summary, given the probable inaccuracies in data collection, it is difficult to state anything about the relationship between repeated exposure to the delayed prompting procedure, the three different conditions, or the possible conflicting contingencies, and the occurrence of correct simultaneous responses.

Latency. During experimental sessions, latencies were recorded to the nearest half of a second. Thus, if a latency was noted as 1.2 seconds it was rounded down to 1 second. Likewise, a latency of 1.4 seconds was rounded up to 1.5 seconds. To record data in terms of tenths of a second would suggest a degree of precision that was not possible during experimental sessions. Figure 12 shows the average latency for each trial for both subjects under the three different reinforcement conditions. These data were calculated by averaging the recorded latencies for each discrimination task, and then averaging those data.

Latency data for S1 averaged .8 seconds during Condition B, 1.2 seconds during Condition A, and 1.1 seconds during Condition C. For S2, the average latency during Condition B was 1.5 seconds, 1.7 seconds during Condition A, and 2.1 seconds during Condition C. The latencies for both subjects seemed to be generally controlled by the contingencies in effect for anticipatory vs. prompt-controlled and simultaneous responses, with shorter latencies being associated with the condition that provided higher reinforcement density for anticipatory responses, and longer latencies during that condition in which prompt-controlled and simultaneous responses were reinforced on a higher density schedule.

Figures 13 and 14 show the latencies for consecutive responses during the acquisition of one discrimination under each of the three different conditions for both S1 and S2. The tasks selected were those which were most representative of the number of trials to criterion under each particular condition. The pattern of responding for

FIGURE 12. Average latency for S1 and S2 during discrimination training across Conditions A, B, and C.

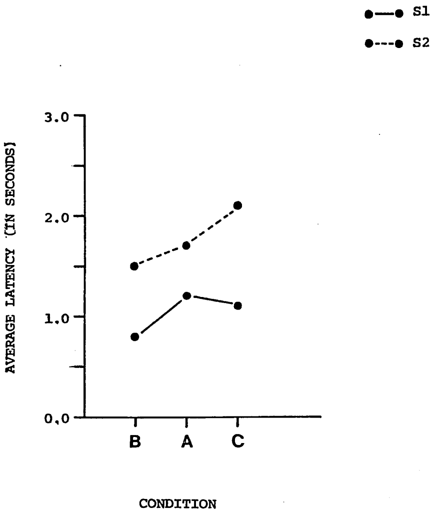
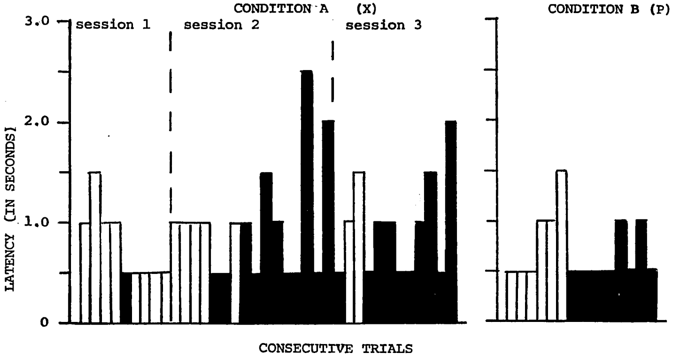

S1
S2
AVERAGE LATENCY (IN SECONDS)
3.0
2.0
1.0
0.0
B
A
C
CONDITION

FIGURE 13. Sample response latency for S1 during discrimination training under Conditions A, B, and C.


CONDITION A (X)
CONDITION B (P)
session 1
session 2
session 3
3.0
2.0
1.0
0
LATENCY (IN SECONDS)
CONSECUTIVE TRIALS

