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Differential reinforcement of low rate responding in social skills training



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ABSTRACT

Social skills are unique in that excessive rates of responding may be just as socially undesirable as deficient responding. Furthermore, most social skills training programs utilize group formats such that one intervention (e.g., differential reinforcement) is applied universally to children with varied behavioral repertoires. Following exposure to continuous schedules of reinforcement for pro-social behaviors, we observed excessive levels of peer-directed compliments and physical contact. Thus, we evaluated the effectiveness of a full-session differential reinforcement of low rate responding (DRL) schedule in maintaining socially appropriate levels of these interactions. We used descriptive observations of typically developing children to establish normative criteria for the DRL schedules. Results indicated full-session DRL schedules were effective in maintaining participants' responding at levels below criterion levels without wholly eliminating responding.

Individuals with autism spectrum disorders display marked difficulties related to social functioning. These difficulties are often sources of persistent distress in addition to being associated with long-term negative outcomes (Greene et al., 1999; Chamak & Bonniau, 2016). Indeed, the severity of social deficits associated with autism have been found to be one of the strongest predictors of long-term outcomes (Howlin, Moss, Savage, & Rutter, 2013). Fortunately, behavioral interventions have been highly effective in teaching a variety of pro-social skills to individuals with autism spectrum disorders (Koegel & Frea, 1993; Pickles et al., 2016). For example, Leaf et al. (2012) used modified behavioral skills training to teach individuals with autism to engage in social skills including: greeting others, offering assistance, giving compliments, and losing graciously.

Behavioral interventions often utilize ratio schedules to increase target responding across a variety of behavioral topographies including social interaction (Allen, Hart, Buell, Harris, & Wolf, 1964; Ferster & Skinner, 1957). However, social skills are unique in that they are often 1) highly contextual and excessive responding may be just as socially undesirable as deficient or absent responding and 2) taught in group settings wherein reinforcement contingencies are applied uniformly to students with idiosyncratic behavioral repertoires.

Interventions that promote indiscriminately high rates of responding may have unintended effects of increasing skill performance to socially unacceptable levels. For example, a child may emit sportsman-like comments too often or under the wrong conditions (e.g., saying "good job" after every pass in basketball). Furthermore, problem behavior may be reduced using differential reinforcement of alternative behavior (DRA) only to be replaced by another problem (e.g., excessive levels of the alternative response). For this reason, added schedule requirements may be necessary to facilitate socially appropriate skill development.

In the context of a group contingency, reinforcement schedules favoring performance of pro-social skills are typically applied to children who exhibit deficits in those areas as well as children whose responding is within normal limits. Such applications have repeatedly been shown to be effective (Stage & Quiroz, 1997; Theodore, Bray, & Kehle, 2004) and to minimize the effort required of

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interventionists (Cooper, Heron, & Heward, 2007; Davis & Blankenship, 1996). However, given individual differences in baseline responding and/or motivation, simple group contingencies such as DRA may be associated with unacceptably high rates of *pro-social* responding (e.g., appropriate touching) for some group members.

Differential reinforcement of low rate responding (DRL) represents an alternative to ratio schedules in that responding at or below a pre-specified rate is reinforced. As such, it is recommended as a strategy for target behaviors that are problematic only when they occur in excess but are not intended to be eliminated completely (Cooper et al., 2007; Martin & Pear, 2015). Multiple procedural variations of DRL have been used in applied settings, including spaced responding, interval, and full-session DRL.

Ferster and Skinner (1957) originally conceptualized the logic of DRL, and Deitz (1977) defined three methodologies for application: Spaced responding, interval, and full session DRL. According to spaced responding DRL, reinforcement only occurs if a minimum amount of time elapses between responses, and responses that occur prior to the end of the programmed interval are not reinforced (Catania, 2013). In applied studies, a minimum inter-response time (IRT) for reinforcer delivery has been associated with decreases in rapid eating (Wright & Vollmer, 2002) and stereotypy (Singh, Dawson, & Manning, 1981) among individuals with developmental disabilities as well as inappropriate question-asking among school children (Deitz, 1977).

