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A REVIEW OF RECENT STUDIES ON DIFFERENTIAL REINFORCEMENT DURING SKILL ACQUISITION IN EARLY INTERVENTION

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Although the use of differential reinforcement has been recommended in previous investigations and in early intervention curriculum manuals, few studies have evaluated the best method for providing differential reinforcement to maximize independent responding. This paper reviews previous research on the effectiveness of differential reinforcement as treatment and describes important areas of future research.

Key words: acquisition, differential reinforcement, early intervention, reinforcement quality, reinforcement schedules

Differential reinforcement is an operant procedure used to increase the occurrence of desirable behavior while simultaneously decreasing undesirable behavior. The use of differential reinforcement is recommended in early intervention (EI) programs because children in EI often do not acquire skills in the absence of motivational procedures (Karsten & Carr, 2009; Leaf & McEachin, 1999; Lovaas, 2003). In addition, prompting procedures may be necessary initially, because children who require EI may not have extensive skill repertoires that could be exposed to differential reinforcement. Thus, one challenge in EI programming is to identify differential reinforcement procedures that minimize prompt dependence and promote independent responding as the ultimate goal. However, only a few studies have examined the effects of differential reinforcement on independent and prompted responding in EI programs. Therefore, the purposes of this review are (a) to provide a summary of previous research related to differential reinforcement during acquisition-based procedures in EI and (b) to suggest areas of future research.

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Empirical Evaluations of Differential Reinforcement

Skill acquisition in EI is assessed by measuring whether levels of correct independent responding meet a prespecified mastery criterion. Independent responding is an important dependent variable in EI because it demonstrates that the child is able to emit a correct response without assistance. Thus, determining the best methods for promoting independent responding is a critical area for research. To that end, studies have examined the effects of differential reinforcement on prompted and independent responding using (a) different schedules of reinforcement and (b) different qualities of reinforcement for the two responses.

Schedules of reinforcement. Studies have examined variations in differential reinforcement schedules for prompted and independent responding to identify schedules that increase the efficiency of learning (i.e., quickly increase independent responding). Olenick and Pear (1980) implemented differential reinforcement during tact training using 5-s constant time delay (hereafter referred to as ''prompt delay'') with 3 children with severe intellectual disabilities. The evaluation included four conditions.

In two of the conditions, reinforcement was provided on a fixed-ratio (FR) 6 or 8 schedule. Reinforcement was provided on an FR 1 schedule for correct independent responses and on an FR 6 or FR 8 schedule for prompted responses in the third condition. In the fourth condition, reinforcement was provided on an FR 1 schedule for prompted responses and on an FR 6 or 8 schedule for correct independent responses. Results indicated that all participants had the highest accuracy and number of independent responses on the FR 1 schedule for independent responses. These findings suggest that schedules of reinforcement that favor independent responding may produce more rapid skill acquisition. However, the authors implemented a fairly thin schedule of reinforcement in the first two conditions (i.e., FR 6 or 8) and did not conduct any sessions at a 0-s prompt delay, both of which are inconsistent with typical procedures used in EI (Walker, 2008). Thus, it is not clear that the results of this study are representative of acquisition in clinical settings, in which rich schedules of reinforcement and a 0-s prompt delay are used most typically in initial stages of learning.

Touchette and Howard (1984) extended the work of Olenick and Pear (1980) by evaluating additional reinforcement schedules in conjunction with a progressive prompt-delay procedure to teach 3 individuals with severe intellectual disabilities letters, numerals, or words. In the continuous reinforcement (CRF) condition, reinforcement was provided (i.e., token and praise) on an FR 1 schedule for correct independent and prompted responses. In the CRF/FR 3 condition, the schedules of reinforcement for correct independent and prompted responses were FR 1 and FR 3, respectively. In the FR 3/CRF condition, correct independent responses were reinforced on an FR 3 schedule and prompted responses on an FR 1 schedule. The results showed that 2 of the participants had more rapid acquisition of target discriminations when the schedule of reinforcement favored independent responding. The 3rd participant displayed similar levels of correct independent responding across conditions, which is particularly interesting because one of the schedules (FR 3/CRF) actually favored prompted responding. The results of this investigation may be representative of expected outcomes in EI programs because the experimenters included a 0-s prompt delay and provided a rich schedule of reinforcement (i.e., FR 1) for independent responses in most conditions. However, it remains unclear whether initial exposure to nondifferential reinforcement during the 0-s prompt delay influenced the subsequent effects of differential reinforcement on the rate of acquisition.

Although the results of Touchette and Howard (1984) have important implications for programming differential reinforcement during prompt-delay procedures in EI programs, replications and extensions of this work were conducted only recently. Hausman, Kahng, and Ingvarsson (in press) evaluated skill acquisition by 3 individuals with intellectual disabilities under three different reinforcement schedules. The experimenter used least-to-most prompting (i.e., vocal, gestural, and physical) to teach spelling or matching. The CRF/CRF and CRF/FR 3 conditions were analogous to the conditions of the same name in the Touchette and Howard study; however, edible items were used instead of tokens as reinforcement. In the CRF/extinction condition, edible items and praise were delivered following correct independent responses, and prompted responses produced praise only. Results showed higher levels of independent responding when prompted responding was placed on extinction (i.e., the CRF/extinction condition) for 2 participants. The 3rd participant showed similar levels of correct independent responding under the CRF/extinction and CRF/FR 3 conditions. This study extended the results of previous evaluations by examining the effects of extinction on correct independent responses. The

results suggested that higher levels of independent responding may be obtained when no reinforcement is provided for prompted responding. This finding may be helpful in guiding clinicians who have concerns about placing prompted responses on extinction because of the importance of prompted responding in the initial stages of learning.