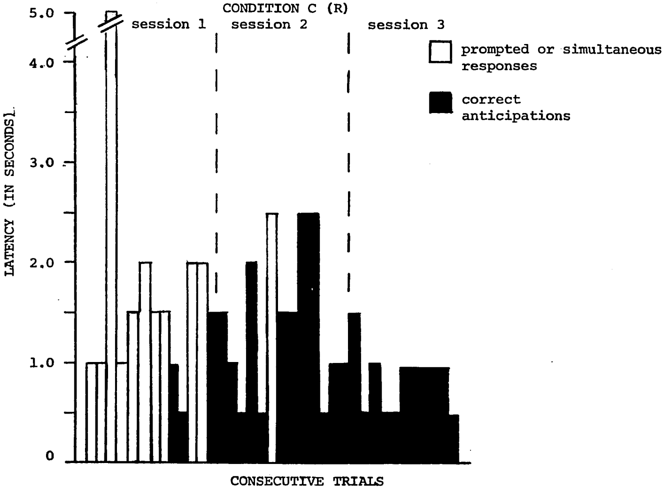
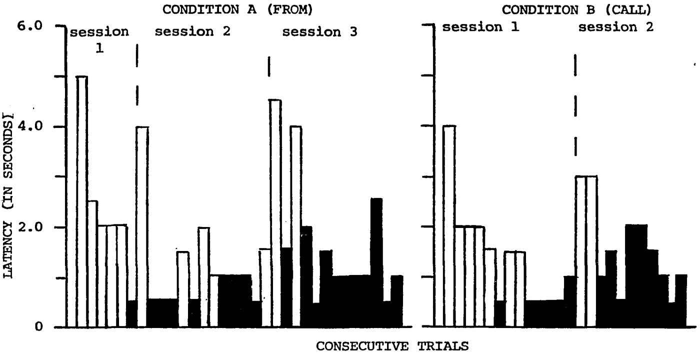
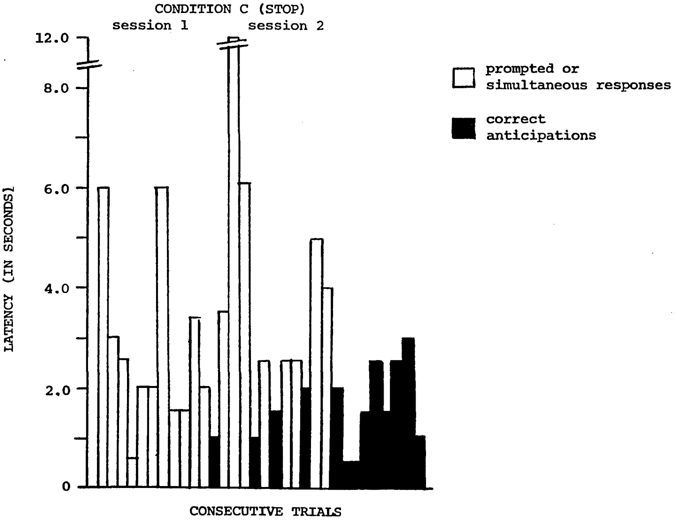

CONDITION C (R)
session 1
session 2
session 3
5.0
4.0
3.0
2.0
1.0
0
LATENCY (IN SECONDS)
prompted or simultaneous responses
correct anticipations
CONSECUTIVE TRIALS

FIGURE 14. Sample response latency for S2 during discrimination training under Conditions A, B, and C.


CONDITION A (FROM)
session 1
session 2
session 3
CONDITION B (CALL)
session 1
session 2
LATENCY (IN SECONDS)
6.0
4.0
2.0
0
CONSECUTIVE TRIALS

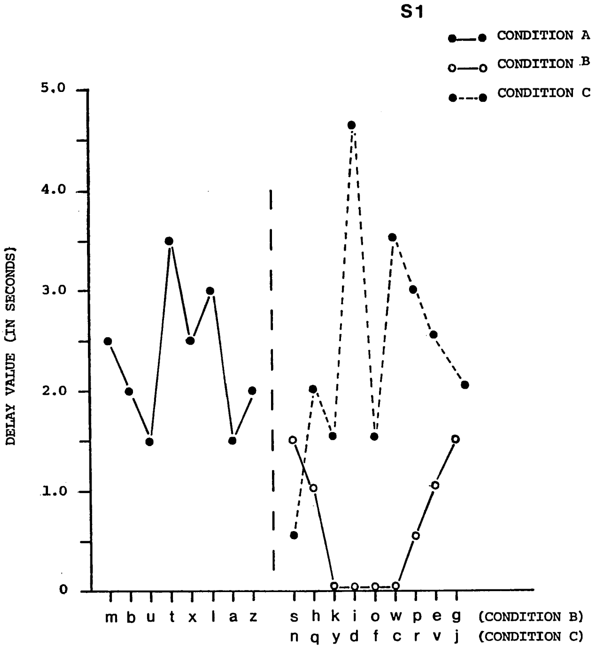

CONDITION C (STOP)
session 1
session 2
LATENCY (IN SECONDS)
12.0
8.0
6.0
4.0
2.0
0
CONSECUTIVE TRIALS
prompted or simultaneous responses
correct anticipations

both subjects under Condition B seems distinctly different from that observed during Conditions A and C. Under Condition B contingencies, responding was almost totally prompt-controlled until it dramatically shifted to anticipatory responding. During A--and especially C--conditions, anticipatory and simultaneous responses were interspersed between prompt-controlled responses before criterion was reached. These figures also show the relatively long latencies associated with Condition C, and the relatively short latencies associated with Condition B, with Condition A latencies usually falling somewhere in between these two.

