The Effects of Reinforcement Magnitude on the Transfer of Stimulus Control

L. Martin Grabijas
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THE EFFECTS OF REINFORCEMENT MAGNITUDE
ON THE TRANSFER OF STIMULUS CONTROL

by

L. Martin Grabijas

A Thesis
Submitted to the
Faculty of The Graduate College
in partial fulfillment of the
requirements for the
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Western Michigan University
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Communication training for the developmentally disabled is becoming a vital component among residential training facilities. Such education necessarily entails the transfer of stimulus control from a prompt stimulus to a stimulus inherent in the task. The current study investigated the effects which different values of a reinforcer may have on the transfer of stimulus control. Three severely, mentally retarded adults were taught manual sign language, while two values of the reinforcer were varied according to two classes of response: preprompt and postprompt responding. A within subjects design was incorporated with a delayed prompting procedure in identifying the precise moment of transfer of stimulus control. Subsequent analyses of Conditions B and C revealed a significant shift in the moment of transfer. The signs acquired under each condition generalized across settings and trainers, and were maintained over time.
ACKNOWLEDGEMENTS

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L. Martin Grabijas
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INTRODUCTION

Current research in applied behavior analysis has demonstrated a growing interest in the parameters responsible for the acquisition of stimulus control, especially with respect to communication training for retarded and emotionally impaired children (Rincover & Koegel, 1975; Smeets & Striefel, 1976; Duker & Morsink, 1984). Of primary concern to educators of the retarded is the simplification of training, resulting in a reduction or elimination of errors (Sidman & Stoddard, 1967). Further, once a task has been acquired, efforts are concentrated on the maintenance over time and generalization across settings of the acquired task, in producing results which are ecologically important to the subject, as well as experimentally significant to the research team (Baer, Wolf & Risley, 1968; Horner, 1981).

While the disabled adult's ability to communicate his needs is often considered of critical importance for his admission and continuation in formalized educational programs (Smeets & Striefel, 1976), productive verbal behavior is not typically required of residents in institutions or the retarded (Striefel, Bryan & Aikins, 1974). Because environmental contingencies in institutions are organized such that reinforcement is more likely to
occur for behaviors like "instruction following," the development of productive verbal behavior is deficient or at least nonessential.

Within virtually all communication training programs, the goal is the transfer of stimulus control from the prompt stimuli provided by the trainer to task-related stimuli (Touchette & Howard, 1984). The assumption is that once the appropriate response reliably occurs in the presence of the prompt and the training stimulus, stimulus control will transfer from the prompt to the training stimulus at some point (Koegel & Rincover, 1976). However, it is often the case that when the prompt is removed, the appropriate response is weak or absent (Touchette and Howard, 1984). It is the facilitation of this transfer which has been the focus of current research in stimulus control. Three unique procedures have demonstrated varying degrees of success in transfer of stimulus control experiments—trial and error learning, graduated stimulus change, and delayed prompting.

In its simplest form, a trial and error paradigm involves the presentation of a task (discrimination), followed by response-contingent reinforcement for accurate responding and extinction or mild punishment for incorrect responses (Sidman & Stoddard, 1967). Initial responding occurs at random to the stimulus dimensions, therefore resulting in errors. At some point, the student begins to respond reliably to the target stimulus, thereby exhibiting
proper transfer of stimulus control. While this procedure has rendered successful results in training settings (Koegel & Rincover, 1976), several disadvantages have been noted. With respect to the education of the developmentally disabled, Sidman and Stoddard (1967) state that the learning process is greatly enhanced through the reduction of errors. Because most differential reinforcement procedures produce some responding to irrelevant stimuli, there has been a general acceptance of errors as a necessary condition for discrimination learning (Terrace, 1963). However, when such conditions exist, error patterns are reinforced and often perseverate over time during learning by trial and error, thereby interfering with learning. Errorless discrimination learning challenges the prevalent view (that errors are necessary), demonstrating rapid acquisition of the discrimination, as well as accurate responding which maintains over time (Terrace, 1963; Sidman & Stoddard, 1967; Touchette, 1968; Brown & Rilling, 1975; MacDonald & Marcucella, 1976). Further, Touchette and Howard (1984) state that the demands of trial and error learning provoke problem behaviors such as apathy, tantrums, aggression and self-injury. Given these limitations of trial and error learning, it is apparent that educators of the developmentally disabled are relying on alternate methods of discrimination training.

Fields, Bruno and Keller (1976) describe graduated
stimulus change as a procedure by which a response is brought under the control of new stimuli by first superimposing them upon a set of original stimuli, and then gradually eliminating the originals. The acquisition of control by the new stimuli with this procedure involves a two-stage process. First, the original stimuli exert primary control over the response, both alone and in a compound arrangement with the new stimuli. Then, through repeated pairings and by the gradual fading out of the primary stimuli, the new stimuli gain sole control over the response.

Duker and Morsink (1984) report the successful transfer of stimulus control from vocal and visual stimuli to manual signs using the graduated stimulus change paradigm. Similarly, Koegel and Rincover (1974) gradually faded in "classroom stimuli" in transferring stimulus control of behaviors learned in a one-to-one situation to a large classroom situation. Despite the fact that the above data indicate that retarded children who show no signs of learning a discrimination by trial and error can be taught by a program of graduated stimulus changes, this procedure still presents certain problems (Touchette, 1968). First, because the original controlling stimuli are faded out, it often becomes increasingly more difficult for the student to discriminate the relevant aspects of the new stimuli (Smeets, Lancioni & Hoogeveen, 1984). Such discriminations
often result in errors or perseverating response patterns (Brown & Rilling, 1975). Further, the exact point at which the transfer of stimulus control occurs is obscured (Touchette & Howard, 1984). Without such information, one of two problems likely occurs; the original stimuli are removed prematurely, initiating incorrect response patterns, or presentations of the original stimuli are unnecessarily extended, thereby fostering dependence in the form of selective attention to the dimensions of the original stimuli.

