1978

Using differential reinforcement to train instruction following behavior through the transfer of stimulus control from physical guidance to verbal instructions

Jon deLongpre'
University of the Pacific

Using Differential Reinforcement to Train Instruction Following Behavior through the Transfer of Stimulus Control from Physical Guidance to Verbal Instructions

---

A Thesis
Presented to
the Graduate Faculty of
the University of the Pacific

In Partial Fulfillment
of the Requirements for the Degree
Master of Arts

---

by
Jon deLongpre'
May 1978

Acknowledgments

To all of the people at the University of the Pacific who provided the author with advice, thank you. A very special thanks to Dr. John R. Lutzker for his continued support, guidance, and friendship as advisor and thesis committee Chair. Dr. Timothy C. Blackburn helped to make this all possible through his invaluable professional direction and his wonderful warm friendship. Thank you, Georganne White-Blackburn, for your sincere inspiration and wisdom. Dr. John H. Mabry made a fine contribution and his support is very much appreciated. Dr. Douglas W. Matheson, thank you for your help and for putting up with all of us behaviorists. And, Jolene, thanks for being there when you were needed.

Abstract

A differential reinforcement procedure was investigated as a means for transferring stimulus control from physical guidance to verbal instructions in the training of instruction-following behavior. An eight year old, severely retarded female was trained to respond to nonsense verbal prompts which, through training, had become discriminative stimuli for (a) "clap your hands", (b) "raise your hand", and (c) "tap the table". The use of differential reinforcement of singular and paired verbal/physical prompt components increased the response rates to levels above the 80% criterion level. Training of these responses was accomplished across behaviors in a multiple baseline format.

Using Differential Reinforcement to Train Instruction Following Behavior through the Transfer of Stimulus Control from Physical Guidance to Verbal Instructions

An important area of language training regards language as a stimulus which controls motor responses (receptive language). That is, though it is important for a person to possess the skills necessary to emit language as a response, that person must also be able to follow verbal instructions (i.e., his motor responses must come under control of verbal stimuli - instructional control). Striefel, Bryan, and Arkins (1974) suggest that, typically, residents in institutions for the retarded are not required to engage in verbal behavior; futhermore these residents are more likely to be reinforced for instruction-following behaviors.

Whitman, Zakaras, and Chardoz (1971) point out that while many studies have discussed the importance of verbal instructions for establishing and maintaining behavior, few have addressed themselves to developing verbal stimulus control of instruction-following behavior. Striefel et al. (1974) also indicate that little has been done regarding stimulus control of verbal instruction-following behavior. Whitman et al. (1971) trained two severely retarded children motor responses to a variety of verbal instructions by positive reinforcement, physical guidance, and fading procedures. Striefel and Wetherby (1973) obtained similar results utilizing similar procedures.

In 1974 Striefel et al. established instruction-following behavior in developmentally disabled individuals within a framework of stimulus control transfer. Transfer is defined as the acquisition of stimulus control by one stimulus dimension (e.g., verbal instructions) that has been paired with another stimulus dimension that already controls the response (e.g., physical guidance). This study was modeled after a large body of literature reporting errorless transfer of stimulus control (Moore & Goldiamond, 1964; Terrace, 1963a, 1963b, 1966; Touchette, 1968, 1971). The procedures followed in these studies, as well as those used by Striefel et al., were designed to transfer the stimulus control of a behavior from one stimulus to another stimulus or set of stimuli that did not initially control that behavior. This was accomplished by first pairing the initial controlling stimulus with the new stimulus, and then gradually fading the initial stimulus, leaving the response in the control of the new stimulus. Many other studies have been reported that worked within a stimulus control transfer, or errorless fading paradigm (e.g., Bijou, 1968; Corey & Shamow, 1972; Lovaas, Schriebman, Koegel, & Rehm, 1971; Schilmoeller & Etzel, 1977; Schreibman, 1975; Sidman & Stoddard, 1966, 1967). However, to date, the Striefel et al. study is the only attempt to increase instruction-following behavior with these procedures.

