PRECLUDING THE S- IN ESTABLISHING COLOR DISCRIMINATIONS IN AUTISTIC CHILDREN

THESIS

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By

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A procedure in which the S- was prevented from being responded to, by electro-magnets, was used to establish color discriminations. The procedure was modified in Situation 1, to include the prevention of responses to the S+ if the S- was responded to first.

The original procedure and modified procedure were used in Situation 1, with only the modified procedure being used in Situations 2 and 3. The procedure of reinforcing responses to the S+ and extinguishing responses to the S-, through non-reinforcement, was used in Situation 4.

Data recorded consisted of the number of trials, the number of reinforcements, and which stimulus was first responded to. Criteria for the acquisition of a discrimination was 100 first responses to the S+.

Results indicated that the modified procedure was much more effective in establishing the discriminations, than the original procedure or the procedure of reinforcing responses to the S+ and extinguishing responses to the S-. The modified procedure enhanced the establishment of stimulus control, reduced the number of errors and eliminated stereotyped responses.
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The handicapped child is a topic that continues to gain in public concern, a trend accentuated further by recent legislative and judicial decisions establishing their rights to equal educational benefits. The majority of people associate these decisions with pertaining to the mentally retarded child, but they also apply to a small but significant group of children who are classified as autistic. In 1943, Leo Kanner described a group of these youngsters who were unlike the retarded population with whom they had previously been confused, thus creating a new diagnostic syndrome for them called "early infantile autism" (Kanner, 1944). The syndrome was characterized by the "children's inability to relate themselves in the ordinary way to people and situations from the beginning of life . . . an obsessive desire for the maintenance of sameness" and "a fascination for objects" (Kanner, 1943, 212-222).

While Kanner suggested the primary cause of the autistic child's inability to establish affective contact with other people was organic, he implied that child-parent relationships played some role as well. He described parents of autistic
children as follows:

In the whole group there are few really warmhearted fathers and mothers. For the most part, the antecedents and collaterals are persons strongly preoccupied with abstractions of a scientific, literary, or artistic nature and limited in genuine contact with people. Even some of the happiest marriages are rather cold and formal affairs. (Kanner, 1957, pp. 742)

In addition to Kanner's theories, many more suggestions as to the cause of autism have been made. Rimland (1964) has proposed that an oversupply of oxygen to the reticular formation in early infancy could cause or stimulate autism. Koegler and Colbert have also placed the cause with disease or abnormality in the reticular formation (1959). The high degree of similarity between descriptions of autistic and brain-damaged children's behavior has been pointed out. Hyperactivity, visual-motor disturbances, distractibility, and impaired interpersonal relationships are common to both syndromes (Baer, 1961).

Emphasis on faulty parent-child relationships has been proposed by many researchers (Bettelheim, 1950; Esman, Kohn, & Nyman, 1959; Bender, 1947; Goldfarb, Braunstein, & Scholl, 1959). These studies have tended to place the cause on disturbed family patterns and inadequate or impersonal mothers, but it should also be mentioned that these could be the result of as well as the cause of autistic children.
Multiple causative factors have entered the picture of autism also. A model of the etiology of autism, in which children may be affected by brain damage and/or pathologic family conditions, has been presented by Goldfarb (1961). Eisenberg and Kanner (1956) have also proposed that autism's etiology may lie in areas similar to these.