Interval DRL is a variation on this approach in which a session is divided into intervals, and reinforcement is delivered at the conclusion of an interval only if the frequency of responding is below a pre-determined criterion during that interval. For example, Deitz (1977) and Deitz et al. (1978) successfully reduced the frequency of classroom disruption by having teachers 1) set a criterion for each interval and 2) deliver rewards to students who engaged in problem behaviors at levels below the specified criterion for a set number of intervals. Full-session DRL follows similar logic, but reinforcement is delivered following the conclusion of a session in which the total count of behavior was less than the pre-determined criterion. Hagopian, Kuhn, and Strother (2009) utilized such a procedure to reduce inappropriate touching, inappropriate comments, and social withdrawal in a child with developmental delays. Austin and Bevan (2011) also used full-session DRL to reduce children's requests for assistance from their teacher. These methods may be preferable to spaced-responding DRL schedules in applied settings (e.g., classrooms) where resources for tracking inter-response times are limited and/or data must be collected for multiple children simultaneously. In both of these studies, individual instances of behavior continued to produce some form of reinforcement or feedback. Thus, it is unclear whether feedback provided solely at the end of the session would be sufficient to maintain responding at targeted levels.

Recent research suggests that interval and full-session DRL schedules are likely to reduce responding below acceptable rates, often eliminating them altogether (Jessel & Borrero, 2014). Indeed, much of the research involving DRL schedules has involved behaviors that are not socially acceptable at any level, and the gradual elimination of the target response was programmed by systematically increasing the IRT requirement or decreasing the criterion for reinforcement in each interval/session. As such, these schedules may be better characterized as *alternative* DRO DRL schedules (Ferster & Skinner, 1957), given that reinforcement may be obtained by responding below criterion levels or abstaining altogether.

Clearly, variations between these methods may have significant clinical implications when addressing complex social behaviors. Spaced responding DRL is likely more effective in maintaining low rates of responding given that such responding is required to access reinforcement. Full session DRL may be associated with the greatest reduction (if not complete elimination) of responding given the absence of programmed reinforcement or feedback within sessions. However, it is unknown whether these procedures are differentially effective for social vs. arbitrary responses given that the former are more likely to come into contact with additional sources of social reinforcement (e.g., reciprocal social interaction with peers).

The uses of DRL schedules in applied settings clearly merit further investigation to identify interventions that will facilitate socially appropriate levels of responding. Thus, the purpose of this study was to evaluate the effectiveness of a full-session DRL procedure to maintain social behaviors at acceptable levels without eliminating these behaviors entirely.

1. Methods

1.1. Participants and setting

Participants included 5 children enrolled in a group treatment program designed to facilitate social skill development. Each group included 4–5 participants matched by age and functioning level and 3 trained therapists. Therapists provided prompting and feedback in the use of various social skills in the context of semi-structured recreational activities. All experimental procedures were approved by the university's Institutional Review Board, and informed consent forms were signed by each of the participants' parent or legal guardian.

Barry was a 14 year-old male with diagnoses of Attention Deficit-Hyperactivity Disorder, Autism, Post-traumatic Stress Disorder, and Oppositional-Defiant Disorder. Donny was a 12 year-old male diagnosed with Asperger's Syndrome and Attention Deficit/Hyperactivity Disorder. Joe was a 10 year-old male diagnosed with Social Communication Disorder. Bernard and Harry were both 13 year-old males diagnosed with Autism. All participants engaged in reciprocal communication using full sentences, and all exhibited socially acceptable behaviors (positive comments, appropriate physical contact) at rates parents and therapists deemed to be excessive relative to their peers. One participant (Donny) initially engaged in acceptable levels of the target behavior (appropriate physical contact) that became excessive with the introduction of an independent group differential reinforcement contingency. Although group members were discouraged from openly criticizing the behaviors of their peers, it is noteworthy, that therapists observed participants' peers making disapproving faces and/or questioning their excessive performance of the target responses.

Sessions took place on the clinic playground and at various recreational areas (e.g., football field, gymnasium, soccer field). The order and location of group activities was randomly selected.