A final problem with the graduated stimulus change procedure involves "stimulus blocking" or "overshadowing" (Horner, 1981). When two or more stimuli are presented simultaneously as they are in the graduated stimulus change paradigm, it is common for one of the stimuli to "block" the acquisition of control of the other stimulus (Koegel & Rincover, 1976). Thus, the training may require an even slower stimulus change and greater repetition of individual trials.

It is apparent, therefore, that the two procedures described above are complicated by aberrant response patterns due to the production of errors, as well as the unnecessary repetition of training in transferring stimulus control from the trainer's prompts to the target stimuli. A final procedure presented in the literature has demonstrated promising results in eliminating these complications.
The delayed prompting procedure (Touchette, 1971) may be described as follows: the discriminative stimulus and a prompt are presented simultaneously at the start of a trial. When post-prompt responding reliably occurs for several trials, a delay is introduced between the presentation of the discriminative stimulus and the prompt. The delay is increased over trials, until pre-prompt responding occurs. It is at this point that the student's responding is under the control of the discriminative stimulus alone, indicating that transfer has taken place. The major advantage of delayed prompting, therefore, is the identification of the exact trial upon which the transfer occurred (Brown & Rilling, 1975; MacDonall & Marcucella, 1976; Touchette & Howard, 1984).

Further, while errors do occasionally occur with this procedure (Sisman & Stoddard, 1967), delayed prompting consistently produces fewer errors when compared with trial and error learning (MacDonall & Marcucella, 1976), and with the graduated stimulus change procedure (Brown & Rilling, 1975). One possible explanation for the relatively low error rate is that during early trials, there is relatively little response time before the prompt occurs (Walls, Haught & Dowler, 1982). The prompt therefore occurs before an error can be made. A second possibility is that the physical characteristics of the discriminative stimulus remain unchanged throughout the acquisition of the
discrimination (MacDonall & Marcucella, 1976). For this reason, the delayed prompting procedure requires very little sophistication in preparing the stimulus materials and is efficient to implement (Brown & Rilling, 1975; Smeets & Striefel, 1976).

A final advantage of delayed prompting is that the discrimination is not forced by the trainer as it is with the graduated stimulus change procedure (MacDonall & Marcucella, 1976). Rather, the acquisition of stimulus control is demonstrated at the student's natural rate of learning.

Since the refinement of the stimulus control procedures, researchers have demonstrated other variables affecting the transfer of stimulus control. Schusterman (1967) states that the point of transfer may vary markedly from one subject to the next. These intersubject differences have been attributed to abnormalities in the sensory functioning of the learner (Koegel & Rincover, 1976), and the subject's immediate history with the stimulus or task procedure (Terrace, 1963; Touchette, 1971). Also, response patterns may vary according to the type of developmental disability as autistic children tend to display peculiarities like "overselectivity" in their responses to multiple stimulus inputs (Koegel & Rincover, 1974; Rincover & Koegel, 1975).

Similarly, the results of stimulus control experiments
were disparate when dimensions of the visual aids or prompts were altered (Sidman & Stoddard, 1967). Smeets, Lancioni & Hoogeveen (1984) found that pictorial prompts were more effective than vocal prompts for teaching difficult discriminations. In transferring stimulus control from visual to vocal stimuli in sign language training, Kohl (1981) stated that signs involving symmetrical hand movements were acquired faster than asymmetrical signs.

While it is true that the refinement of the stimulus control techniques has led to relatively errorless learning, errors still occur in all of the procedures and must be consequated in some fashion. Touchette and Howard (1984) used a time-out procedure when errors occurred, in which the trainer said "no," removed the stimulus materials and looked away for ten seconds. Striefel, Wetherby and Karlan (1976) used a similar procedure, but added overcorrection to the end of the time-out. Other studies have used different consequation procedures for errors such as modeling the correct response (Striefel et al., 1974) and extinction (Sidman & Stoddard, 1967; Rincover & Koegel, 1975). While the results of the above consequation procedures have rendered mixed results, when using the delayed prompting technique, Touchette and Howard (1984) found that decreasing the delay value when errors occur reliably circumvents the problem of repeated errors.

A variable demonstrating a significant effect on the
transfer of stimulus control is reinforcement density or frequency (Touchette & Howard, 1984). Within the delayed prompting paradigm, responding may be classified into pre-prompt and post-prompt responses. When the probability of reinforcement is equal for both pre- and post-prompt responses, there is an inherent disparity in reinforcement density. That is, because pre-prompt responses are closer to the initiation of the trial, the density of reinforcement over time is necessarily higher when these responses occur. When the reinforcement frequency is purposely arranged to favor anticipatory responding, the result is more pronounced, causing the moment of transfer to occur sooner in the training (Terrace, 1966, pp. 316-317; Touchette & Howard, 1984).

With respect to reinforcement amount or magnitude, the results of operant conditioning experiments are somewhat mixed. Auge (1973) found a significant increase in response probability by increasing the duration of the reinforcer. Similarly, Schrier (1962) reports a significant decrease in response latency when the reinforcement magnitude was increased from 1 to 32, while Clayton (1964) produced increased responding with only a fourfold difference in reinforcement magnitude.

However, in studies comparing the relative effect of reinforcement frequency versus reinforcement magnitude, the results consistently favor reinforcement frequency as having

Neuringer (1967) accounts for the above discrepancies by distinguishing between "within subjects" and "between subjects" designs. That is, when a within subjects procedure is employed, the subjects experience two values of the reinforcer, necessarily producing two distinct response patterns. In the between subjects design, however, the subjects are placed into two groups, with each group experiencing only one value of the reinforcer. Thus, only one response pattern is produced for each subject, with little or no difference in response rates between groups.