Autistic children tend to exhibit a number of behavioral characteristics that are somewhat peculiar to them. Rimland (1964) has noted variations in severity in these response patterns among the autistic, but a lack of continuous gradation from normal to autistic. He has also stated that the autistic possess the ability to talk, in that he has the necessary structures. Notwithstanding, some 50% are mute. As a rule autistic children enjoy very good health; they are usually free from asthma, allergies, metabolic disturbances, and skin problems, and do not exhibit apparent physical anomalies (Kanner, 1943). There is also no discernable brain damage and the EEG is normal (Eisenberg & Kanner, 1956). Kanner (1943) reported that autistic children's scores on the Seguin Form Board indicated the potential for excellent cognitive development, and that some are musically gifted and others are capable of remarkable feats in rote memorization. They may occupy themselves for hours with toys, but are unlikely to manipulate them in the appropriate manner, ignoring their conventional use. As infants, autistics will not reach out to be picked up, and remain stiff and unaccommodating in an
adult's arms. This follows through to their pre-school days, when they refuse to acknowledge other people's presence and prefer to be left alone. In addition, the autistic are hampered by odd responses to sensory input; preference for the use of touch, taste, smell, and movement to explore the environment; a tendency to use peripheral rather than central vision; problems in differentiating right-left, up-down, back-front; a tendency to abnormal stereotyped body movements; and "a remarkable ability to store memories of things exactly as they were first seen, heard, or felt." (Wing, 1973, p. 106-122)

Similar to the many proposed causes of autism are the many methods which have been used to treat the autistic. Institutionalization provided one of the earliest methods of dealing with these children, although it was the persons outside the institution who benefited most from this type of treatment. Treatments along physical lines such as chemoelectroconvulsive shock, prefrontal lobotomies, and drug therapies have produced some results but are not generally considered to be effective. Recent developments in research have pointed to possible therapies such as vitamin therapy, correction of hypoglycemia, and detection of food intolerances (Rimland, 1973). Perhaps one of the most outstanding steps forward has been the realization that autistic children are
not of normal ability and emotionally disturbed, but are suffering from delays or abnormalities in specific areas of development, and that therefore an active program of teaching is called for (Wing, 1973).

The most effective method of teaching autistic children has been the use of operant conditioning techniques. Pioneers in this method of treatment were Ferster and DeMyer (1961). They were able to achieve very high levels of accuracy in matching to sample, and therefore obtained attention to intellectually demanding tasks through the use of machines which dispensed trinkets or candy contingent upon correct responses.

Since these early days in the use of operant conditioning with autistic children, many other researchers have used these techniques to develop responses in autistics which would have been unheard of years before. Examples of these are autistic children interacting through vocal and facial responses to produce cooperative responses on manipulanda in order to receive reinforcement (Hingtgen, Sanders, & DeMyer, 1965), the reduction of temper-tantrum behavior and establishment of glasses-wearing behavior to prevent blindness (Wolf, Risley, & Mees, 1964), establishment of imitative behavior (Lovaas, Frietas, Nelson, & Whalen, 1967), and establishment of normal speech in four children whose speech had been echolalic (Risley & Wolf, 1967).

Many candidates seem likely when the primary behavioral
deficits that are associated with autism are considered. Ferster (1958) stated that mental patients may lack "parts of the complex repertoire necessary to achieve reinforcement from the complicated social environment" (p. 107). This deficiency might be the result of an inadequate reinforcement history, but whatever the cause, the lack of stimulus control must be dealt with.

Similarly, this lack of stimulus control has rendered autistic children very poor candidates for discrimination training. An example of this would be their responding in the same manner each time the stimuli are presented, or in other words, stereotyped responding.

Stereotyped responses are those which follow a set and predictable pattern, such as responding to all stimuli in a certain position in discrimination training. Simon and Craft (1972) suggested that irrelevant cues from changing displays will elicit stereotypic responses. Developmental periods have been indicated by Gholson, Levine, and Phillips, (1972), in that kindergarten children virtually always show stereotyping in discrimination learning. This would agree with Andreewsky and Nicolas (1973), who produced results that indicated that production of stereotyped patterns of responding was inversely related to educational attainment.

Whatever the cause of stereotyped responses, the problem of overcoming or eliminating them still remains. However, a number of techniques developed in recent years have made this
a much smaller problem than it was in the past.