1.2. Response measurement and inter-observer agreement

For Harry, the target response included positive comments directed toward peers. Comments consisted of audible vocalizations that were directed toward the peers in his group and included a congratulatory or encouraging statement (e.g., “good job,” “nice try”). Target responses for Barry, Donny, Joe, and Bernard included appropriate and inappropriate physical contact. Appropriate physical contact was defined as contact (initiated by the participant) between the participant’s hand and the hand, arm, or shoulder of a peer or staff member. Inappropriate physical contact was defined as contact (initiated by the participant) between any part of the participant’s body and any part of another person’s body not listed above (e.g., tickling, wrestling, rubbing a peer’s head). Inappropriate contact also included any forceful physical contact (regardless of location) that might better be described as aggression (although no instances of forceful contact were observed). In some instances, multiple responses were emitted in quick succession (e.g., a “secret” handshake). In these cases, a second response was scored only if 2 or more seconds elapsed (without physical contact) between the termination of the first response and the initiation of the second response.

Two observers simultaneously but independently collected data for 32% of sessions for Barry, 30% of sessions for Donny, 29% of sessions for Joe, 13% of sessions for Bernard, and 33% of sessions for Harry. Total count agreement was calculated for each participant by dividing the lower total number by the larger total number and multiplying by 100. Mean total count agreement was 88% (range 70% to 100%) for positive statements for Harry. For appropriate physical contact, mean total count agreement was 87% (range 67–100), 97% (range 80%–100%), 96% (range 75%–100%), 90% (range 80%–100%), for Barry, Donny, Joe, and Bernard respectively. For inappropriate physical contact, mean total count agreement was 91% (range 67%–100%) for Joe and 100% for Barry, Donny, and Bernard.

1.3. Social validity assessment

To determine socially appropriate rates of the target responses, therapists collected normative data on a sample of 28 typically developing peers of similar ages to the target participants. Participants in this assessment included typically developing children (ages 10 and 11) who participated in the group treatment program as peer models as well as members of a local youth soccer league (ages 11 and 12 years). None of these children was identified as being at risk of or formally diagnosed with any neurological or developmental disorder.

Sessions were conducted in accordance with the methods utilized in the baseline condition described below with identical operational definitions. Four 5-min sessions were conducted to establish normative levels of positive comments. Five 10-min sessions were conducted to establish normative levels of appropriate physical contact. These sessions were extended due to higher variability in rates of physical contact that appeared to occur in bursts ($x = 0.2$ per min; range = 0–0.5 per min) relative to positive comments ($x = 0.3$ per min; range = 0.1–0.4 per minute). The results of these sessions informed the target rate of behavior utilized in the DRL conditions described below. Because response rates were variable across individuals, the maximum number of responses observed was chosen as the target for DRL conditions in order to maximize the likelihood that participants would be successful in meeting their respective goals.

1.4. Procedures

Within-subject reversal designs were embedded into a multiple baseline design across participants for Barry, Donny, Joe, and Bernard. Harry’s data were evaluated at a separate time using a simple within-subject reversal design. Upon reasonable demonstration of experimental control, treatment components were faded in order to assess maintenance of treatment effects.

Sessions lasted 5 min for Harry and 10 min for Barry, Donny, Joe, and Bernard. Therapists recorded the total number of times participants engaged in the target response during the interval and delivered tokens (stickers) at the end of the session according to the prescribed schedule. Stickers could be exchanged for small toys and edible items from the group’s treasure box (participant preferences were taken into account in selecting items for treasure boxes which included items such as Pokemon® cards, small action figures, and edibles) at the end of the day’s activities. If the child did not have an opportunity to engage in the target response (e.g., he was not within 10 f of another individual), for more than 10 s, the session was terminated until such time as the child was able to engage in the target response.

1.4.1. Baseline

During Baseline, no programmed consequences were delivered. No prompting or feedback was provided for appropriate physical contact. Across all conditions, inappropriate physical contact was blocked and/or redirected. This initial condition was not run for Harry as his excessive responding (and thus eligibility for participation) was not apparent until reinforcement was implemented.

1.4.2. Pretraining

Prior to the FR 1 condition (following between sessions three and four for Barry, Donny, Joe, and Bernard), participants received training to deliver positive statements to their peers and to differentiate between appropriate and inappropriate physical contact. Participants were given opportunities to practice and receive feedback on these skills in the context of structured interactions with therapists. All participants demonstrated fluency in the target skills prior to initiation of the FR 1 condition. Specifically, in three consecutive role play scenarios with therapists, Harry demonstrated the ability to deliver positive statements using the following steps: standing within 5 feet of a peer, orienting toward the peer, using pleasant tone of voice and body language, and making a vocal

statement of approval or encouragement. Barry, Donny, Joe, and Bernard, demonstrated the ability to discriminate between appropriate and inappropriate touch in 10 out of 10 role play scenarios.