The current study extends the above research by examining the effects of reinforcement magnitude on the transfer of stimulus control. A within subjects design was incorporated with the delayed prompting procedure in identifying the precise moment of transfer of stimulus control for all subjects. The dependent variable, rate of acquisition of manual signs, was assessed across two values of the reinforcer for all subjects. Maintenance and generalization of training is also addressed.
METHOD

Subjects

The current study incorporated three severely mentally retarded adults, residing in Kalamazoo group homes. The subjects have little or no vocal productive language skills, but have manual sign language vocabularies estimated at 100 to 300 words. All subjects have received traditional sign language training (imitation of a modeled sign) at their home or in their day care placements.

Setting

All training transpired in the subjects' respective group homes to avoid the distraction of stimuli in a novel setting. The training sessions were held in the home's usual "programming room", where training in daily living and other skills typically takes place. Each subject participated in one, 30 minute training session per day. The sessions were held between 3 pm and 5 pm (before dinner), to insure the effectiveness of the edible reinforcement. A total of 15 baseline and 25 experimental sessions were run over an 8 week period.

Discriminative Stimuli

At the start of each session, all subjects were pretested on manual signs until a set of 5 unlearned signs
had been gathered for each subject. The pretest consisted of asking the subject to perform a certain sign (i.e., "sign DOG."). The subject was asked three times to perform the sign. If the sign was correctly performed at least 2 out of 3 times, the sign was added to the 'learned' list. If the sign was correctly performed 0 or 1 times, it was added to the set of 5 training stimuli for the day. Because each subject had a different signing repertoire coming into the study, the training stimuli (i.e., signs) taught each day varied from subject to subject. However, to insure homogeneity of the stimuli, only one-hand and two-hand symmetrical signs were used, or signs involving gross motor movements. The discriminative stimuli used for each subject are listed in Appendices B, C and D.

Procedure

A trial began when the experimenter said "Look here." and established eye contact. The experimenter then said "Sign ___." simultaneously signing the training stimulus while he stated it. Correct responses were reinforced immediately, while an incorrect response resulted in the experimenter looking away from the subject for 10 seconds (time-out, Touchette & Howard, 1984). Four consecutive correct responses resulted in a 0.5 second increase in the delay between the verbal instruction and the visual prompt, up to a maximum delay of 5 seconds. If the subject did not
make the correct sign before the delay had lapsed, the experimenter performed the sign. If the subject made the correct sign before the delay had ended, the prompt was not given. Two consecutive incorrect anticipations resulted in decreasing the delay by 0.5 seconds. The 0.5 second delay increment was used based on Touchette's (1971) work, as it provides several exposures to the prompt prior to the delay value exceeding the subjects' normal response latency. The criterion for mastery for each stimulus was 4 out of 4 correct, unprompted trials at a single delay value. Figure 1 presents the above procedure in a flowchart format.

Schedules of Reinforcement

All correct responses were reinforced immediately (CRF). The reinforcers used in the current study were raisins. Since this type of reinforcement was currently being used successfully with the subjects in their respective group homes, no pretraining was necessary. Further, no raisins were consumed between 12 pm and 3 pm to enhance the reinforcing value of the raisins. The independent variable, reinforcement magnitude, was varied according to two classes of responses: (1) correct responses occurring prior to the prompt, and (2) correct responses coinciding with or occurring after the prompt.
Figure 1. Flowchart of Delayed Prompting Procedure.
Condition A

All subjects were placed on 10 days of baseline training in which the reinforcement was the same for correct responses both before and after the prompt (CRF 1/CRF 1).

Condition B

Correct responses occurring before the prompt produced 5 reinforcers, while correct responses coinciding with or occurring after the prompt produced 1 reinforcer (CRF 5/CRF 1).

Condition C

Correct responses occurring before the prompt produced 1 reinforcer, while correct responses coinciding with or occurring after the prompt produced 5 reinforcers (CRF 1/CRF 5).

The experimental design of the above conditions followed the "ABCAB" format as outlined by Baer, Wolf and Risley (1968). Following 10 sessions under Condition A, all subjects were exposed to Condition B for a period of 10 session days, followed by 10 sessions under Condition C, followed by a return to Condition A for 5 sessions and Condition B for 5 sessions. In distinguishing between conditions, the second exposures to Conditions A and B are referred to as Conditions A' and B' respectively.
Data Analysis

Because the current study incorporated the delayed prompting procedure, the exact trial upon which stimulus transfer took place for each subject was identified during Condition A. Subsequent analysis of experimental Conditions B and C revealed the effects which reinforcement magnitude had upon the rate of acquisition of stimulus control. Further the return to Conditions A' and B' precluded the contribution of extraneous variables to the data obtained.

Generalization and Maintenance

As a test for generalization of training, on 9 of the training days, a second experimenter randomly tested the training stimuli at the end of the session. The testing took place in a room other than the "programming room," as a test for generalization across trainers and settings.

The maintenance of training was assessed on three separate occasions. Ten days following the first training session, the experimenter assessed the subject's abilities to perform the signs learned on the first day of training. The same procedure was used for training days #10 and #20.

Data Collection and Reliability

The experimenter recorded data for all sessions. For 10 (25%) of the training sessions, an outside
observer recorded reliability data. Reliability averaged 97.87% for the 10 sessions, ranging from 91.60% to 100.00%. The reliability sessions were distributed throughout all phases of the experiment. A sample data sheet may be found in Appendix A.
RESULTS

Accuracy of Responding

Because the delayed prompting procedure typically reduces or eliminates errors in discrimination training, it was anticipated that the subjects in the current study would acquire the discriminations with a high rate of accuracy. Subjects 2 and 3 responded with 100% accuracy across all phases of the experiment while Subject 1 produced five errors during the first exposure to Condition A, for an overall accuracy rate of 99%. It is apparent, therefore, that the disparity in reinforcement magnitude during Conditions B and C did not affect the accuracy of responding during the training.