Generally the technique used to establish a discrimination was to extinguish responses to the negative stimulus (S-) through non-reinforcement and to increase the probability of responses to the positive stimulus (S+) through positive reinforcement. The S- is the stimulus that indicates that a particular response will result in non-reinforcement. The S+ is the stimulus that indicates that a particular response will result in reinforcement. Essentially, establishing a discrimination means bringing the organism under stimulus control.

In the past, unsuccessful attempts at discrimination training have tended to be attributed to some characteristic of the subject. Bijou and Baer (1967) stated that reasons for an individual's failure to learn a discrimination might be that he is color blind, not responding to the reinforcer as positive, physically ill, emotionally upset, or has a past history making extinction a condition in which he has often been reinforced for persevering long enough. However, what they did not state was that the technique used might not be capable of establishing stimulus control.

Terrace in his experiments with "errorless" learning has shown "fading" techniques to be very effective in establishing discriminations, and even transferring discriminations across two continua (Terrace, 1963a, 1963b). Touchette (1968), using a "fading" technique, was able to teach a discrimination by
"trial and error". In addition, complex discriminations such as circle-ellipse have been achieved in retarded children with this method (Sidman & Stoddard, 1967).

Other methods of establishing stimulus control have followed the "errorless" learning concept but have utilized means other than fading. Sidowski and Greene (1968) demonstrated the superiority of "errorless" learning by prompting over-confirmation in a paired-associate study with college freshmen. Storm and Robinson (1973) obtained "errorless" learning by removing the operandum for the S-. Their results indicated that neither presenting the S- immediately in a discrimination task nor varying the S- away from the 3+ along one or more physical dimensions is necessary for obtaining errorless discriminations.

Moore (1966) utilized a unique type of apparatus to obtain "errorless" learning. A keyboard, similar to a typewriter, was tied into a computer and only the correct key was operable for any given trial.

Occasionally a subject will bring a response bias to the experiment with him, or possibly have one established during a baseline phase. This results in stereotyping. Since the subject may have the tendency to respond to the S-, then the problem becomes one of preventing him from making the wrong response. Azrin (1965) reported that non-reinforcement or extinction of a response will result in emotional behavior similar to the emotional behavior that results from the
presentation of an aversive stimulus. Such emotional behavior greatly interferes with the learning of a discrimination. Therefore, it appears that preventing the subject from making responses to the S-, may be the treatment of choice.

"Precluding the S-" (Whaley, 1974) is a technique which should satisfy the above requirement. In this technique the S- is prevented from being manipulated or responded to by the subject. Consequently, wrong responses do not occur and "errorless" learning is achieved. In addition, the inability of the subject to respond to the S- should cause him to attend to the stimuli, augmenting the establishment of stimulus control. The prevention of errors, or non-reinforced responding, will also eliminate the emotional responses to the S- and again enhance the learning of the discrimination.

In this study, the technique of "precluding the S-", as mentioned above, was employed. It was utilized in an effort to teach color discriminations to autistic children, one of which had previously been unable to learn them through other techniques.

The purpose of this study was to determine the efficacy of the "precluding the S-" technique in teaching discriminations to autistic youngsters, preventing wrong responses, and enhancing the establishment of stimulus control. It was hypothesized that the technique would reduce errors to a zero level and speed up the acquisition of the discrimination.
METHOD

Subjects:
A male and female, ages 6 years, 3 months and 7 years, 2 months, respectively were the subjects in this study. Jeffery, the male, had been seen by various agencies and specialists in the Dallas area. He came to be a student at the Center for Behavioral Studies through the Denton Independent School District. Cathy, the female, had also been seen by various agencies such as the Callier Hearing and Speech Center and the Children's Medical Center, in the Dallas area. She had been diagnosed as mildly retarded, developmental lag, and autistic. Cathy also came to the Center for Behavioral Studies through the Special Education Department of the Denton Independent School District.