1.4.3. FR 1

During the FR 1 condition, participants were told they could earn stickers that could be exchanged for items from a treasure box at the end of the day's activities. Participants were told they would earn one sticker each time they engaged in the specified behavior (i.e., positive statements for Harry and appropriate physical contact for Barry, Donny, Joe, and Bernard). Therapists placed a sticker on the participant's nametag immediately following each instance of the target behavior and provided no additional interaction.

1.4.4. DRL

During the DRL condition, participants were instructed prior to the session that they could continue to earn stickers for engaging in low rates of the target responses. Specifically, Harry was told he could earn 5 stickers for delivering two or fewer positive comments over the course of a 5-min session. Barry, Donny, Joe, and Bernard were told they could earn 5 stickers for engaging in 5 or fewer instances of physical contact over the course of a 10-min session. All participants were able to re-state the contingency and accurately report the number of stickers they would earn if they engaged in various levels of the target response. During sessions, no signals were provided regarding the participant's current count of responses or the amount of time that had elapsed. Participants' questions regarding the current count and/or time elapsed (Harry only) were ignored. At the end of the session, participants received feedback regarding the number of responses emitted and stickers were delivered accordingly. If the participant exceeded the DRL requirement, no stickers were provided and the participant was encouraged to try again during the next session. Further attempts by the participant to obtain stickers were ignored.

1.4.5. Contingency Only

Procedures were identical to the DRL condition with the exception that contingencies were not stated verbally prior to the beginning of the session. In Harry's case, therapists gestured by holding up 2 fingers prior to the beginning of sessions. For all other participants, no rules were provided prior to sessions. However, participants continued to earn reinforcement for meeting the DRL requirement.

1.4.6. Maintenance

Procedures were identical to baseline. No rules were provided prior to sessions, and participants received no prompting or feedback regarding positive comments or appropriate physical contact. No inappropriate physical contact was observed.

2. Results

Fig. 1 shows the results for Barry, Donny, Joe, Bernard, and Harry respectively. During baseline, Barry engaged in low levels of inappropriate touch, but consistently exceeded the criterion level of appropriate touch. This pattern continued with the introduction of differential reinforcement (FR 1) for appropriate touch. The DRL contingency was associated with a decline in appropriate touch to below the criterion level. In the second FR 1 condition, responding increased to prior levels. A DRL probe session demonstrated criterion levels of responding were regained prior to removing verbal prompts. In the Contingency Only condition, responding initially returned to baseline levels but quickly decreased to below the criterion.

Donny initially engaged in low (but non-zero) rates of inappropriate touching and low rates of appropriate touch. While levels of inappropriate touch dropped to zero with the introduction of differential reinforcement, this phase was also associated with increased appropriate touch that exceeded the criterion level. Introduction of the DRL contingency was associated with variable levels of appropriate touch that met the DRL criterion in 4 out of 5 sessions. Reversal was associated with an increase in appropriate touch followed by reduction to criterion level when the DRL contingency was reinstated. Prompt removal in the Contingency Only condition was associated with an initial increase in responding that quickly declined to meet the criterion level. Low levels of responding were maintained when the contingency was removed altogether.

During baseline, Joe engaged in unacceptably high levels of inappropriate touching and variable levels of appropriate touch. Introduction of differential reinforcement was associated with a slight decrease in inappropriate touching and an increase in appropriate touching (in excess of the criterion level). In the DRL condition, both inappropriate and appropriate touching decreased. A reversal probe was associated with an increase in appropriate touch followed by reduction to criterion level when the DRL contingency was reinstated. Like Barry and Donny, removing prompts led to a brief increase followed by levels of appropriate touch that were below the criterion level.

Throughout baseline, Bernard consistently engaged in high levels of both inappropriate and appropriate touching. With the introduction of differential reinforcement for appropriate touching, inappropriate touching decreased but appropriate touching continued to exceed the criterion level. With the introduction of the DRL contingency, appropriate touching immediately decreased to the criterion level, and inappropriate touching remained at near-zero levels. Levels of appropriate touching were maintained below the criterion when differential reinforcement for appropriate touching was re-introduced and when no programmed reinforcement was provided in the final phase.