Trials to Criterion

Criterion for mastery of a single discrimination was 4 out of 4 correct anticipations at a single delay value. Figure 2 presents the mean trials to criterion for Subjects 1, 2 and 3 across all conditions of the experiment. While each subject displayed distinct, idiosyncratic response patterns, all of the subjects' response patterns were affected by alterations in reinforcement magnitude across the various conditions of the experiment.

The mean trials to criterion for Subject 1 across each condition were as follows: A-16.48, B-11.20, C-14.08,
Figure 2. Mean Trials to Criterion for Subjects 1, 2 and 3 Across All Experimental Conditions.
A'-16.32 and B'-11.36. A one-way analysis of variance (ANOVA) was computed for the above means, indicating a significant difference between means at the p<.001 level (F=29.15). In determining specific differences, correlated t-tests were run on the above means in the following comparisons: A-B, B-C and A'-B'. The differences between these means were all found to be statistically significant at the p<.01 level.

The mean trials to criterion for Subject 2 across conditions were: A-14.08, B-9.84, C-12.24, A'-14.08 and B'-9.76. The ANOVA for the scores for Subject 2 revealed a significant difference between means at p<.001 (F=22.71), while t-test scores for the same comparisons also indicated statistically significant differences (p<.001).

Subject 3 produced mean trials to criterion as follows: A-14.66, B-9.76, C-12.32, A'-13.92 and B'-9.76. The differences between the means for Subject 3 were also found to be significant using the ANOVA (F=20.65, p<.001), but the differences were not as pronounced with the t-test manipulations (A-B, p<.001; B-C, p<.02; and A'-B', p<.01).

It should be noted that Subject 1 was mildly afflicted with cerebral palsy. Response latencies were therefore longer for this subject, as reflected in the disparity between the average mastery of each task during all conditions. Further, the average trials necessary to meet criterion was affected by changes in reinforcement...
magnitude; Conditions B and B' (CRF 5/CRF 1) reduced trials to criterion while Conditions C (CRF 1/CRF 5) and A' (CRF 1/CRF 1) increased the necessary number of trials to meet criterion.

Finally, it was anticipated that Condition A would contaminate the scores obtained under Condition A' by providing an immediate history with the procedure. Subjects 1 and 3 did have slightly lower trials to criterion under Condition A', but this difference was too small to be of any practical significance.

Transfer Trial

The transfer of stimulus control took place on the trial where uniform preprompt responding began. That is, during a given discrimination, when the subject began to respond consistently before the prompt, a series of consecutive, preprompt responses was observed. The first preprompt response in the series to mastery was the transfer trial. Figure 3 shows the mean transfer trial for Subjects 1, 2 and 3 across all conditions of the experiment.

Subject 1 produced the following mean transfer trial scores across the various conditions: A-12.92, B-8.04, C-10.72, A'-12.96 and B'-8.08. Again, a one-way ANOVA was performed on the above data, showing significant differences between means at the \(p<.001\) level \((F=29.39)\). A correlated t-test was performed for the above means in the following
Figure 3. Mean Transfer Trial for Subjects 1, 2 and 3 Across All Experimental Conditions.
comparisons: A-B, B-C and A'-B'. The differences between these sets of means were found to be significant at the p<.01 level of statistical significance.

The mean transfer trial across experimental conditions for Subject 2 were: A-10.52, B-6.40, C-8.62, A'-10.80 and B'-6.12. Statistically significant differences were found using the ANOVA at p<.001 (F=22.55). Differences between these means were also found significant at the p<.01 level using the correlated t-test.

The scores for Subject 3 were as follows: A-11.20, B-6.40, C-8.66, A'-10.44 and B'-5.96. The differences between the means for Subject 3 were again found statistically significant with the ANOVA (F=20.67, p<.001), but to a lesser degree using the t-test manipulations: (A-B, p<.001; B-C, p<.05; and A'-B', p<.01).

While Subjects 2 and 3 had transfer scores somewhat lower than Subject 1, all subjects' responding was sensitive to variations in reinforcement magnitude; when the value of the reinforcer favored anticipatory responding (Conditions B and B'), fewer exposures to the prompt were needed for transfer to occur. Conversely, when the magnitude of the reinforcer was biased towards prompt-controlled responding, the prompt was presented on a greater number of trials before transfer occurred.
Delay in Effect at Transfer

During a given discrimination, 4 consecutive correct responses resulted in a 0.5 second increase in the delay between the verbal instruction and the visual prompt. When a transfer of stimulus control occurred, the delay value currently in effect was recorded, and then averaged with the other delay values reported for that session. This score is the average delay necessary for accurate, preprompt responding to occur. Shorter delays would foster dependence on the prompt, while longer delays would promote errors. Figure 4 shows the mean delay value in effect at transfer for Subjects 1, 2 and 3 across all conditions.

The mean delay values at transfer for Subject 1 across all conditions were as follows: A-1.36, B-0.84, C-0.84, A'-0.42 and B'-0.84. A one-way ANOVA indicated a significant difference between means at $p<.001$ ($F=19.18$). Comparisons between the means of Conditions A-B, B-C and A'-B' using the correlated t-test revealed statistically significant differences at the $p<.01$ level.

