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Direct Versus Indirect Response-Reinforcer Relationships in Teaching Autistic Children[1]

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One possibility suggested by the literature for maximizing the efficiency of behavior modification procedures concerns the relationship between target behaviors and their reinforcers. Therefore, in this experiment three severely autistic children were taught a total of six new target behaviors (in a multiple baseline design) employing two different response-reinforcer relationships: (1) those where the target behaviors were a direct part of the response chain required to procure a reinforcer (e.g., opening the lid of a container to obtain a food reward inside the container); and (2) those where the target behavior was an indirect part of the chain leading to the reinforcer (e.g., the therapist handing the child a food reward after the child had opened the lid of an empty container). In all cases, the results showed rapid acquisition only when the target behavior was a direct part of the chain leading to the reinforcer. The results are discussed in terms of several possible conceptualizations concerning efficient reinforcement contingencies, and in terms of their implications for teaching autistic children.

The treatment of autistic children within a behavior modification framework has progressed enormously over the past 15 years. Such children have been taught to speak (Hewett, 1965; Lovaas, 1977; Lovaas, Berberich, Perloff, & Schaeffer,

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1966; Risley & Wolf, 1967; Schreibman & Carr, 1978), to play appropriately with toys (Koegel, Firestone, Kramme, & Dunlap, 1974), to behave appropriately in social situations (Lovaas, Koegel, Simmons, & Long, 1973), to learn in school settings (Koegel & Rincover, 1974; Rincover & Koegel, 1977a,b), etc. One element that has been relatively constant throughout this research has been an emphasis on the contingent use of reinforcers. Numerous types of reinforcing stimuli have proven effective, and there has been little evidence that certain types may be more effective than others (cf. Lovaas & Newsom, 1976; Rincover, Newsom, Lovaas, & Koegel, 1977).

Several investigators have, however, suggested that learning may be facilitated by taking into consideration certain *relationships* between the behavior being taught and its reinforcer (cf. Koegel & Egel, 1979). One specific relationship, discussed by Ferster (1967) is the possible importance of employing natural versus arbitrary response-reinforcer contingencies. For example, the response of putting on a coat in cold weather might be effectively rewarded by the natural reinforcement of warmth. Similarly, Holland and Skinner (1961) noted that some responses directly "produce" stimuli that act as reinforcers, so that a child's scribbling behavior (for example) may be reinforced by the patterns it produces.

In this investigation we systematically assessed the importance of two general types of response-reinforcer relationships. One was a direct response-reinforcer relationship, which we defined as the target response being directly within the chain of behaviors required to procure the reinforcer. That is, with a direct response-reinforcer relationship, when the *child procures the reward, the child will necessarily emit the target response,* due to the properties of the stimulus situation. For example, if a child is being taught a color discrimination, the child's task might be to open the lid on a given colored box containing a food reward. In this instance, in obtaining the food reward, the child necessarily emits the target response of responding to a specific colored container. If, on the other hand, the child's response of opening the lid of an empty container was reinforced by the therapist handing the child a food reward, the response-reinforcer relationship would be *indirect* since the natural properties of this stimulus situation do not require the child to respond to the colored containers in order to procure the reinforcer. For example, the child could procure the reinforcer by simply grabbing it out of the therapist's hand, Thus, in this latter instance, we would expect more difficulty in teaching the child about the containers.

The specific purpose of this investigation was to systematically examine the difference in target behavior acquisition when the target response is a direct part of the response chain related to procuring the reinforcer, as compared to when the target response is an indirect part of the chain leading to the reinforcer.

METHOD

Subjects and Settings

Three severely autistic children, aged 4, 5, and 6 years, participated in the investigation. All three were enrolled in treatment programs in the experimental Autism Clinic at the University of California at Santa Barbara. They were selected from the total clinic population because their clinicians reported concern about these children's particularly slow rates of acquiring new target behaviors. Each child was essentially nonverbal, engaged in low levels of appropriate play and social behavior, and was generally unresponsive to most verbal instructions. All were untestable on standardized IQ tests; they were estimated to be functioning socially at the 1.4-, 2.1-, and 4.6-year levels on the Vineland Social Maturity Scale.