Previous attempts at two-color discrimination training with Jeffery were unsuccessful. Several techniques, including matching to sample, had been attempted, but with no success.

There were no previous attempts at teaching a color discrimination to Cathy, prior to this study.

Apparatus:

The primary apparatus unit used in the study was $3/4 \times 3/4 \times 6.2$-cm board, with two 6.3-cm electro-magnetic discs on top of the board and two toggle switches on the experimenter's side of the board with which to control the electro-magnetic discs. A diagram of the apparatus is presented in Figure 1.
The two electro-magnetic discs were obtained from the Edmund Scientific Company. The electro-magnetic discs are placed horizontal to the experimenter and subject sides of the board, 7.5-cm apart and on the median of the board. The stimuli were 7 x 3.7-cm wooden blocks. The blocks were attached to 6.3-cm in diameter metal discs this allowed the blocks to be held to the board by the electro-magnets. There were four wooden blocks painted black, white, red, and green. Also employed in the study was a 30.5 x 22.9-cm cardboard screen, to block the subjects from observing the arranging of the blocks, hand counters to record the data, a variety of food reinforcers, a randomized placement schedule for stimuli, and an orienting response lever.

Procedure:

The procedure involved the experimenter and subject facing each other across a table upon which the magnetic board was placed. Reinforcers were placed to the right of the board; the experimenter was right-handed, so that they would be easily accessible. Response counters were placed in the lap of the experimenter, unless assistants were available for the recording of data.

Data was recorded in blocks of 20 trials each. Each child was only worked with for one hour each day, which generally afforded time for three to five blocks.

Each trial consisted of the following sequence: (1) the
experimenter placing the screen between himself and the subject, (2) rearrangement of the colored blocks according to the randomized placement schedule, (3) setting the switches for the electro-magnets, (4) the subject pressing the orienting response lever and establishing eye contact with the experimenter, (5) the experimenter removing the screen, (6) the subject responding to the stimuli by picking the S+ up, handing it to the experimenter, and (7) then receiving a primary reinforcer. A secondary reinforcer such as "good boy" was used as a bridging mechanism between the response and the primary reinforcer. This procedure allowed the subject to pick up the S+ when he was at first unable to pick up the S-. As will be seen later, it was necessary to modify the procedure to prevent this occurrence.

Data recorded consisted of the number of trials, the number of reinforcements, and which stimulus was first responded to.

Prior to the running of each situation a baseline of 100 trials (five 20 trial blocks) was taken. This was done in order to determine if the subject had a response bias toward the color which was to be learned and if the subject had the response of picking up a block in his repertoire. During the baseline phase the subject was reinforced on each trial without regard to the type of response.

The study involved four situations. Situation 1 was teaching a black-white discrimination to Jeffery, utilizing
the procedure in which responses to the S- were precluded by the electro-magnet. The black block was the S+, so the magnet for it was turned off and the magnet for the white block, the S-, was turned on. This proved less than adequate since it resulted in Jeffery's switching to the S+, when he was unable to pick up the S-. As a result, the procedure was modified. In the modified procedure, when an attempted response was made to the S- the electro-magnet on the S+ was immediately turned on. Thus if the subject did not respond to the S+ first, neither block could be picked up since both were held fast by the electro-magnet.

Situation 2 involved teaching a green-red discrimination to Jeffery, using the modified procedure. The green block was the S+ and the red block was the S-.

Situation 3 involved teaching a black-white discrimination to Cathy, using the modified procedure. The black block was the S+ and the white block was the S-.

Situation 4 involved teaching a green-red discrimination to Cathy, using the procedure of positively reinforcing responses to the S+ and extinguishing responses to the S- through non-reinforcement of those responses. The electro-magnets were not utilized in this situation. The green block was the S+ and the red block was the S-.

The criterion used to determine the acquisition of a color discrimination were five consecutive 20 trial sessions at 100% first responses to the S+.