It is important to note that all of the above-mentioned research largely depends on the fading out or fading in of specific stimuli. In many cases, the use of fading would seem to be cumbersome. Some studies have had to undergo major and repeated revisions of their fading procedures before transfer of stimulus control was obtained (Bijou, 1968; Schilmoeller & Etzel, 1977; Sidman & Stoddard, 1967). Other studies have partially attributed failure of stimulus control transfer to problems with fading procedures (Cheney & Stein, 1974; Gollin & Savoy, 1968; Schwartz, Firestone, & Terry, 1971; Smith & Filler, 1975). Still other studies have resorted to elaborate apparatus (Schreibman, 1975) and complex procedures of both time-delay fading (Striefel et al., 1974; Touchette, 1971; Whitman et al., 1971) and visual cue fading (Schreibman, 1975).

Unfortunately, unlike much of the rest of the behavior modification technology, the inclusion of fading procedures by trainers has led to difficulties in developing a systematic and quantifiable training program prior to actual client training. The degree to which a stimulus should be faded, both the speed and the size of each step, can only be determined by moment-to-moment feedback from the client's response approximations during training. This leaves the trainer in a position of making subjective decisions based in part on his or her prior training experience and current skill level. Furthermore, this creates another difficulty when an experienced trainer is engaged in teaching an inexperienced trainer how to implement fading procedures (i.e., teaching the subjective decision criteria).

For many years the animal research literature has been filled with examples of stimulus transfer experiments which utilize differential reinforcement procedures rather than those of fading (e.g., Egger & Miller, 1962; Jenkins & Harrison, 1960; Jenkins & Sainsbury, 1969, 1970; Kamin, 1969; Wagner, 1969). These studies examine the transfer of control across two stimuli. To illustrate the training procedures, the notation used by Wagner (1969, p. 93) will be used here. Consider two stimuli, A and B, both of which are discriminative stimuli for the same response. Secondly, consider reinforcement of a correct response to a stimulus (A for example), as A(+) and non-reinforcement of a correct response to that stimulus as A(-). Finally, consider the paired presentation of stimulus A and stimulus B as AB. Then, the notation for non-differential reinforcement of correct responses to AB trials would be AB(+). Differential training involves AB(+) as well as the non-reinforcement of responses to A, or A(-). Therefore, differential training is noted as AB(+),A(-). Thereby, correct responses to presentations of both stimuli together, AB, are always reinforced, and responses to presentations of the A stimulus alone are never reinforced.

Next, assume that A has a prior history of occasioning the desired response and B has no control over the behavior. The animal research, cited above, demonstrates that stimulus control can be transferred from A to B by the presentation of multiple trials AB(+) randomly intermixed with multiple trials of A(-) (i.e., differential reinforcement AB(+),A(-)). Jenkins and Sainsbury (1968) state that, when the presence of the B stimulus distinguishes between reinforced and non-reinforced trials (i.e., in AB(+),A(-) training), A loses its ability to elicit a response and B's ability to elicit that response is increased. After repeated trials of AB(+),A(-) training, the response comes under the stimulus control of B without having utilized fading procedures.

It would seem to follow that the addition of B(+) trials would facilitate a faster transfer of control from A to B. This would transform the training notation into AB(+),A(-),B(+). The addition of B(+) trials should tend to increase the distinction between the A and B components of AB during AB(+),A(-),B(+) trials by way of a more powerful differential reinforcement of the B component.

The utilization of differential reinforcement in training humans taken from the animal literature would allow for a more systematic and quantifiable pre-training procedure. Its usage would enable a trainer to be equipped with a precise, written, step-by-step format before initiating training. Secondly, these procedures would be more easily taught to trainers than could those requiring subjective judgments (i.e., fading). The present study was designed to empirically assess the transfer of stimulus control from physical guidance, A, to verbal instructions, B, in controlling instruction-following behaviors in humans. This was accomplished by utilizing the expanded animal literature model, noted as AB(+),A(-),B(+).