Therapists and Treatment Programs

In all conditions throughout this study, the therapists were advanced undergraduate students who had had at least two lecture and two practicum courses in behavior modification and autism. In 80% of the trials in this investigation the therapists were naive to the experimental hypothesis. In all conditions in this experiment the therapists used treatment programs based upon the guidelines suggested by Koegel, Russo, and Rincover (1977). That is, the children were usually given about four sec to respond to an S^D, and correct responses were reinforced with praise and tangible reinforcers (described below). A mild verbal "no" was presented for incorrect responses, and approximately every third consecutive incorrect response was followed by one or two prompted trials. Prompted responses were reinforced but scored as incorrect since the therapist only prompted after the child began to initiate an incorrect response. These procedures are typical of those employed in many schools and clinics and have been described in detail in numerous research publications (e.g., Lovaas, Schreibman, & Koegel, 1974; Risley & Wolf, 1967; Schreibman & Koegel, in press).

Design

A multiple baseline design was employed to investigate whether unsuccessful attempts to teach the three children certain target behaviors, which were indirectly related to the reinforcers (baseline condition), could be improved by changing the reinforcing consequences so that the responses became directly

related to procuring the reinforcers. The baseline conditions consisted of 10, 20, 22, 40, 110, and 425 trials, respectively.

Selection of Reinforcers and Target Behaviors

Prior to the start of the experiment, lists were compiled of (1) previously functional reinforcers for each child, and (2) target behaviors that appeared to be difficult for the children to acquire in their ongoing treatment programs. Then, for each child, an arbitrary number of target behaviors and reinforcers were selected for study. The reinforcers were then randomly assigned to either the direct or the indirect condition, and the manner of delivery of the reinforcer was varied so that the relationship between the response and the reinforcer would be either direct or indirect, depending on its assigned condition. All of the indirect relationships, and all but two of the direct relationships, were designed by independent therapists, naive to the specific experiment being conducted.

Procedure

Child 1/Task 1. The therapist attempted to teach Child 1 an imitative verbal response (unvoiced "wh" sound) by handing the child a small piece of cracker or a sip of water following correct responses during the baseline (indirect) condition. After the predetermined number of baseline trials, the direct condition was instituted. In this condition, a pinwheel was held in front of the child's mouth, and if she produced the correct "wh" sound, the air expelled from her mouth was allowed to propel the pinwheel. Thus, in this instance, the natural properties of the stimulus situation were such that blowing at the pinwheel was the easiest way to propel it. As such, when the child propelled the pinwheel, she was producing the target behavior ("wh"). (Note: If she expelled air in any other way than "wh," the therapist held the pinwheel, preventing its movement.)

Child 1/Task 2. The therapist also attempted to teach Child 1 imitative clapping. In the indirect condition, the therapist handed the child a bit of food, water, or a toy for a reward. Then after the predetermined number of baseline trials had been conducted, the direct condition was instituted. In this case, one finger cymbal was attached to each of the child's hands, and she was allowed to tap them together (as a reward) contingent on clapping her hands imitatively. Thus tapping the cymbals together required the child to emit the target response of clapping her hands. (Note: If she attempted to clap her hands at any time other than imitatively, the therapist prevented the cymbals from touching.) After acquisition, the cymbals were removed, and she was again asked to imitate clapping in order to ensure that she would continue to imitate clapping without the sight of the cymbals as a discriminative stimulus.

Child 1/Task 3. Finally, the therapist attempted to teach Child 1 to discriminate a book from a display of three objects. The target response was to touch the cover of the book following the instruction "Touch the book." First (in the indirect condition), the therapist handed the child a toy train engine, a balloon, or a small cup of water as the reward for correct responses. Subsequently, in the direct condition, a flat piece of cracker (shielded from the child's sight) was placed under the cover of the book and if the child made a correct response (touched the book), she was allowed to open the book and take the cracker. Thus, in order to take the cracker, the child had to emit the target response of touching the book (in the process of opening the cover).

Child 2/Task 1. Child 2 was taught to discriminate a white box from a green box. During the baseline (indirect) condition the therapist rewarded correct responses (picking up the white box when instructed to "Pick up white") by contingently handing the child a piece of cracker. In the subsequent direct condition, the cracker piece (shielded from the child's sight) was placed in the recess under the correct box. Thus, when the child took the cracker, he had emitted the target behavior of picking up the correct box.