Initially, latencies tended to be relatively short when the delay was short. Then, latencies began to increase as the delay increased; finally, the latency began to shorten as the delay was still further lengthened. This bi-modal distribution was apparent across all discrimination tasks and conditions for both subjects. The data shown for S2 in Figure 14 are however, somewhat different than that of S1 as shown in Figure 13. At the beginning of each session, the latencies were much longer initially than they had been at the end of the previous session for the same discrimination task. S2 appeared to need a few "warm up" trials before conforming to the bi-modal pattern of distribution previously described.

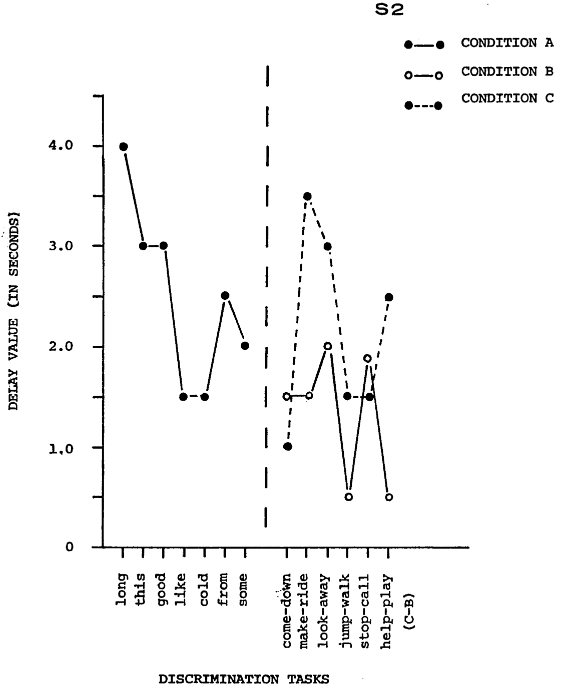
Delay value in effect when transfer began. Figures 15 and 16 show the delay value in effect for the first trial that was one of the ten consecutive trials for defining transfer of stimulus control. The data from S1 and S2 show that delay values varied both across and within conditions. For S1 during Condition A, the value of the delay

FIGURE 15. Value of delay when transfer of control of responding began for S1 under Conditions A, B, and C.



DISCRIMINATION TASKS

FIGURE 16. Value of delay when transfer of control of responding began for S2 under Conditions A, B, and C.


S2
CONDITION A
CONDITION B
CONDITION C
DELAY VALUE (IN SECONDS)
4.0
3.0
2.0
1.0
0
long
this
good
like
cold
from
some
come-down
make-ride
look-away
jump-walk
stop-call
help-play
(C-B)
DISCRIMINATION TASKS

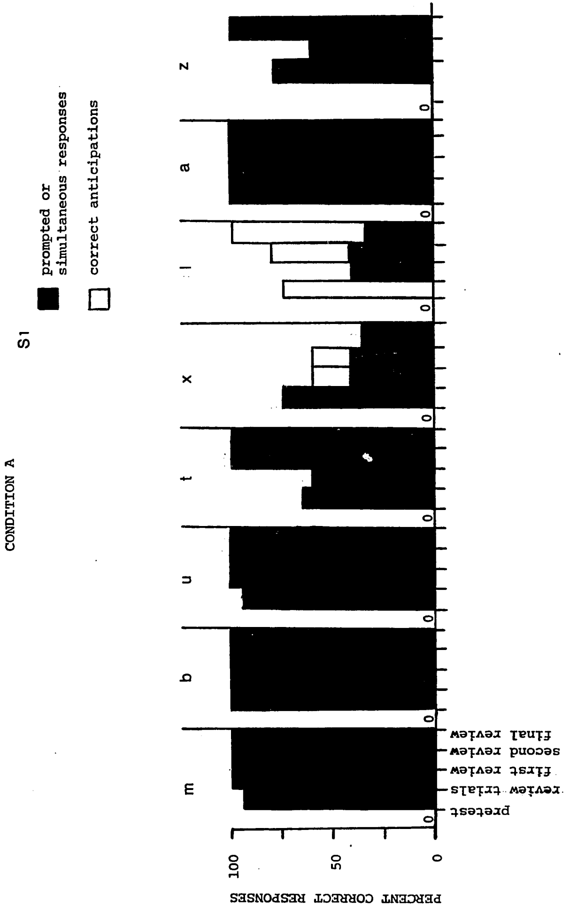
varied from 1.5 to 3.5 seconds with five of the eight transfers taking place when the delay value ranged from 1.5 to 2.5 seconds. During Condition B, the range of the delay value in effect was from 0 to 1.5 seconds, with five of the eight transfers taking place when the delay value was either 0 or .5 seconds. (This means that the first trial in the ten trial series took place during the fourth simultaneous presentation of the prompt and the verbal stimulus, and that the latency for the second trial was less than .5 seconds--the next delay value.) During Condition C, the delay value in effect during the initial transfer trials ranged from .5 to 4.5 seconds with transfer occurring when the delay value ranged from 1.5 to 2.5 for five of the nine discrimination tasks. The delay value never reached its maximum value of five seconds during discrimination training (although it did during some review trials).