Subject 2 produced the following mean delay values at transfer: A-1.11, B-0.61, C-0.87, A'-1.20 and B'-0.58. The ANOVA computations indicated a significant difference between means at $p<.001$ ($F=17.21$). The correlated t-test scores for the differences between these means were also significant at the $p<.01$ level.
Figure 4. Mean Delay in Effect at Transfer for Subjects 1, 2 and 3 Across All Experimental Conditions.
The mean delay value data for Subject 3 was again similar to the data for Subject 2: A-1.17, B-0.64, C-0.89, A'-1.16 and B'-0.56. The ANOVA computations for differences between means were significant at \( p<.001 \) (\( F=15.16 \)). The t-test manipulations for the data obtained on Subject 3 revealed the following significant differences between means: A-B, \( p<.001 \); B-C, \( p<.10 \); and A'-B', \( p<.01 \).

The average delay necessary to produce accurate preprompt responding was affected by changes in the reinforcer. It should be noted that Subject 3 had a longer history of manual sign language training coming into the experiment, as well as a larger repertoire of manual signs. Because his potential to improve performance during Conditions B and B' was less than for the other subjects, the differences between the mean delay values during the various conditions were not as significant as they were for Subjects 1 and 2. This may also account for the smaller difference between Conditions B and C for Subject 3.

### Percent Correct Anticipations

The percentage of responses occurring before the prompt was computed as follows: for each discrimination taught, the number of preprompt responses was divided by the total number of responses. The responses occurring at the 0.0 second delay value were not included in this computation as
there was no possibility for preprompt responding to occur at this delay. Figure 5 represents the mean percent of the responses which were correct anticipations for Subjects 1, 2 and 3 across all conditions of the experiment.

The mean percent of correct anticipations for Subject 1 across all conditions were: A-46.20, B-68.00, C-49.38, A'-41.25 and B'-64.50. A one-way ANOVA showed significant differences between means at p<.001 (F=22.68). A correlated t-test was performed on the differences between these means in the following comparisons: A-B, B-C and A'-B'. These differences were statistically significant at p<01.

The scores for Subject 2 were: A-55.63, B-85.75, C-61.75, A'-45.33 and B'-87.50. The ANOVA manipulation for the differences between means was significant at p<.001 (F=21.64). The t-test results for the same comparisons that were performed on the data for Subject 1 found the differences between the means to be significant at the p<.01 level.

The data for Subject 3 were as follows: A-51.19, B-86.25, C-63.17, A'-49.08 and B'-91.83. The one-way ANOVA was significant at p<.001 (F=27.40). The t-test computations on the data for Subject 3 revealed statistically significant differences between the means at the following levels of significance: A-B, p<.001; B-C, p<.02; and A'-B', p<.001.

The percentages of correct preprompt responses for all
Figure 5. Mean Percent of Responses Which Were Correct Anticipations for Subjects 1, 2 and 3 Across All Experimental Conditions.
subjects were high during Conditions B and B', but perfect sessions of 100% correct anticipatory responding were only achieved by Subject 2 twice, and Subject 3 three times. The lowest score was produced by Subject 1 (35.42%).

Again, the subjects' response patterns were sensitive to changes in reinforcement magnitude: Conditions B and B' (CRF 5/CRF 1) increased the percentage of anticipatory responses, while Conditions C (CRF 1/CRF 5) and A' (CRF 1/CRF 1) decreased anticipatory responding.

Generalization of Training

Generalization of training across settings and across trainers was assessed for each subject across Conditions A, B, and C. Table 1 shows the percentage of manual signs correctly performed in a novel setting and in the presence of a second trainer, for Subjects 1, 2 and 3 across Conditions A, B and C.

Subjects 1 and 3 both demonstrated a high level of generalization of learned tasks across trainers and settings. Because this level of generalization was fairly consistent across conditions, it may be inferred that this was due to the delayed prompting procedure itself, and not the reinforcement value in effect.

The data for Subject 2 indicate poor generalization of training. This performance may be attributed to factors related to his developmental disability. Subject 2 was
Table 1

Percentage of Acquired Discriminations Which Generalized Across Trainers and Settings for Subjects 1, 2 and 3 During Conditions A, B and C.

<table>
<thead>
<tr>
<th>CONDITION</th>
<th>SESSION</th>
<th>SUBJECT 1</th>
<th>SUBJECT 2</th>
<th>SUBJECT 3</th>
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<td>91.11%</td>
<td>37.78%</td>
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labelled autistic, so it may be the case that he displayed "overselectivity" (Rincover & Koegel, 1975) to the various stimulus inputs during training. That is, he may have overselected stimuli associated with the primary trainer or the primary setting. Thus, discriminations acquired in the presence of this trainer were not maintained in the presence of a second trainer or in a novel setting.

Maintenance of Training

Table 2 represents the maintenance over time of manual signs learned by Subjects 1, 2 and 3 across Conditions A, B and C.

Similar to the generalization data, Subjects 1 and 3 displayed good maintenance over time of the discriminations learned. Again, alterations in the value of the reinforcer apparently did not affect these results.

The maintenance data for Subject 2 were somewhat better than his generalization data. His performance may once again be attributed to his tendency to overselect certain stimulus inputs, resulting in the interference of proper maintenance of stimulus control.
Table 2

Maintenance of Acquired Signs Over Time for Subjects 1, 2 and 3 Across Conditions A, B and C.

<table>
<thead>
<tr>
<th>CONDITION</th>
<th>SESSION</th>
<th>SUBJECT 1</th>
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<th>SUBJECT 3</th>
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<td>C</td>
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<td>86.67%</td>
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DISCUSSION

Within virtually every educational setting, the trainer's goal is to establish a strong stimulus-response relation between a stimulus inherent in the task and a specific target behavior (Touchette & Howard, 1984). Once the response is shaped and brought under the control of a prompt stimulus, the focus of training is the transfer of control from the prompt stimulus to the target stimulus. While communication training among developmentally disabled populations is based on this premise, there are inconsistencies with respect to methodology of training. However, the desired objectives of all training procedures are more congruent; reduce or eliminate errors, and achieve lasting results in the most efficient manner possible (Sidman & Stoddard, 1967). The current study approached these objectives by implementing a simple, yet precise training procedure in producing a zero or near-zero error rate, as well as results which generalized and maintained over time. The variable of reinforcement magnitude was imposed on a delayed prompting procedure, revealing significant shifts in key dimensions of stimulus control transfer.