There were four experimenters utilized throughout the
four situations. Control for experimenter bias was maintained by strict adherence to the procedures described above.

RESULTS

All baselines indicated that the children were responding in a stereotyped manner. It was clear that responding was controlled by spatial cues (right or left side placement) and not by the color of the blocks.

The data for Situation 1 is presented in Figure 2. The percent of correct responses (response to S+ first) are presented on the ordinate of the graph and the data sessions are shown on the abscissa. The vertical line on session 58 represents the change to the modified technique. Prior to the 58th session the chart indicated correct responses to the S+ fluctuating about the 50% level, which indicates stereotyped responding. Since Jeffery was able to switch to the S+ if his first response was to the S-, he was reinforced on every trial throughout the first 57 sessions. The contingencies established with the original procedure did not break up the stereotyped response pattern. After the modified procedure was introduced in the 58th session, the stereotyped responding was broken up after the 60th session and criterion is reached on the 80th session.

Figure 3 presents the data for Situation 2. The data reveals that Jeffery essentially had the discrimination after the 11th session but that the criterion was not reached until the 36th session. Session 26 was discontinued because of
equipment failure.

The data for Situation 3 is presented in Figure 4. A stereotyped response pattern was obtained until the 10th session, when there was an abrupt change in Cathy's response pattern. Criteria is reached on the 15th session.

Situation 4 data is presented in Figure 5. It reveals that Cathy's stereotyped response pattern was evident throughout the 81 sessions and that the percentage of responses to the S+ was at the chance level.

DISCUSSION

In examining the data from Situation 1 (in Figure 2), one must notice the dramatic effect the change in procedure produced in Jeffery's responding. Through the 57th session little or no variation from the stereotyped response pattern was effected by the procedure of "precluding the S-" only. However, when the procedure was modified to include the preclusion of the S+ if the S- was responded to first, the discrimination was quickly achieved. A possible explanation of this phenomenon is that Jeffery was allowed to switch from the S-, when it was held down by the magnet, to the S+, and therefore be reinforced. These contingencies in effect were strengthening, or at least maintaining, his stereotyped response to one side. Until the procedure was modified, Jeffery would very seldom, if ever, look at the stimuli. One has to admit that it would be very difficult to establish
stimulus control if the subject did not attend to the stimuli. When the modified procedure was introduced, his rate of being reinforced was reduced by 50% for the first three sessions. This caused some emotional behavior, but its most noted effect was that he began attending to the stimuli. The attending behavior along with the more stringent contingencies established were possibly the determining factors in Jeffery's acquisition of the discrimination through the modified procedure.

The data indicate that the modified procedure utilized in Situation 1 was effective in teaching the discrimination, establishing stimulus control, and speeding the acquisition of the discrimination.

In order to reduce controversy, errors will be defined as non-reinforced trials. Although the subject was not able to actually pick the S- up, under the modified procedure even touching the S- rendered the S+ unable to be picked up also. So on those trials in which the subject attempted to pick up the S-, no reinforcers were delivered.

Although the modified procedure did not reduce errors to a zero level, the speed at which the discrimination was achieved did substantially diminish the number of errors made.

The data from Situation 2 (in Figure 3) indicates that 12 more sessions under the modified procedure were necessary for Jeffery to reach criterion than in Situation 1. This immediately suggests that a period of familiarization, in this case the 57 sessions under the original procedure, might enhance the
acquisition of the discrimination. However, this must be discounted because during that period Jeffery did not attend to, much less become familiar with, the stimuli. Another consideration is that Jeffery effectively had the discrimination after the 11th session, only once falling below the 90% level of correct responses. Nevertheless, without these considerations he did acquire the discrimination quickly and with fewer errors than with the technique of only reinforcing responses to the $S+$ and extinguishing responses to the $S-$ (as in Situation 4).