Child 3/Task 1. Child 3 was taught a shape discrimination (circle vs. square). During the baseline (indirect) condition, a plastic circle and square were presented along with the S^D, "circle" (vs. "square"). If the child put the correct shape in the therapist's hand, the child was given a spoonful of ice cream. In the direct condition, rather than placing the shape in the therapist's outstretched hand, the child was permitted to drop the correct shape (but not the incorrect shape) into a tennis ball can, which made a pleasant sound (for this child). Thus, when the child produced the sound, the child had emitted the target response of choosing the correct shape to drop into the tennis ball can.

Child 3/Task 2. Child 2 was also taught to identify (hand the therapist) his own printed name, from a display of four other names, using ice cream as the reward during the indirect (baseline) condition. During the direct condition, letting him drop the name card in a playschool mailbox (if he selected the correct name) was the reward. Again, when the child produced the sound, he had emitted the target response of choosing the correct name to drop into the mailbox.

As noted above, in all portions of this investigation, all of the rewards (whether directly or indirectly related to the responses) were selected from a pool of previously functional reinforcers. Also, in some cases the same reward (e.g., cracker) was employed in both conditions. As such, it seems unlikely that any given reinforcer might have influenced the results. However, in order to more systematically control for the possibility that any given specific reinforcer might have been more powerful than others (whether directly related to procuring the reinforcer or not), we did several additional assessments with Child 2. Specifically, for three additional matched pairs of tasks, the identical rewards were used: one task in each matched pair was taught with a direct response-

reinforcer relationship, and the other task was taught with an indirect response-reinforcer relationship.

Throughout this phase, the order of training (direct vs. indirect relationship) was arbitrarily determined, and conditions were changed following a random number of trials (5, 40, or 50) or when the response was acquired, whichever came first. Tasks were considered acquired following a minimum of five consecutive correct responses.

In one set of matched tasks, Child 2 was presented with a display of two different 4" X 4" colored boxes, and when the therapist gave the instruction "red," the child was required to pick up the red box. In the indirect condition, the child was handed a raisin or a spoonful of applesauce (alternated approximately every three trials) as a reward for correct responses. In the direct condition, he was presented with a different display and was required to select a blue box. However, in this direct condition, the applesauce or raisin (shielded from the child's sight) was placed in the recess under the correct colored box, and he was permitted to have the reward if he picked up the correct box.

Additionally, Child 2 was taught several imitative responses. In the direct condition, using a raisin reinforcer, he was taught to bend over imitatively. A plate with a raisin on it was placed on the floor in front of him. In this situation when the child bent over (to pick up the raisin), he was emitting the target response of imitative bending. In the indirect condition he was taught to touch his shoulder, and in this case the therapist placed a raisin in his mouth as the reward.

In another imitative learning situation, using applesauce as a reward, he was taught to touch an empty spoon to his head. In the indirect condition, the therapist then gave him a different spoonful of applesauce as the reward. In the direct condition, he was taught to touch a spoon to his mouth imitatively, using a spoon that was previously dipped in applesauce.

To ensure that a discrimination had been acquired, and that the child was not merely reaching out for the desirable food, he was then shown two of the reinforcers at the same time (e.g., a raisin on the floor and a spoon dipped in applesauce) and was required to discriminate imitatively between the two responses (e.g., bending vs. touching the spoon to his mouth) presented in a random order.

Reliability

In addition to the regular observers, an additional reliability observer (who was naive to the experimental hypothesis) recorded correct and incorrect responding throughout 70% of the sessions in this investigation. Percent agreement was calculated by dividing the number of agreements by the number of agreements plus disagreements X 100 for each session. The average percent agreement for both correct and incorrect responses was 99% (range: 80 to 100%).

RESULTS

The results of the multiple baseline analysis with the three children (working on a total of six tasks) are shown in Figure 1. Percent correct responding is shown on the ordinate, and blocks of trials are on the abscissa.