Two values of the reinforcer were varied according to two classes of response: responses occurring before the prompt, and responses coinciding with or occurring after
the prompt. Conditions A and A' (CRF 1/CRF 1) did not favor either response class, and were therefore used as a means of comparison for subsequent conditions. Conditions B and B' (CRF 5/CRF 1) favored anticipatory responding, while Condition C (CRF 1/CRF 5) encouraged subjects to wait for the prompt before responding. Although each subject displayed distinct response patterns, fairly consistent results were observed across all conditions. Transfer of stimulus control from a visual prompt to a stimulus inherent in the task occurred under all conditions, but with significant differences in the moment of transfer.

Each subject was exposed to a given discrimination until the criterion was reached. Conditions B and B' consistently decreased the number of trials necessary to achieve mastery. Conversely, Conditions C and A' were associated with a greater number of trials to reach criterion. It is interesting to note that the return to Condition A' following Condition C produced an even slower transfer of stimulus control. Although Condition A' is not purposely biased to either class of response, there is an inherent disparity in reinforcement density. That is, because preprompt responses are closer to trial initiation, the reinforcement density over several trials is necessarily greater when these responses occur. For this reason, it was expected that the results of Condition A' would be similar to those of Conditions B and B'. It may be the case,
however, that because Condition C preceded Condition A', it contaminated the results obtained during Condition A'. For example, Condition C favored prompt-controlled responding, resulting in a greater number of trials before preprompt responding occurred. When this response pattern had stabilized, Condition A' was introduced, and the pattern was maintained, as this condition did not discourage postprompt responding, nor did it greatly promote anticipatory responding. In actuality, the greater the number of trials to criterion with this condition, the greater the number of reinforcers obtained.

As previously stated, each subject displayed a distinct response pattern. This observation is reflected in the moment of transfer or mean transfer trial. For example, because Subject 1 was mildly afflicted with cerebral palsy, the mean transfer trial for this subject was higher during Condition A than for the other subjects. Subject 1 therefore had a greater potential to improve, thus allowing for results which showed greater differences between means than did the results for the other subjects. Conversely, Subject 3 had a longer history of sign language training, and therefore produced results which did not vary quite as much across conditions.

The mean delay value required for transfer to occur was relatively low for all subjects across each condition. It is interesting that although Condition C (CRF 1/CRF 5), and
to a lesser extent Conditions A and A' (CRF 1/CRF 1), should promote higher delay values, no subject approached the maximum delay of 5.0 seconds. Because this finding was consistent across conditions, it may be attributed primarily to the transfer procedure itself. That is, because Condition C provides a greater reinforcer for prompt-controlled responses, it was anticipated that all subjects would wait for the prompt during every trial in this condition. Since this consistently was not the case, there must be some aspect of the delay procedure which exerts greater control in producing transfer than the pre-arranged contingency of reinforcement in effect. This finding is also suggested by the data reported as "mean percent correct anticipations". During Conditions B and B', the response pattern which would produce the greatest amount of reinforcement would be a series of 3 correct preprompt responses, then 1 postprompt response, then 3 preprompt, and so on. With this pattern, the subject would benefit from preprompt responding by receiving a large reward, while the occasional postprompt response would prevent the attainment of criteria, and thus, increase the number of trials at a given discrimination. These data strongly suggest that at some point, reinforcement latency has precedence over reinforcement magnitude, a finding previously cited (Hobson, 1978).

The generalization and maintenance data were strong for
two of the subjects. Again, because the results were consistent across experimental conditions, it is assumed that the value of the reinforcer in effect at any given time did little to hinder or encourage the generalization and maintenance of the acquired discriminations.

The performance of Subject 2 during generalization and maintenance sessions was rather poor. Because he was diagnosed as autistic, this finding was consistent with those of Rincover and Koegel (1975). They found that autistics tend to overselect stimuli in situations involving multiple stimulus inputs. Thus, Subject 2 may have overselected irrelevant stimuli in the training setting. When tested with another trainer in a novel setting or at a later time in training, the response was lost or under the control of those irrelevant stimuli.

Several shortcomings of the current study should be noted. With respect to the subjects incorporated in the study, the sample was small and not exceedingly homogeneous. The manual signs used as discriminative stimuli were only those involving one-hand, or two-handed gross motor movements. However, it was not possible to insure complete homogeneity as some signs involved three dimensional movement while others did not. Also, presentation of early conditions may have contaminated performance during subsequent conditions. Thus, practice effects and other immediate history variables were not controlled. Finally,
because the reinforcement magnitude was disparate for the two classes of response throughout the various conditions, the effects of reinforcement frequency may have clouded the data obtained.

The findings of the current study, while not conclusive, do have important practical significance. First, the data strongly suggest that when the value of the reinforcer favors anticipatory responding over prompt-controlled responding, the time and effort of training a discrimination decreases for both trainer and student. Typical results may not be as pronounced as those obtained in the current study, but even a small improvement, when compounded over several years of extensive training, may substantially decrease the total amount of training.

Second, the results of the current study support the findings of previous studies by demonstrating a reduction or elimination of errors using the delayed prompting technique.