Method

Subject

Subject was Faith, an eight year old severely retarded female enrolled at the Walton Developmental Center, Stockton, California. Her records indicated that she had normal hearing and vision. She had no motor response problems which would inhibit her from performing the target behaviors.

Setting

All pre-test, baseline assessments, and training sessions were conducted in a private, quiet room containing two chairs and a table. The training room, 12 ft. by 6 ft. (3.66 meters by 1.83 meters), was connected to an observation room via a one-way mirror and an intercom system.

Procedure

Target behaviors. Three instruction-following responses taken from Peterson (1968) were selected for training; (a) tap the table, (b) raise your hand, and (c) clap your hands. In order to control for a prior and/or local history of responding to verbal instructions of the target behaviors, nonsense words were used as the verbal prompts during training. They are as follows: (a) tap the table; timp tab dob, (b) raise your hand; roose yab hienz, and (c) clap your hands; clemp yib hoont.

Data collection. Data were collected by the trainer on the number of correct responses to presentations of verbal only prompt trials for each target behavior. This was done by checking off the appropriate box on a prepared data sheet after each trial. These data were then calculated as percentage of correct responses. Data were similarly collected on the independent variable for the delivery of the appropriate stimuli for each trial and the appropriate delivery of reinforcement or non-reinforcement for that trial.

Reliability. Reliability sessions were conducted in at least 25% of all conditions. These consisted of independent observations by a trained observer viewing the sessions through the one-way mirror and listening by way of the intercom system. Reliability was calculated for both the dependent and independent variables by dividing the number of agreements by the number of agreements plus disagreements per session. Separate calculations were made for the dependent and independent variables. The mean reliability for these measures was 94% (range = 88% to 100%) for the dependent variable and 99% (range = 97% to 100%) for the independent variable.

Pre-test. A pre-test was administered prior to the beginning of baseline assessment to determine if Faith would engage in the correct responses upon request, prior to any training. She was given the exact verbal prompt (not the nonsense prompt) for each target behavior, for each of the three pre-test days. No physical prompts were given and no reinforcement was made available for correct responses. Any correct response on any trial for any target behavior would have disqualified her for inclusion in this study.

Baseline assessments. Both Faith and the trainer were seated in the chairs facing one another, separated by the table. Each verbal prompt (nonsense) was delivered by the trainer in a random order for 35 trials. All randomization conducted in this study was done using a random number table; entry by the flip of a coin. Data were collected on each instance of a correct response for each presentation of a verbal prompt. Reinforcement was not available.

A(+) training: physical guidance only. This condition was provided in order to produce a strong stimulus control bias in favor of physical guidance, A. Training of each behavior during A(+) trials included complete physical prompts such that Faith was physically guided through the entire response. Thus, she necessarily responded at 100% correct rate during these trials. Reinforcement was delivered immediately after each response. This included verbal praise (not containing the decription of the target behaviors), physical contact, and an edible reinforcer. Probe trials consisting of the trainer delivering the verbal prompts were conducted as the dependent variable measure. No reinforcement was available for correct responses to probe trials.

AB(+) training: physical guidance paired with verbal prompts. This condition was included to assess the effects of simple physical/verbal prompt pairing (i.e., would stimulus control transfer after pairing only). Training of each target behavior during AB(+) trials included the same complete physical prompts as in A(+) trials with the addition of the nonsense verbal prompt, B, immediately preceding but not overlapping the physical prompt. Reinforcement was again delivered on a CRF schedule. Probe trials (B only) were conducted to assess the dependent variable measure.