Stereotyped responding, with only one fluctuation in session two, until the 10th session, when an extremely abrupt change in Cathy's responding occurred, is found in Situation 3 (data presented in Figure 4). Criterion was reached within 15 sessions, which indicates that she acquired the discrimination eight sessions faster under the modified procedure than Jeffery's quickest acquisition in Situation 1. A possible explanation of this effect is that Jeffery demonstrated much more disruptive behavior during the sessions than Cathy, therefore interfering with his acquisition of the discriminations. Another factor to consider would be that Jeffery had experienced previous attempts at teaching him color discriminations. Learning could have occurred during those attempts that might have interfered with his acquisition of the discriminations in these situations.

Situation 4 (data presented in Figure 5) was carried out in an effort to determine the effects of an extended attempt
to teach a color discrimination through the procedure of reinforcing responses to the S+ and extinguishing responses to the S- through non-reinforcement. The magnets were not utilized in this procedure. The length of the attempt was determined by the length of Situation 1.

During this procedure Cathy was only able to achieve the 75% level of correct responses in two sessions. The remainder of her sessions fluctuated very closely about the 50% level of correct responses. At times during this situation, Cathy would vary her stereotyped pattern of responding, generally in those sessions in which she achieved 60% or above and 40% and below correct responses. Although the stereotyped pattern of responding was broken up at times, it did not allow her to reach a high level of accuracy. The level of correct responding for the entire situation did not vary from the chance level of probability.

This demonstrates by contrast the effectiveness of the modified technique in establishing stimulus control, reducing the number of errors, and speeding the acquisition of the discrimination.

Wing (1973) indicated that an active program of teaching was called for in dealing with the autistic. The procedure which was successful in this study should be a valuable tool in programs for these persons in the future. Its use will possibly provide faster, easier, and more effective learning in certain types of situations. However, its use should not
be restricted to the autistic, because it is applicable in many areas in the field of education. Teaching machines would be an area in which this technique could be easily and effectively utilized.

Specifically, this procedure has taken a step toward reducing the applicability of the statement that autistics are poor candidates for discrimination training. It was shown to be an effective method of establishing stimulus control and eliminating stereotyped responding.

Also demonstrated in this study was the greater effectiveness of the "precluding the S-" procedure in establishing a discrimination over the method of reinforcing responses to the S+ and extinguishing responses to the S-. Although they are admittedly similar in some instances, the variation between the two makes for a good deal of difference in their effectiveness. Therefore, there is no need to attribute the reason for the unsuccessful attempt to establish a discrimination (in Situation 4) to some attribute of the subject, because it was demonstrated to be a weakness in the method employed.

Earlier it was hypothesized that the "precluding the S-" procedure would reduce errors to a zero level, but due to the necessary modification of the procedure this was not realized. Nonetheless, it would be interesting and possibly beneficial to compare the modified "precluding the S-" procedure with "errorless" learning achieved with a fading technique on the
variables of emotional responding in the presence of the S-,
behavioral contrast, peak shift, and performance while under
the influence of a tranquilizing drug. These four variables
have been used by Terrance (1963b, 1963c, 1964) to compare the
effects of discriminations obtained with and without errors.
Albeit errors did occur in the discriminations obtained with
the modified "precluding the S-" procedure, they were reduced
in number and occurred in a situation different from the usual
method of reinforcing responses to the S+ and extinguishing
responses to the S-.

Therefore the effects of the errors
which occurred in the modified "precluding the S-" procedure
might possibly be comparable to the "errorless" learning
achieved with fading.

The data obtained in this study have definite implications
in the training of the autistic. They could also be applied
in the field of education, and indicate the potential for
interesting and beneficial studies in experimental settings.
FIGURE 1 - MAGNET BOARD AND STIMULUS

STIMULUS
3.7 X 3.7 X 7 CM
FIGURE 2 — SITUATION 1
FIGURE 3 - SITUATION 2
FIGURE 4 – SITUATION 3
FIGURE 5 - SITUATION 4
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