For S2, the data presented in Figure 16 show a steady decrease in the delay value in effect when transfer began during Condition A. The delay value ranged from 1.5 to 4 seconds, with transfer beginning in 60% of the discrimination tasks when the delay value was between 1.5 and 2.5 seconds. During Condition B, the value of the delay in effect ranged from .5 to 2.0 seconds with transfer beginning in four of the six discrimination tasks when the delay value was between 1.5 and 2 seconds. During Condition C, transfer began for three of the six discrimination tasks when the delay value ranged from 1.5 to 2.5 seconds, with a range of 1 to 3.5 seconds. It is interesting to note that the delay value did not reach its maximum value of eight seconds with this subject, either. This was rather unexpected given this subject's impaired fine motor coordination. Data collected prior to the study, using already acquired discriminations, suggested that average latency for this subject was between three and four seconds.

In summary, Figures 15 and 16 suggest that transfer began at a lower delay value when Condition B contingencies were in effect. The delay values in effect during transfer under Conditions A and C were virtually identical. These data also show the high degree of variability in the value of the delay when transfer begins, despite identical reinforcement contingencies.

Review trials and sessions. Figures 17, 18, and 19 for S1 and Figures 20 and 21 for S2 show data collected during review trials and sessions. For Condition A review trials, the percent of correct anticipations for S1 averaged 68 and 71, respectively (with a range of 40% to 100% during both review sessions). The final review session, which was also a measure of generalization, averaged 74% of the responses as correct anticipations, with a range of 33% to 100%. During Condition B, the percentage of responses which were correct anticipations averaged 35% with a range of 0% to 100%. For the first and second review sessions, the percentage of responses which were correct anticipations averaged 35% with a range of 0% to 100%. During the first and second review sessions, the percentage of responses which were correct anticipations averaged 64% and 62% respectively with a range of 0% to 100% during the first review session, and 20% to 100% during the second review session. Seventy-eight percent of S1's responses to tasks, which had originally been acquired under Condition B contingencies, were correct anticipations during the final review session. During review trials of tasks that had been acquired under

FIGURE 17. Percent correct for S1 during pretest, review trials, first, second, and final review sessions during Condition A.



CONDITION A
S1
prompted or simultaneous responses
correct anticipations
m
b
u
t
x
l
a
z
PERCENT CORRECT RESPONSES
100
50
0
pretest
review trials
first review
second review
final review

FIGURE 18. Percent correct for S1 during pretest, review trials, first, second, and final reviews for Condition B.

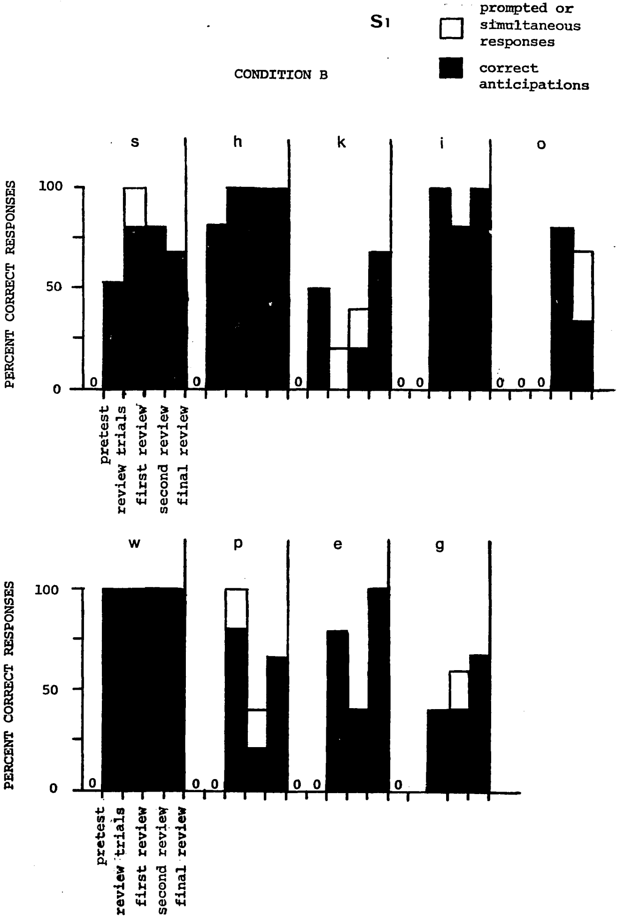
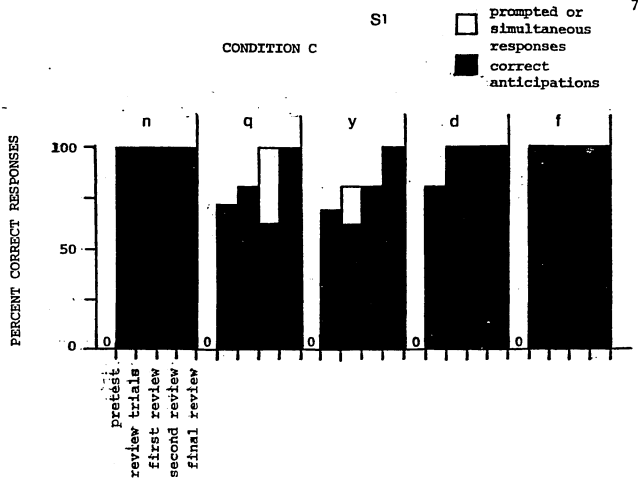