Finally, the data obtained during Condition C (CRF 1/CRF 5) indicate that even when a parameter such as reinforcement magnitude is inappropriately arranged to favor prompt-dependent responding, when used in conjunction with the delayed prompting procedure, transfer of stimulus control still reliably occurs.
REFERENCES


APPENDIX A

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APPENDIX B

Discriminative Stimuli for Subject 1 Across All Experimental Conditions
### APPENDIX B

**Discriminative Stimuli for Subject 1 Across All Experimental Conditions.**

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**CONDITION B**

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**CONDITION C**

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</tr>
<tr>
<td>32.</td>
<td>HANDS, FEET, BONES, BLIND, TOUCH</td>
<td>0</td>
</tr>
<tr>
<td>33.</td>
<td>TASTE, LIFE, REST, WAKE UP, HEALTHY</td>
<td>0</td>
</tr>
<tr>
<td>34.</td>
<td>YOUNG, OLD, FAT, SORE, NERVOUS</td>
<td>0</td>
</tr>
<tr>
<td>35.</td>
<td>SWEAT, UPSET, DIZZY, FAINT, MEDICINE</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>36.</td>
<td>A COLD, FLOOR, KEY, FURNITURE, TABLE</td>
<td></td>
</tr>
<tr>
<td>37.</td>
<td>BLANKET, MIRROR, BATH, LIGHTBULB, UMBRELLA</td>
<td></td>
</tr>
<tr>
<td>38.</td>
<td>HANG UP, IRON, REFRIGERATOR, THIRSTY, SALT</td>
<td></td>
</tr>
<tr>
<td>39.</td>
<td>PEPPER, SOUR, TEA, CREAM, JELLY</td>
<td></td>
</tr>
<tr>
<td>40.</td>
<td>BACON, EGG, DESSERT, PEACH, SPAGHETTI</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX C

Discriminative Stimuli for Subject 2 Across All Experimental Conditions.
APPENDIX C

Discriminative Stimuli for Subject 2 Across All Experimental Conditions.

<table>
<thead>
<tr>
<th>SESSION</th>
<th>STIMULI</th>
<th>ERRORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONDITION A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>UNCLE, AUNT, COUSIN, KID, PARENTS</td>
<td>0</td>
</tr>
<tr>
<td>2.</td>
<td>THOSE, THIS, HIS, MYSELF, SOMEONE</td>
<td>0</td>
</tr>
<tr>
<td>3.</td>
<td>MONTH, YEAR, WHO, EVERYDAY, NOON</td>
<td>0</td>
</tr>
<tr>
<td>4.</td>
<td>ONCE, SOMETIMES, UNTIL, NEXT, BRAIN</td>
<td>0</td>
</tr>
<tr>
<td>5.</td>
<td>REASON, WONDER, PURPOSE, SMART, STUPID</td>
<td>0</td>
</tr>
<tr>
<td>6.</td>
<td>PRESSURE, BELIEVE, DOUBT, COMPARE, OBEY</td>
<td>0</td>
</tr>
<tr>
<td>7.</td>
<td>EXPERIENCE, EXPERT, PROVE, ATTENTION, SILLY</td>
<td>0</td>
</tr>
<tr>
<td>8.</td>
<td>HATE, LONELY, FRUSTRATED, HEART, WISH</td>
<td>0</td>
</tr>
<tr>
<td>9.</td>
<td>COMFORTABLE, COMPLAIN, SELFISH, JEALOUS, UNFAIR</td>
<td>0</td>
</tr>
<tr>
<td>10.</td>
<td>FRIEND, POLICE, ROBBER, KING, CAPTAIN</td>
<td>0</td>
</tr>
<tr>
<td>CONDITION B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>BUSY, BUILD, PAINT, PICTURE, PAY</td>
<td>0</td>
</tr>
<tr>
<td>12.</td>
<td>RICH, POOR, COINS, CHECK, CHEAP</td>
<td>0</td>
</tr>
<tr>
<td>13.</td>
<td>CAN, IMPROVE, DROP, ABOVE, MIDDLE</td>
<td>0</td>
</tr>
<tr>
<td>14.</td>
<td>ACROSS, GONE, TOGETHER, APART, INTO</td>
<td>0</td>
</tr>
<tr>
<td>15.</td>
<td>MAKE, WAIT, LOOK, MAYBE, CAREFUL</td>
<td>0</td>
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<tr>
<td>16.</td>
<td>STAY, TAKE, DEMAND, GIVE, CHOOSE</td>
<td>0</td>
</tr>
<tr>
<td>17.</td>
<td>WILLING, CALL, SEND, HAS, MEET</td>
<td>0</td>
</tr>
<tr>
<td>18.</td>
<td>FAIL, RUB, SHARE, STEAL, WARN</td>
<td>0</td>
</tr>
<tr>
<td>19.</td>
<td>OPPOSITE, EXACT, IMPORTANT, CLEAN, STRONG</td>
<td>0</td>
</tr>
<tr>
<td>20.</td>
<td>LIE, TRUE, UGLY, LAZY, WEAK</td>
<td>0</td>
</tr>
<tr>
<td>CONDITION C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.</td>
<td>FAVORITE, DANGER, DRY, SHARP, SECRET</td>
<td>0</td>
</tr>
<tr>
<td>22.</td>
<td>AND, BOTH, FULL, SMALL, BIG</td>
<td>0</td>
</tr>
<tr>
<td>23.</td>
<td>ADD, COUNT, CROWDED, EMPTY, WEIGH</td>
<td>0</td>
</tr>
<tr>
<td>24.</td>
<td>SPEAK, VOICE, WHISPER, SIGNS, FINGERSPELL</td>
<td>0</td>
</tr>
<tr>
<td>25.</td>
<td>MEMBER, MAGAZINE, SHOUT, ARGUE, STORY</td>
<td>0</td>
</tr>
<tr>
<td>26.</td>
<td>WORD, LIBRARY, LEARN, TEACH, VOTE</td>
<td>0</td>
</tr>
<tr>
<td>27.</td>
<td>THING, MUSIC, ART, TEST, DICTIONARY</td>
<td>0</td>
</tr>
<tr>
<td>28.</td>
<td>BRIDGE, CITY, FLAG, ELEVATOR, SIGNATURE</td>
<td>0</td>
</tr>
<tr>
<td>29.</td>
<td>MAGIC, WORLD, NATURE, SUN, MOON</td>
<td>0</td>
</tr>
<tr>
<td>30.</td>
<td>ICE, COOL, BREEZE, LIGHTNING, CLOUD</td>
<td>0</td>
</tr>
<tr>
<td>CONDITION A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31.</td>
<td>FLOWER, BODY, HEAD, FACE, ARM</td>
<td>0</td>
</tr>
<tr>
<td>32.</td>
<td>HANDS, FEET, BONES, BLIND, TOUCH</td>
<td>0</td>
</tr>
<tr>
<td>33.</td>
<td>TASTE, LIFE, REST, WAKE UP, HEALTHY</td>
<td>0</td>
</tr>
<tr>
<td>34.</td>
<td>YOUNG, OLD, FAT, SORE, NERVOUS</td>
<td>0</td>
</tr>
<tr>
<td>35.</td>
<td>SWEAT, UPSET, DIZZY, FAINT, MEDICINE</td>
<td>0</td>
</tr>
</tbody>
</table>