A(-),AB(+),B(+) training: stimulus control transfer. This condition consisted of the expanded animal literature training model. The training was conducted by randomly intermixing A(-) trials, AB(+) trials, and B(+) trials. A(-) trials were identical to those in the physical guidance only training except that reinforcement was no longer made available during those trials. The AB(+) trials were identical in all respects to the AB(+) training trials above (i.e., reinforcement was on a CRF schedule). B(+) trials, verbal prompts only, were added whereby the nonsense verbal prompt was delivered without any physical guidance. This is analogous to the probe trials above, except that now, during B(+) trials, reinforcement was delivered on a CRF schedule contingent on a correct response. The dependent measure was assessed from the number of correct responses during B(+) trials.

<u>B(+) training: verbal prompts only</u>. This post-training condition consisted of trials of verbal prompts only. Reinforcement was delivered on a CRF schedule contingent on a correct response. Data were collected on the number of correct responses.

<u>Design</u>. With the exception of the pre-test sessions and the B(+) training (post-training), all training was conducted across behaviors in a multiple baseline format. Baseline sessions consisted of 35 trials of verbal prompt only. A(+) training, AB(+) training, and A(-),AB(+),B(+) training sessions consisted of six blocks of six trials per target behavior per day plus 35 probe trials per day. The order in which trials were presented within each block was determined by random. The order of target behavior training was randomized for each session. The average length of time for each training session was 55 minutes. The target behaviors were introduced for training sequentially and cummulatively. The criteria for

condition change was determined prior to the onset of the study and was set at either 80% correct response rate for five consecutive sessions, or a stable zero response rate. B(+) training (verbal prompts only) was instituted for all three target behaviors simultaneously once Faith maintained an 80% correct response rate for all three target behaviors.

Results

Figure 1 shows the percentage of correct responses to verbal only prompts in all conditions across all target behaviors. Results are presented in percentage correct scores to adjust for slight variations in the number of possible responses across conditions (range = 30 to 36).

The pre-test and baseline scores were stable at zero across all behaviors. The AB(+) condition scores (physical/ verbal pairing) were stable at zero for behavior 1 ("tap the table") and behavior 3 ("clap your hands"). On day 18 and day 22 there was one correct response of "raise your hand" during the AB(+) condition. All other data for the "raise your hand" behavior during AB(+) condition was stable at zero.

All three target behaviors were trained to at least the 80% criteria level during the A(-),AB(+),B(+) condition. The mean number of sessions (days) for the three target behaviors to reach criteria during this condition was 11.0. All response rates stayed at 80% or above with the exception of day 58 where behavior 2 ("raise your hand") dropped to