S1
prompted or simultaneous responses
correct anticipations
CONDITION B
s
h
k
i
o
w
p
e
g
PERCENT CORRECT RESPONSES
100
50
0
pretest
review trials
first review
second review
final review

FIGURE 19. Percent correct for S1 during pretest, review trials, first, second, and final reviews for Condition C.


S1
CONDITION C
prompted or simultaneous responses
correct anticipations
PERCENT CORRECT RESPONSES
100
50
0
n
q
y
d
f
pretest
review trials
first review
second review
final review

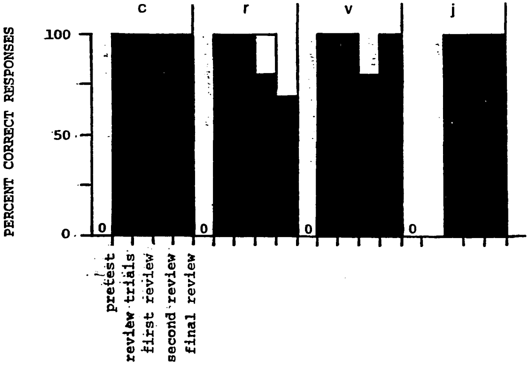

PERCENT CORRECT RESPONSES
100
50
0
c
r
v
j
pretest
review trials
first review
second review
final review

FIGURE 20. Percent correct for S2 during pretest, review trials, first, and final reviews for Conditions A and B.

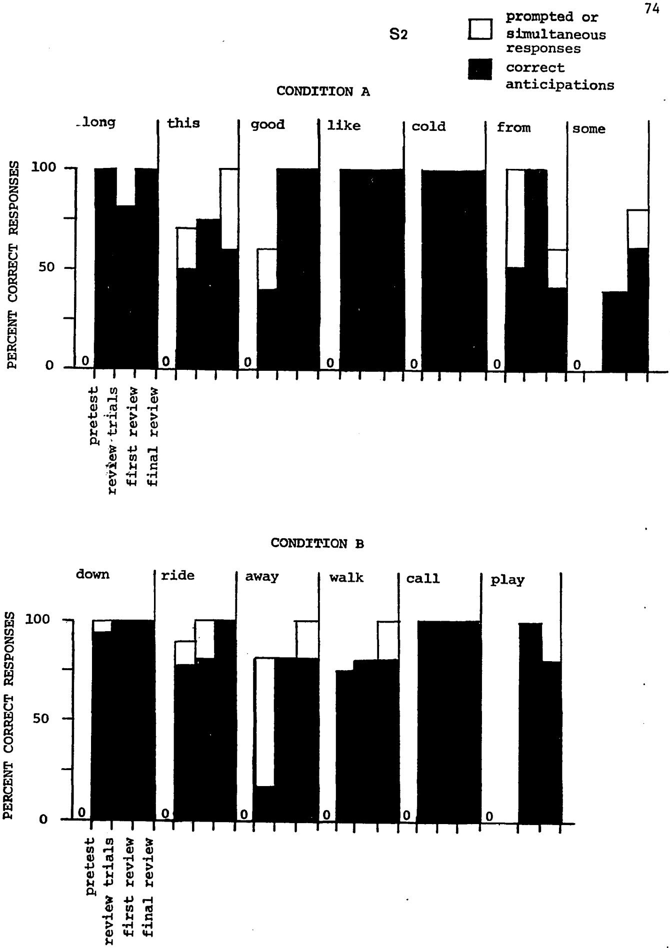
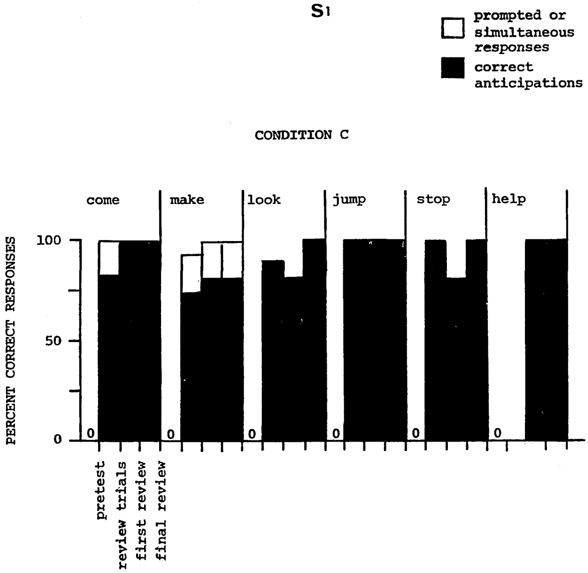