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CONDITION B
36. A COLD, FLOOR, KEY, FURNITURE, TABLE 0
37. BLANKET, MIRROR, BATH, LIGHTBULB, UMBRELLA 0
38. HANG UP, IRON, REFRIGERATOR, THIRSTY, SALT 0
39. PEPPER, SOUR, TEA, CREAM, JELLY 0
40. BACON, EGG, DESSERT, PEACH, SPAGHETTI 0
APPENDIX D

Discriminative Stimuli for Subject 3 Across All Experimental Conditions.
## Discriminative Stimuli for Subject 3 Across All Experimental Conditions

<table>
<thead>
<tr>
<th>Session</th>
<th>Stimuli</th>
<th>Errors</th>
</tr>
</thead>
</table>
| **Condition A**
1. | UNCLE, AUNT, COUSIN, KID, TWINS | 0 |
2. | THIS, EVERYBODY, SOMEONE, THOSE, EVERYDAY | 0 |
3. | STILL, THEN, REGULAR, FAITHFULLY, SOMETIMES | 0 |
4. | MEMORIZE, REASON, HOPE, IDEA, OPINION | 0 |
5. | AGREE, DISAGREE, ENEMY, MISUNDERSTAND | 0 |
6. | PRESSURE, BELIEVE, OBEY, DECIDE, OR | 0 |
7. | HABIT, AFFECT, USED TO, RELATIONSHIP, TRICK | 0 |
8. | HUMBLE, BLUSH, KIND, COMFORTABLE, SELFISH | 0 |
9. | UNFAIR, NEIGHBOR, SAILOR, PRESIDENT, PRINCIPAL | 0 |
10. | ASSISTANT, BUSINESS, RICH, POOR, BORROW | 0 |
| **Condition B**
11. | DROWN, CLUMSY, LEAD, ARRIVE, HURRY | 0 |
12. | FIND, EASY, AHEAD, POSITIVE, IMPROVE | 0 |
13. | MIDDLE, ABOVE, THROUGH, ACROSS, DISAPPEAR | 0 |
14. | NOTICE, SEARCH, BEHAVIOR, DEMAND, CHOOSE | 0 |
15. | INVITE, MEET, CONGRATULATE, WIN, SEND | 0 |
16. | CALL, VOLUNTEER, BLAME, INNOCENT, SUPPORT | 0 |
17. | AVOID, BLOCK, FAIL, HIDE, SAFE | 0 |
18. | SHARE, STEAL, CATCH, INTERESTING, OPPOSITE | 0 |
19. | STRANGE, LUCKY, FAVORITE, DANGER, SHINING | 0 |
20. | MEDIUM, LIE, FALSE, TRUE, UGLY | 0 |
| **Condition C**
21. | SUBTRACT, ADD, CROWDED, EMPTY, EQUAL | 0 |
22. | WHISPER, COMAND, STORY, ARGUE, INSULT | 0 |
23. | MEMBER, VOTE, PROMISE, MAGAZINE, SHOUT | 0 |
24. | COLLEGE, EDUCATION, LEARN, STUDY, LIBRARY | 0 |
25. | DICTIONARY, LESSON, TEST, VOCABULARY, WORD | 0 |
26. | POETRY, MUSIC, ART, WORKSHOP, GRADUATE | 0 |
27. | MAGIC, BRIDGE, CITY, ELEVATOR, SIGNATURE | 0 |
28. | ELECTRICITY, CHAIN, STRING, PRESENT, TICKET | 0 |
29. | FUNERAL, WORLD, NATURE, LAND, ICE | 0 |
30. | RAINBOW, LIGHTNING, THUNDER, SHADOW, RIVER | 0 |
| **Condition A**
31. | ROCK, MOUNTAIN, VALLEY, GRASS, GARDEN | 0 |
32. | FARM, BONES, BLIND, LIFE, REST | 0 |
33. | SLEEP, WAKE UP, HEALTHY, THIN, SORE | 0 |
34. | NERVOUS, SWEAT, UPSET, DIZZY, FAINT | 0 |
35. | TEMPERATURE, MEDICINE, POISON, BLOOD, FURNITURE | 0 |
CONDITION B

36. TABLE, BLANKET, SOAP, SEW, LIGHTBULB  0
37. WASHER, DRYER, REFRIGERATOR, DELICIOUS, BAKE  0
38. CREAM, PICKLE, KETCHUP, SAUCE, SYRUP  0
39. LEMON, STRAWBERRY, COCONUT, COUNTRY, AMERICA  0
40. OWL, MOSQUITO, INSECT, BEE, WORM  0
BIBLIOGRAPHY


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