PERCENTAGE CORRECT RESPONSES TO VERBAL PROMPT

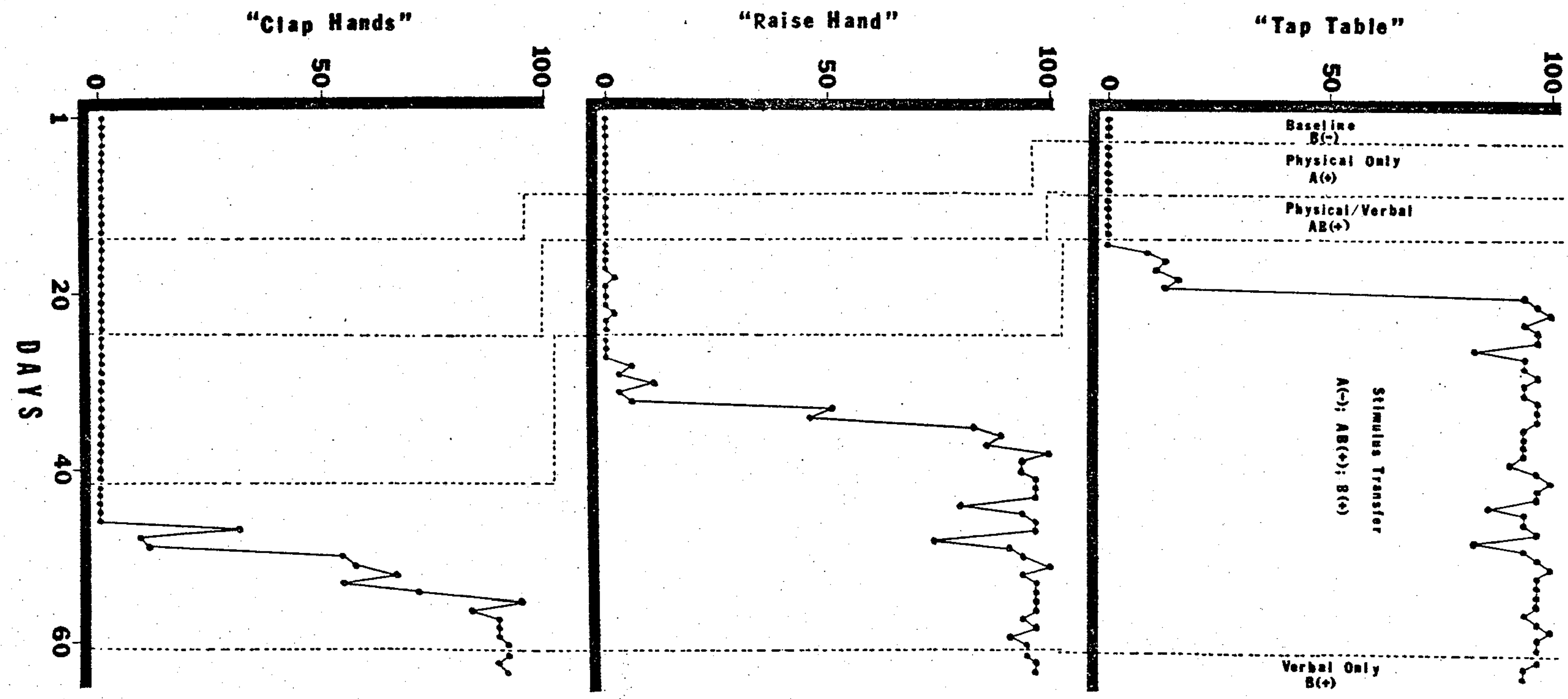

Figure 1. Percentage of correct responses to nonsense verbal only prompts in all conditions across all target behaviors (A = physical prompts; B = verbal prompts; AB = physical and verbal prompts paired).

74%. On day 59, behavior 2 returned to 91% and remained above criteria for the duration of the study. The mean correct response rates for each behavior after reaching criteria are as follows: (a) behavior 1; "tap the table", $\overline{X}$ = 95.2, (b) behavior 2; "raise your hand", $\overline{X}$ = 93.2, (c) behavior 3; "clap your hands", $\overline{X}$ = 89.2. The mean correct response rate for the behaviors combined was $\overline{X}$ = 94.0. The mean correct response rates for each behavior from the onset of A(-),AB(+),B(+) training are as follows: (a) behavior 1; $\overline{X}$ = 84.3, (b) behavior 2; $\overline{X}$ = 70.8, (c) behavior 3; $\overline{X}$ = 46.7. The mean correct response rate for the behaviors combined from the onset of this condition was $\overline{X}$ = 73.0.

Results of the B(+) condition (verbal prompts only; CRF) indicate that the percentage of correct responses were maintained above criteria across all target behaviors. The mean correct response rates for each behavior during B(+) training are as follows: (a) behavior 1; $\overline{X}$ = 95.0, (b) behavior 2; $\overline{X}$ = 96.0, and (c) behavior 3; $\overline{X}$ = 90.3. The mean correct response rate for the behaviors combined was $\overline{X}$ = 94.0.

The data collected on the independent variables (i.e., delivery of the appropriate stimuli and the appropriate delivery of reinforcement or non-reinforcement) were combined for each behavior across all conditions. The mean percentage of correct delivery were as follows: (a) behavior 1; $\overline{X}$ = 99.9, (b) behavior 2; $\overline{X}$ = 100, and (c) behavior 3;

$\overline{X}$ = 99.7. The mean percentage of correct deliveries for all behaviors combined across all conditions was $\overline{X}$ = 99.9.