S2
prompted or simultaneous responses
correct anticipations
CONDITION A
long
this
good
like
cold
from
some
PERCENT CORRECT RESPONSES
100
50
0
pretest
review trials
first review
final review
CONDITION B
down
ride
away
walk
call
play

FIGURE 21. Percent of correct responses for S2 during pretest, review trials, first, and final reviews for Condition C.

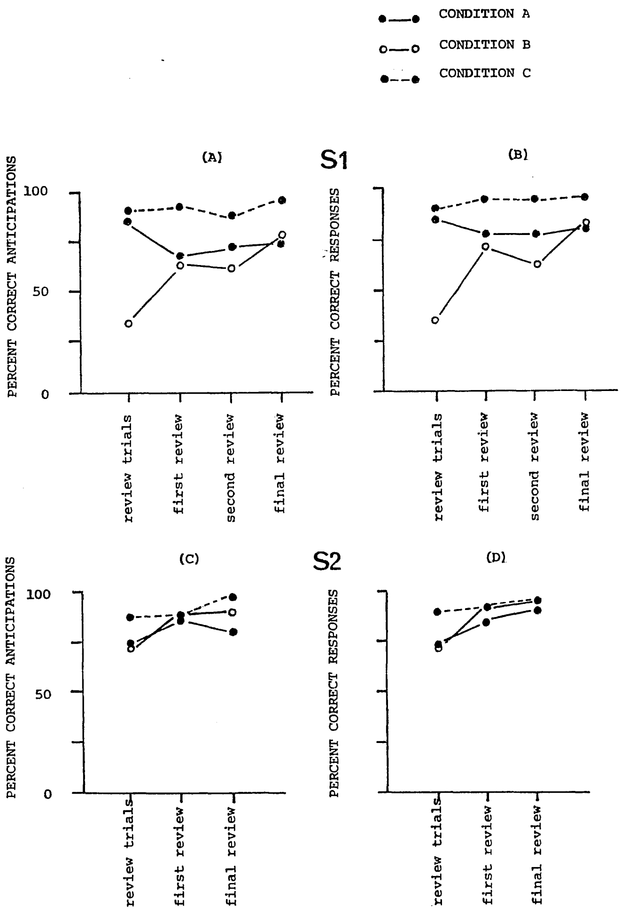

S1
prompted or simultaneous responses
correct anticipations
CONDITION C
come
make
look
jump
stop
help
PERCENT CORRECT RESPONSES
100
50
0
0
0
0
0
0
0
pretest
review trials
first review
final review

Condition C contingencies, 90% of the responses were correct anticipations. During the first and second review sessions, 93% and 89% of S1's responses were correct anticipations, with a range of 60% to 100% during both of these review sessions. In the final review, 96% (range of 67% to 100%) of S1's responses to tasks which had originally been learned under Condition C contingencies, were correct anticipations.

These data suggest that, in general, retention was poorest for those tasks which had been acquired under Condition B contingencies, and best for those tasks which had been learned under Condition C contingencies. The average percent correct anticipations for S1 was 75% for Condition A tasks, 60% for Condition B tasks, and 92% for Condition C tasks. (See Figure 22.) This same relationship is maintained when percentage correct is calculated (correct anticipatory, simultaneous, and prompt-controlled responses combined): 81% for Condition A, 63% for Condition B, and 95% for Condition C tasks. It would also appear that the percentage of responses which were correct anticipations seemed to increase with review sessions, despite the fact that no additional training was taking place. This general improvement is apparent across all conditions.

For S2, measures of retention of tasks learned under Condition A contingencies showed the percentage of correct anticipatory responses during review trials to be 73% (with a range of 37% to 100%), 86% for the first review, and 80% for the final review (with a range of 40% to 100% for both of these review sessions). For Condition B tasks, the average percentage of responses which were correct

FIGURE 22. (A) Percent correct anticipations by S1 during review trials, first, second, and final review sessions. (B) Percent total correct responses by S1 during review trials, first, second, and final review sessions. (C) Percent correct anticipations by S2 during review trials, first, and final review sessions. (D) Total percent correct responses by S2 during review trials, first, and final review sessions.