The results of these three studies provide evidence that acquisition may occur more slowly if similar schedules of reinforcement are provided for prompted and independent responses. However, the procedures in these evaluations varied in a number of ways that may influence the rate of acquisition. For example, prompt-delay procedures commonly include a 0-s delay during the initial trials or sessions of treatment, and exposure to nondifferential reinforcement during the 0-s delay may influence the effects of subsequent differential reinforcement. Additional research on differential reinforcement during prompting procedures that closely match those used in EI programs is necessary to identify best practices for skill-acquisition procedures in clinical settings.

Differentiation in the quality of reinforcement. The studies discussed above evaluated the effects of reinforcement density on prompted and independent responses; however, it is possible to manipulate reinforcement in other ways. Karsten and Carr (2009) evaluated picture sequencing and tact acquisition by 2 boys with autism when the quality of reinforcement was manipulated for independent and prompted responses. The experimenters used a 3-s constant prompt delay, but, as in Olenick and Pear (1980), no sessions were conducted at a 0-s delay. In the nondifferential reinforcement condition, the most highly preferred reinforcer (i.e., high-preference food and praise) was used for correct independent and prompted responses. In the differential reinforcement condition, the most highly preferred reinforcer was used following correct prompted responses until the first occurrence of a correct independent response. Thereafter, the experimenter used high-quality food and praise only following correct independent responses, and prompted responses resulted in access to a lower quality consequence (i.e., praise only). A multielement design was used to compare differential and nondifferential reinforcement across targets with the 1st participant. The differential reinforcement condition was more effective initially, but both procedures were equally effective when compared across novel targets in additional phases. The authors hypothesized that these results were due to multiple-treatment interference. After evaluating each procedure with a reversal design (i.e., ABA design in which differential reinforcement was Condition A and nondifferential reinforcement was Condition B) with the 2nd participant, acquisition occurred only under the differential reinforcement condition. Because the reversal design was conducted with only 1 participant, further research is needed to identify whether similar results would be obtained with additional participants.

Clinical Considerations and Future Research

Although the studies we reviewed provide encouraging findings regarding the effectiveness of differential reinforcement for promoting skill acquisition in EI, more research in this area is needed before it is possible to delineate best practices. For example, only one study we reviewed faded reinforcement for prompted responses during training trials. Karsten and Carr (2009) removed high-quality reinforcement for correct prompted responses following the first instance of correct independent responding. However, some children may continue to require frequent prompts after the first instance of an independent response, and prompted responses may be extinguished if an effective reinforcer is not provided on a rich enough schedule. On the other hand, reinforcing prompted responses for too long may produce prompt dependence (Clark & Green, 2004; Fisher, Kodak, & Moore, 2007). It

remains unclear whether fading reinforcement across trials or sessions is necessary or confers any additional advantages over the consistent schedules of differential reinforcement found to be effective in the studies described in this review. Future research should evaluate whether schedule fading across trials or sessions decreases prompt dependence and produces more rapid acquisition of skills than do schedules of differential reinforcement that remain unchanged throughout treatment. Additional investigations of this type may help to clarify how best to apply different qualities or schedules of reinforcement in acquisition-based procedures to reduce prompt dependence, promote skill acquisition, and reduce the likelihood of extinguishing correct prompted responses early in treatment.

Several variables may influence the effectiveness of differential reinforcement. For example, baseline levels of responding may provide information regarding whether to apply differential reinforcement for independent responding from the onset of treatment or fade reinforcement for prompted responses over time. If the participant engages in some level of correct responding during baseline, differential reinforcement could be implemented for independent responses immediately during learning trials. However, if the participant displays no correct responding during baseline, the therapist could fade reinforcement for prompted responses once the child engages in some level of correct independent responding. Applying differential reinforcement too early in treatment may prematurely extinguish correct prompted responding. Only one of the studies we reviewed included a baseline. Thus, it is difficult to determine whether the effectiveness of differential reinforcement (or lack thereof) may be explained by baseline responding; this is an important topic of future research.

An additional variable that may influence the effectiveness of differential reinforcement is prior exposure to nondifferential reinforcement. Hausman, Kahng, and Ingvarsson (in press) and Olenick and Pear (1980) incorporated a phase of nondifferential reinforcement prior to evaluating differential reinforcement with the same target stimuli. It remains unclear whether the extended exposure to nondifferential reinforcement slowed acquisition of the target skills in these evaluations. Errorless learning (e.g., prompt delay), in which nondifferential reinforcement is provided prior to differential reinforcement (e.g., in one or two sessions of a 0-s prompt delay), is the most common prompting procedure used in EI programs (Love, Carr, Almason, & Petursdottir, 2009). Therefore, EI programs may use nondifferential reinforcement in the initial portion of treatment but to a lesser extent than the aforementioned studies. Additional research evaluating differential reinforcement under conditions more closely approximating procedures used in EI programs is needed to determine the extent to which the results would be similar to those in the studies we reviewed.

Future studies are needed to address gaps in the literature regarding best practices for the use of differential reinforcement. Until additional research on differential reinforcement is conducted, clinicians may struggle to identify how best to incorporate differential reinforcement into acquisition-based programs in clinical practice.

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