Discussion

The results of this study indicate that instruction-following behavior can be brought under verbal stimulus control by the use of the stimulus transfer training package. The multiple baseline analysis demonstrated that the training package was responsible for the increase above levels observed during baseline, physical prompts only, or paired physical/verbal prompts conditions. These results were shown to be a function of the stimulus transfer procedures rather than the presentation of singular or paired stimuli components.

The use of nonsense words was an adequate and necessary control for prior and/or local learning history. This did, however, limit the validity of any follow-up sessions in that, there were no reinforcers available in the natural environment which would maintain behavior after termination of training. Further research utilizing English words is needed to assess the maintenance of behaviors trained with these procedures.

Unfortunately, the final condition (i.e., verbal prompts only, CRF; B(+)) had to be terminated prematurely. This was due to Faith's Easter vacation followed immediately by her ten day absence from school. The three days in which B(+) data were collected showed a limited but encouraging trend. If extrapolated, these data may have indicated that once a behavior has come under verbal stimulus control through the use of these stimulus control transfer procedures, the physical prompt dimension of training could be terminated and the behavior could be occasioned by verbal prompts alone. This is, of course, a tenative speculation. Again, further research sould be conducted using English words and longer B(+) training.

It is possible that similar results might have been achieved if the paired physical/verbal prompts condition had been extended (analogous to classical conditioning). It is the author's contention, however, that if behavior levels did increase by way of AB(+) training, the gains would be much slower than those achieved in the present study. Paired physical/verbal training, AB(+), was conducted for a total of 17 days for behavior three; "clap your hands". The data indicate a stable response rate of zero for all 17 days. The longest time taken for any behavior to reach the 80% criteria level was 13 days (during stimulus transfer training). The mean number of days for the response rate to reach criteria was 11.

If there had not been a 19 day absence from training, it would have been interesting to use the stimulus control transfer model to transfer control from the nonsense verbal prompts to English verbal prompts. There would seem to be no evidence that would limit the use of these procedures to transferring control from a physical stimulus dimension to a verbal stimulus dimension. The use of these procedures in transferring control from one verbal stimulus dimension to another verbal stimulus dimension (e.g., teaching a second language) would also be a valuable tool.

In summary, the results reported in this study indicate that the stimulus control transfer model used can be a viable training procedure when used to teach instruction-following behavior. In addition, these procedures were quantified and written exactly as implemented, prior to the onset of training. It is not suggested that this model replace fading procedures. Further research may suggest, however, that the stimulus control transfer model will serve as an alternative to fading and, perhaps, the method of choice when the trainer involved is not at a point where he or she is able to make the subjective decisions necessary to be skillful at fading.

References

Bijou, S.W. Studies in the experimental development of left-right concepts in retarded children using fading techniques. In N.R. Ellis (Ed.), International review of research in mental retardation (Vol. 3). New York: Academic Press, 1968.

Cheney, T. & Stein, N. Fading procedures and oddity learning in kindergarten children. Journal of Experimental Child Psychology, 1974, 17, 313-321.

Corey, J.R. & Shomow, J. The effects of fading on the acquisition and retention of oral reading. Journal of Applied Behavior Analysis, 1972, 5, 311-315.

Egger, M.D. & Miller, N.E. Secondary reinforcement in rats as a function of information value and reliability of the stimulus. Journal of Experimental Psychology, 1962, 64, 97-104.

Gollin, E.S. & Savoy, P. Fading procedures and conditional discrimination in children. Journal of the Experimental Analysis of Behavior, 1968, 11, 443-451.

Jenkins, H.M. & Harrison, R.H. Effect of discrimination training on auditory generalization. Journal of Experimental Psychology, 1960, 59, 246-253.