CONDITION A
CONDITION B
CONDITION C
(A)
S1
(B)
PERCENT CORRECT ANTICIPATIONS
PERCENT CORRECT RESPONSES
100
50
0
review trials
first review
second review
final review
(C)
S2
(D)
review trials
first review
final review

anticipatory responses was 72% during review trials (with a range of 17% to 100%), 90% during the first and final review sessions (with a range of 80% to 100% for both of these review sessions). Condition C tasks during review trials averaged 88% correct anticipations (range of 72% to 100%), 90% during the first review session and 97% during final reviews (with ranges of 80% to 100% for both final and first review sessions).

In summary, like S1's data, Condition C tasks were better retained by S2 with 92% of the responses being correct anticipations than either Condition B (84%) or Condition A (80%) tasks. Again, this same relationship is maintained when all correct responses (regardless of type) are grouped together: 83% for Condition A, 87% for Condition B, and 93% for Condition C tasks. However, for S2, retention was not poorest under Condition B tasks, and was at an acceptable level. S2's data, like that of S1, showed an increase in correct anticipations across review sessions, for all three conditions. (See Figure 22.)

DISCUSSION

The delayed prompting procedure is potentially a valuable technique for both basic research and educational applications: first, it provides the behavior analyst with a technique which will allow more precise measurement of the moment of transfer of stimulus control and therefore, identification of those variables which are critical to successful transfer. Second, it has great potential for use in educational settings, as its simple procedural details may encourage effective discrimination training whereas elaborate fading procedures are effortful which may discourage their extensive use outside the laboratory. However, the delayed prompting procedure has seen little experimental attention, and the variables critical to its effectiveness are not well understood.

The purpose of this research was to attempt an assessment of the role of one variable (reinforcement density) in the transfer of stimulus control with the delayed prompting procedure. The results of this study indicate that the reinforcement density available for anticipatory vs. prompt-controlled responses will affect the transfer of control of responding. The data show that the number of trials to criterion, as well as response latency, was considerably less during reinforcement conditions which most heavily favored anticipatory responses. In addition, the percentage of correct anticipations was higher under this condition, and the percentage of prompt-controlled responses was somewhat less in comparison to Conditions A and C data.

Thus, one of the original questions of this study is answered: yes, the delayed prompting procedure can be made even more effective when the disparity between the reinforcement density available for prompt-controlled and anticipatory responses is increased. The conditions which restrict this statement need to be determined, however, and cannot be stated in an absolute sense on the basis of this study. The importance of previous exposure to the traditional delayed prompting procedure (Condition A), and simultaneous exposure to Condition B, in observing the superiority of Condition B type contingencies, needs to be evaluated.

A second question of this study was: can the delayed prompting procedure be rendered less effective by attempting to make the reinforcement density for prompt-controlled and anticipatory responses less disparate? The answer here is not quite so clear. While the data for the individual discrimination tasks for both subjects showed a general trend towards an increase in the number of trials to criterion with each successive task during Condition C, the averages for both subjects did not suggest that this procedure was less effective than the traditional delayed prompting procedure (Condition A). In addition, the percentage of correct anticipations for each subject during Condition C was either the same or higher than that observed during Condition A. Likewise, the percentage of prompted responses was either the same or slightly less during Condition C than during Condition A. The failure of Condition C to greatly impede the acquisition of discriminations would suggest that reinforcement density is not the only critical variable in determining transfer of stimulus control with this procedure, at least at the values which were tested during Condition C. It would be interesting to measure the strength of these variables with a negative auto-maintenance procedure which obviates reinforcement for anticipatory responses.

Despite the superiority of Condition B contingencies in facilitating transfer, the results of this study also indicated that Condition B was less effective in generating retention, and perhaps appropriate generalization. It is not clear why retention was best for both subjects for those tasks which had been learned under Condition C contingencies. It is possible that a major factor in determining this relationship was the greater number of training and review trials that were conducted with Condition C tasks. Many more responses to the various S^Ds (anticipatory, simultaneous, or prompt-controlled) were reinforced under Condition C contingencies than Condition B. Retention of Condition A tasks might be expected to be poorer because of the amount of time that elapsed between the first review and the final review (or in the case of S1, first and second final reviews). This was also true, but to a lesser extent, for Condition B tasks. However, it is also the case that the lowest percentage of correct anticipations for Condition B tasks always occurred during review trials, when the time that had elapsed since training was minimized. Another possibility is that retention is just poorer for tasks learned under Condition B contingencies and superior for tasks learned under Condition C contingencies, even when the number of reinforced responses, review trials, and elapsed time since training has been equated. However, it is not obvious why this should be the case.