For Harry, data collection was initiated in the context of a continuous reinforcement schedule for positive comments directed toward peers due to excessive rates of responding that were deemed socially inappropriate and anecdotally appeared to annoy his peers. Introduction of the DRL contingency was associated with a gradual reduction in positive comments to meet the criterion level.

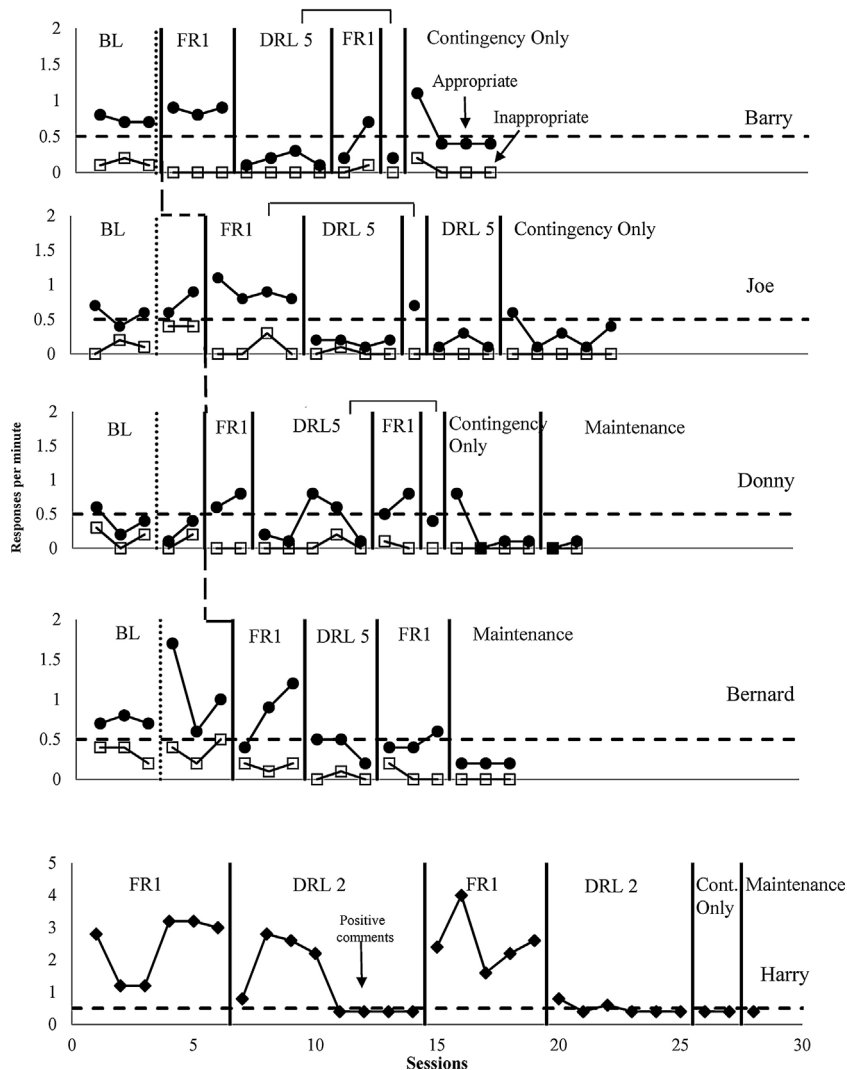


Fig. 1. Rates of social responding across conditions. Dotted vertical lines represent discrimination training for Barry, Donny, Joe, and Bernard. Dotted horizontal lines represent the reinforcement criterion specified by the DRL schedule.

When this contingency was removed and positive comments again resulted in continuous reinforcement, levels of responding returned to earlier levels. Re-introduction of the DRL contingency was associated with a reduction in responding to the criterion level that was maintained when verbal prompts were removed and when the contingency was eliminated altogether.

3. Discussion

Results indicated that full-session DRL was effective in reducing targeted responding to criterion levels while maintaining above zero responding for all five participants (although Donny engaged in very low levels of responding that may have been eliminated had data collection continued). This finding is consistent with and extends upon past research in which participants received within-session feedback regarding their response rates (Austin & Bevan, 2011; Hagopian et al., 2009). It is noteworthy that the current study showed maintenance of low rate responding even in the absence of within-session feedback. In the absence of such feedback, participants who are unclear about how many responses have been emitted and how many (more) will be tolerated may behave conservatively and cease responding altogether. However, our results did not reveal such an effect. Indeed, this study extends upon prior research by demonstrating that the effects of full-session DRL can be maintained in the absence of within-session feedback as well as when the salience of schedule parameters is systematically faded. Although data are limited, our findings indicated these effects were maintained even after the treatment contingency was removed altogether for three participants.