Jenkins, H.M. & Sainsbury, R.S. The development of stimulus control through differential reinforcement. In N.J. Mackintosh & W.K. Honig (Eds.), Fundemental issues in associative learning. Halifax: Dalhousie University Press, 1969.

Jenkins, H.M. & Sainsbury, R.S. Distinctive feature on positive or negative trials. In D. Mostofsky (Ed.), Attention: contemporary theory and analysis. New York: Appleton-Century-Crofts, 1970.

Kamin, L.J. Selective association and conditioning. In N.J. Mackintosh & W.K. honig (Eds.), Fundamental issues in associative learning. Halifax: Dalhouse University Press, 1969.

Lovaas, O.I., Schreibman, L., Koegel, R., & Rehm, R. Selective responding by autistic children to multiple sensory input. Journal of Abnormal Psychology, 1971, 77, 211-222.

Moore, R. & Goldiamond, I. Errorless establishment of a visual discrimination using fading procedures. Journal of the Experimental Analysis of Behavior, 1964, 7, 269-272.

Peterson, R.F. Some experiments on the organization of a class of imitative behaviors. Journal of Applied Behavior Analysis, 1968, 1, 225-235.

Schilmoeller, K.L. & Etzel, B.C. An experimental analysis of criterion-related and non-criteria-related cues in "errorless" stimulus control procedures. In B.C. Etzel, J.M. LeBlanc, & D.M. Baer (Eds.), New developments in behavioral research: theory, method, and application. Hillsdale, New Jersey: Lawrence Erlbaum Associates, 1977.

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

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

Sidman, M. & Stoddard, L.T. Programming perception and learning for retarded children. In N.R. Ellis (Ed.), International review of research in mental retardation, (Vol. II). New York: Academic Press, 1966.

Sidman, M. & Stoddard, L.T. The effectiveness of fading in programming a simultaneous form discrimination for retarded children. Journal of the Experimental Analysis of Behavior, 1967, 10, 3-15.

Smith, R.A. & Filler, J.W. Effects of modified fading procedures on two choice discrimination performance of toddler-age children. Child Development, 1975, 46, 583-587.

Striefel, S., Bryan, K.S., & Aikins, D.A. Transfer of stimulus control from motor to verbal stimuli. Journal of Applied Behavior Analysis, 1974, 7, 123-135.

Striefel, S. & Wetherby, B. Instruction-following behavior of a retarded child and its controlling stimuli. Journal of Applied Behavior Analysis, 1973, 6, 663-670.

Terrace, H. Discrimination learning with and without "errors". Journal of the Experimental Analysis of Behavior, 1963, 6, 1-27. (a)

Terrace, H. Errorless transfer of a discrimination across two continua. Journal of the Experimental Analysis of Behavior, 1963, 6, 223-232. (b)

Terrace, H. Stimulus control. In W.K. Honig (Ed.), Operant behavior: areas of research and application. New York: Appleton-Century-Crofts, 1966, 271-344.

Touchette, P. The effects of graduated stimulus change on the acquisition of a simple discrimination in severely retarded boys. Journal of the Experimental Analysis of Behavior, 1968, 11, 39-48.

Touchette, P. Transfer of stimulus control: measuring the moments of transfer. Journal of the Experimental Analysis of Behavior, 1971, 15, 347-354.

Trabasso, T. & Bower, G.H. Attention in learning: theory, and research. New York: John Wiley and Sons, 1968.

Wagner, A.R. Stimulus validity and stimulus selection in associated learning. In N.J. Mackintosh & W.K. Honig (Eds.), Fundemental issues in associative learning. Halifax: Dalhousie University Press, 1969.

Whitman, T.L., Zadaras, M., & Chardos, S. Effects of reinforcement and guidance procedures on instruction-following behavior of severely retarded children. Journal of Applied Behavior Analysis, 1971, 4, 283-290.