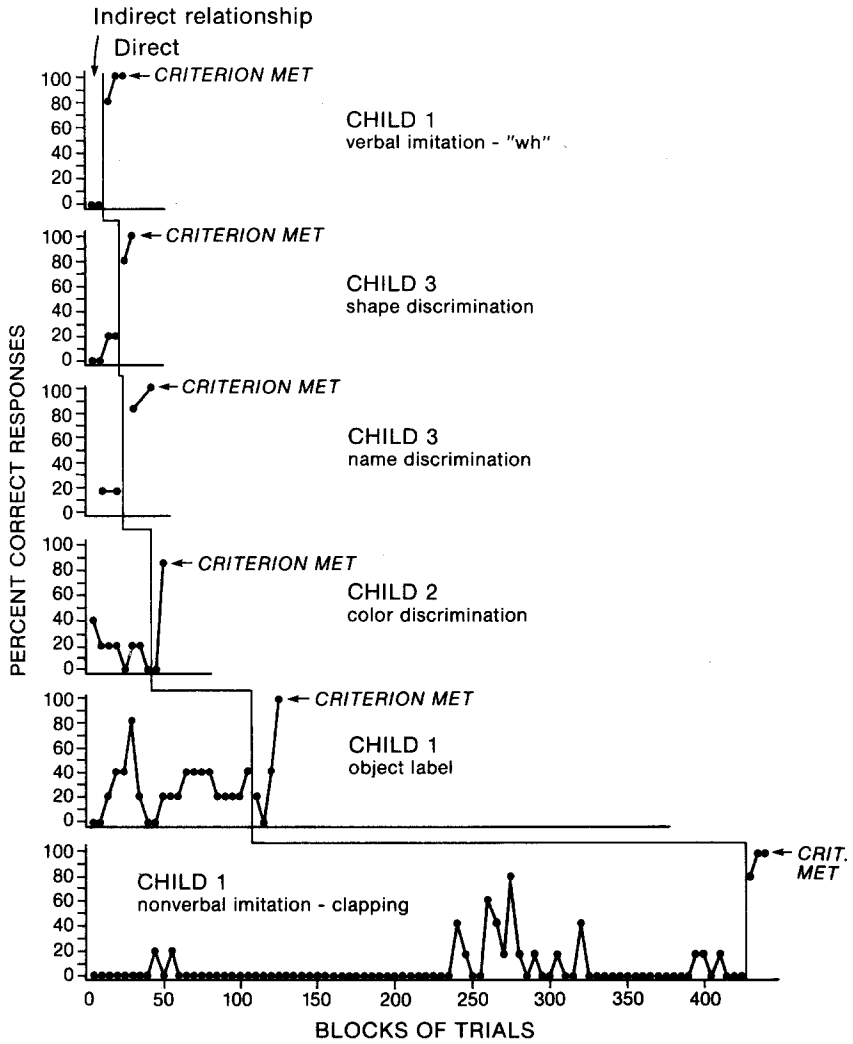

Fig. 1. The results for all six child/task combinations when the therapists' unsuccessful attempts to teach behaviors were remedied by changing the response-reinforcer relationships from indirect to direct. Percent correct responding is plotted in blocks of 5 trials in all instances except Child 3/Task 2 (plotted in blocks of 11 trials) and the last point for Child 2 (which consists of 7 trials).

A different number of baseline trials (10, 20, 22, 40, 110, and 425) requiring an indirect response were used for each child/task combination. In all cases, regardless of the specific task or reinforcer, the baseline data were characterized by consistent low levels of correct responding (typically 40% or below). This was followed by very rapid increases in the percent of correct responses when the response-reinforcer relationship was changed to make the target behaviors directly related to procuring the reinforcers. In each case, the acquisition criterion was met in less than 25 trials.

To ensure that the type of result shown in Figure 1 was not a simple difference in individual reinforcer effectiveness, additional assessments were made for Child 2, where three sets of matched tasks were taught using the identical reinforcing stimuli: one task in each pair was taught with a direct response-reinforcer relationship and the other with an indirect response-reinforcer relationship. In Figure 2, the number of trials to criterion is plotted for each particular task on the ordinate; the pair of tasks (and their specific reinforcers) are labeled on the abscissa.

The data show that for each reinforcer, only the direct response-reinforcer relationship led to rapid acquisition (in 5, 18, and 20 trials, respectively). Correct responding was above 80% even when two reinforcers were visible at the same time (see Procedures above). In contrast, in the indirect condition, the responses were acquired either much more slowly or not at all. All of these data are consistent with those presented in Figure 1.