Perhaps most notably, our results contradict earlier findings by demonstrating response persistence throughout treatment in the absence of any immediate (within session) reinforcement or feedback delivery. Recent research by Jessel and Borrero (2014) suggests the behavioral mechanisms underlying interval and full-session DRL differ from spaced-responding DRL in that the former function

more as ‘DRO-with-tolerance schedules’ that are often associated with elimination of responding. However, some procedural variations between these two studies bear note. First, Jessel and Borrero used a computer application in which multiple schedule components were not explicitly described. It is possible that participants did not readily discriminate schedule changes, though the authors noted that many participants were able to verbally tact the contingencies in place following completion of the study. Perhaps more importantly, Jessel and Borrero used a DRL criterion for allowable responses that may be more stringent than would commonly be used in application. As such, participants may have experienced the contingency as a DRO rather than a DRL. While their arrangement was necessary for purposes of comparing spaced responding and full session DRL, it may limit the generality of findings regarding DRL in applied settings. Even though participants could tact the relevant contingencies, their behavior would still be expected to conform to relevant reinforcement schedules as delivered (rather than as programmed). Additionally, participants were told that various response patterns could not only add to their earnings, but could also subtract from their earnings. Given the effects of loss aversion (Kahneman & Tversky, 1979) on human choice behavior, this procedural variation could have suppressed responding in the absence of highly salient reinforcement contingencies.

Given that the responses targeted in this study involved social interactions, it is not clear whether the maintenance of responding was due to characteristics of the DRL schedule per se. It may be that participants’ learning history (i.e., exposure to continuous schedules of reinforcement) was associated with increased resistance to extinction. Past research showing elimination of responding has also involved responses with dense reinforcement histories (see Dietz & Repp, 1973 and Singh, Dawson, & Manning, 1981), and it is possible that responding would have been extinguished had data collection continued over a longer period of time. Another possible explanation is that the current study targeted social responses which are likely multiply controlled. In other words, responses may have served multiple functions not solely access to tangible reinforcement. Once these behaviors came into contact with natural reinforcement contingencies (e.g., a reciprocated high-5, a positive reaction from a peer), those consequent events may have sufficed to maintain responding even in the absence of the programmed DRL schedule. While more research is needed to investigate this possibility, it is noteworthy that DRL schedules tend to be indicated for social behaviors and not for arbitrary responses that serve no other reinforcing functions. Thus, while it may be that full-session DRL does not maintain all responses at desired levels, variations on this schedule may be appropriate for exactly the types of responses they are typically used to treat.

Finally, it is noteworthy that for three participants, the introduction of continuous reinforcement resulted in modest increases in the target response (appropriate touch) over baseline levels. Thus, one might conclude that the identified reinforcer did not, after all, exert functional control over the target response. However, it is important to note that the introduction of differential reinforcement did result in concomitant decreases in inappropriate touching for each of these participants despite no change in the associated instructions or consequences for that behavior (For all participants who received discrimination training regarding appropriate and inappropriate touch, this training occurred following session 3). Also, assuming a reinforcement process was in effect, it is possible that simple removal of that reinforcement (i.e., without a DRL contingency) would result in maintenance of low level responding for some participants. In other words, once participants contacted naturally occurring social reinforcers for the target behaviors, functional control over responding may have transferred to these contingencies. However, in the context of group-based social skills programming, it may be difficult to identify the participants for whom such transfer of control has occurred and thus, the use of a single DRL schedule may be warranted.

Demonstration of low level response maintenance using full-session DRL schedules is important given that many responses targeted for intervention may be considered socially skilled behaviors when they occur at appropriate levels. Relative to spaced-responding DRL, full-session DRL requires considerably less effort (which may translate to better treatment integrity) on the part of those administering the intervention. Although, spaced responding DRL may be preferable for treating behaviors that serve critical functions or that one cannot risk extinguishing, full-session DRL may be an appropriate alternative in many instances. This study provides preliminary support for the use of such schedules in the context of social skills training programs.

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