Furthermore, it is not possible to determine from this study which one of these factors, or combination of factors, was responsible for the superior retention of Condition C tasks and/or the less than adequate retention of Condition B tasks by S1. This would be an important issue to determine before advocating the implementation of Condition B type contingencies in an educational context. It was interesting, however, to see the general increase in percent correct anticipations, and total percent correct responses during review sessions across conditions--despite the fact that additional training was not taking place in between review sessions. It would be important to replicate these findings as this is a very desirable characteristic of any training procedure.

Finally, the delayed prompting procedure seems to have taught subjects appropriate waiting behavior. Figures 17, 18, 19, 20, and 21 show that there were quite a few trials when retention was being measured that the subjects waited to make a response until the maximum value of the delay had elapsed--even though neither subject had ever been exposed to this delay value during training of any discrimination task (because transfer always occurred prior to reaching that value). The importance of teaching appropriate waiting behavior, when the control exerted by the relevant S^D is weak, probably cannot be overstated. Without a tendency to wait for the prompt and then respond correctly, the individual develops an errorful history of responding. The deleterious effects of an errorful history have been detailed by a number of researchers including Terrace (1963a; 1963b), Sidman and Stoddard (1967), Touchette (1968), and Reese, Howard, and Rosenberger (1977).

Unlike the subjects in the Touchette (1971) study, which utilized reinforcement contingencies that were identical to those in Condition A, transfer was not always characterized by a sudden shift from totally prompt-controlled to exclusively anticipatory responding. The only condition under which this pattern of responding was found to occur was Condition B type contingencies. It is not clear why this sporadic anticipatory responding should be observed under conditions which were, in terms of reinforcement contingencies at least, apparently identical to those used in the Touchette study. For the subjects in this study, it may have been the case that the topography of the relevant S^D was not the only source of control for the initial anticipatory responses. Control may have also been exerted by irrelevant and trivial factors such as the position of the S^D and the characteristics of the stimuli which functioned as S^{Δ}s. Thus, the momentary strength of anticipatory responding may have been relatively weak or strong depending upon the details of these other variables.

This point is related to the problem of defining the moment of transfer. As Sidman and Ray (1970) state, reinforcement cannot possibly account for the occurrence of the first instance of a particular stimulus-response relationship; to do so would be teleological. Thus, the role of reinforcement must be restricted to the strengthening of a particular stimulus-response relationship that already exists. But, for most practical purposes, transfer cannot be defined as the single occurrence of an anticipatory response. The role of the amount of reinforcement density available for prompt-controlled vs. anticipatory responses, while perhaps not relevant to the first occurrence of the appropriate stimulus-response relationship, may in some way minimize control by other variables which may have been responsible for the erratic pattern of anticipatory and prompt-controlled responding observed in Conditions A and C.

From a practical point of view, this is useful information when an attempt is being made to transfer control, especially since it is obvious that Condition B contingencies did not result in a high rate of errorful anticipatory responses (responses which were controlled simply by a past history of reinforcement for responding prior to the delivery of the prompt.) Condition B contingencies have other practical advantages such as a lower rate of token reinforcement per discrimination task when compared to that required for either Condition A or C discrimination tasks. S1 averaged 11 tokens per discrimination task under Condition B while S2 averaged 15 tokens under this same set of contingencies. When these data are compared to 33 tokens under Condition A and 19 tokens during Condition C for both subjects, this represents a considerable savings in reinforcement.

In summary, the results of this study indicate that the variable of reinforcement density for anticipatory vs. prompt-controlled responses is probably a significant one and is deserving of further experimental attention. Additional investigations need to be conducted to determine whether or not transfer is facilitated when the subject is exposed to Condition B contingencies alone (in the absence of previous training with Condition A contingencies, or simultaneous exposure to arrangements such as those used in Condition C). In addition, the variables responsible for the superior retention of Condition C tasks and the poorer retention of Condition B tasks need to be identified in order to make recommendations about the educational applications of the delayed prompting procedure. While the role of reinforcement density was found to be a significant one in affecting transfer with this procedure, the data obtained during Condition C also suggests that there are other, perhaps more powerful, variables that need to be analyzed.

The field of stimulus control can often be characterized as the development and testing of procedures which are designed to produce errorless acquisition. Such attempts are often, but not always, successful. In either case, however, it is frequently impossible or difficult to identify those variables which are critical to successful or unsuccessful transfer. In order for maximum benefit to be derived, additional analyses are needed in order to better understand the nature of stimulus control and to generate rules regarding the variables responsible for successful transfer. The delayed prompting procedure, in addition to its value as a teaching procedure, is one technique which should be most useful in this type of investigation.

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