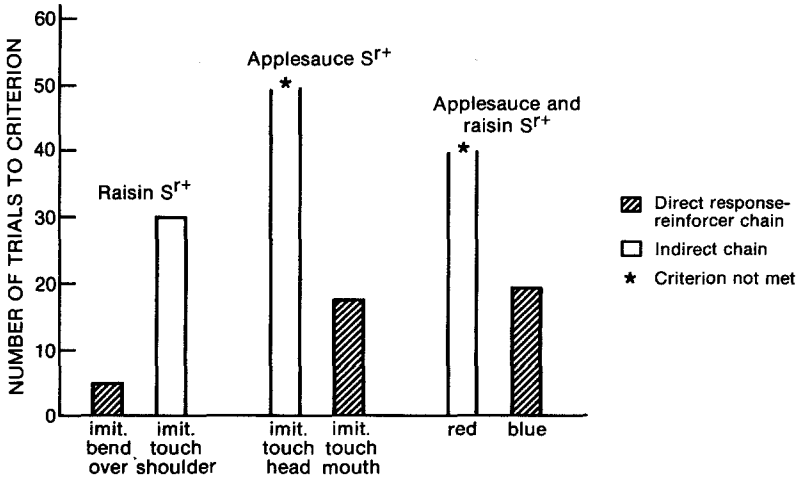

Fig. 2. Additional assessments for Child 2. Number of trials to criterion is shown on the ordinate, and the three pairs of matched tasks (and their specific reinforcers) are shown on the abscissa.

DISCUSSION

Overall, the results of this investigation showed that for these severely autistic children, target responses that were directly in the response chain related to procuring a reinforcer were consistently learned more rapidly than those responses that were an indirect part of the chain leading to the reinforcer. This was a very consistent result, no matter how we approached the issue. In every instance in this investigation, the direct condition showed a considerable advantage, both when the identical reinforcer was employed for different (directly vs. indirectly related) responses and when the identical target behavior was taught with different (direct vs. indirect) reinforcers.

There are several ways one might conceptualize these results. For example, it has long been postulated (cf. Hull, 1932) that the strength of an association between a stimulus and a response is inversely related to the length of the delay between the response and the reward. This function was clearly demonstrated in early animal studies (e.g., Grice, 1948), which found that delays of as little as .5 sec significantly interfered with rats' discrimination learning. These results were similarly replicated with young children, pigeons, bees, etc. (e.g., Grossman, 1971; Shiroiwa, 1975). In this investigation when the target response was a direct part of the chain leading to the reward, the relationship between the response and its reinforcement necessarily resulted in a minimal delay of reinforcer delivery, and it seems possible that this might have facilitated learning.

Kimble (1961) noted that longer delays in reinforcement introduced increasingly lower chains of irrelevant responses *between* a target response and its reinforcement, and that this may interfere with learning. Spence (1956) hypothesized that during the delay, the organism makes other, competing responses, which might become classically conditioned to the target response and interfere with learning. However, if the target response is already a direct part of the chain of behaviors leading to the reward, unrelated responses are held to a minimum, and it is possible that this might facilitate learning.

In more recent research, Kazdin (1977) has also demonstrated this type of effect. He noted that the efficacy of reinforcing one behavior is limited if an inappropriate response happens to be included as a part of the reinforced response chain. Relating this to the present results, we note again that there is little time for irrelevant responses to occur between the response and the reinforcer when the response is a direct part of the chain leading to the reinforcer.

It is also possible to see other parallels that might help to understand the present results (Ferster, 1967; Skinner, 1979). For example, Ferster noted that natural contingencies are those such that the consequences for a response taught in a clinic were identical to the consequences provided in outside (nonclinical) environments. In the present study, the contingencies were also "natural" in the sense that, if the child in the outside environment desired a particular

"reward," a similar response (to at least some of those in the chain being taught in the clinic) would be required to obtain it. Thus it is possible that many trials may occur in the child's natural environment that may help the child learn components of the target behavior being taught in the clinic.

Finally, one could speculate that the direct response-reinforcer relationship may facilitate response acquisition in a manner analogous to the "within-stimulus prompting" technique discussed by Rincover (1978) and Schreibman (1975). With that technique, the prompt is incorporated within the training stimulus, thus enhancing attention to the relevant stimulus dimensions. Similarly, incorporating the target response into the response chain leading to the procurring of the reinforcer may augment the child's attention to the relevant response dimension.

Whatever the exact reason for the results, they have important implications for teaching autistic children. Everytime we used the direct condition, we were able to accomplish extremely rapid acquisition, with relatively little therapist effort. Because of the large number of behavioral deficiencies shown by these (particularly severely handicapped) children, it is crucial for researchers and educators to develop very efficient teaching techniques. The major point of the present investigation is that the results show that important relationships between the target behavior and the reinforcer seem to exist and, when taken into account, may dramatically improve the efficiency of teaching autistic children.

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