RESEARCH ARTICLE

Rules and Statements of Reinforcer Loss in Differential Reinforcement of Other Behavior

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Abstract

Providing a rule regarding consequences for behavior can increase the efficacy of differential reinforcement of other behavior (DRO) procedures in the treatment of severe problem behavior (Watts, Wilder, Gregory, Leon, and Ditzian, *Journal of Applied Behavior Analysis*, 46, 680–684, 2013). The purpose of the current study was to replicate and extend the literature on DRO procedures by evaluating the efficacy of rules and statements of reinforcer loss (SRL) in the treatment of severe problem behavior. Conditions included baseline, no rule DRO, rule DRO, and rule DRO with SRL. For 2 of 3 participants, neither the no rule DRO nor the rule DRO condition reduced problem behavior. The rule DRO with SRL condition produced a substantial decrease in problem behavior for all participants, suggesting that a consequent rule enhances the efficacy of DRO. The current study extends the literature on DRO procedures by providing data on nontargeted (“other”) behavior. An increase in other behavior was observed for 2 participants.

Keywords Differential reinforcement of other behavior · Rules · Problem behavior · Verbal behavior · Rule-governed behavior

Differential reinforcement of other behavior (DRO) is a contingency in which a reinforcer is delivered following an interval of time during which an individual did not engage in target responding (Catania, 2013). DRO can be an effective intervention in the treatment of severe problem behavior such as aggression, self-injurious behavior (SIB), and disruptive behavior (Jessel & Ingvarsson, 2016; Matson et al., 2011; Poling & Ryan, 1982). In a review of DRO procedures, Whitaker (1996) found that DRO procedures were effective with children with varying degrees of intellectual disabilities and that more training was necessary for individuals with severe intellectual disabilities. Furthermore, DRO has been shown to be successful with and without rules given to the individual regarding

the consequences for one’s behavior (Mazaleski, Iwata, Vollmer, Zarcone, & Smith, 1993; Ringdahl et al., 2002).

Watts, Wilder, Gregory, Leon, and Ditzian (2013) assessed the effects of adding rules to a DRO procedure to determine whether the rule would enhance the treatment’s effectiveness. These researchers targeted highly preferred toy play as an analog for behavior maintained by automatic reinforcement. Participants in this study were Level 2 learners or higher on the Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP; Sundberg, 2008). In the baseline condition, the therapist remained in the room but did not interact with the participant and did not deliver reinforcers. In the no rule DRO condition, a reinforcer was delivered if the participant did not engage with the highly preferred toy for 20 s. The rule DRO condition was identical to the no rule DRO condition except that prior to the start of a session, a specific rule was delivered that explained the contingencies. For example, the therapist would say, “Don’t touch the [name of toy] for 20 s, and you get a [name of edible]” (p. 681). In addition to toy play with highly preferred toys (the target behavior), data were also collected on toy play with low-preferred toys in an effort to measure “other” behavior. The researchers found that the speed and effectiveness of DRO in the reduction of highly preferred toy play was superior in the rule DRO condition compared to the no rule DRO condition. For two participants,

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playing with highly preferred toys decreased substantially in the rule DRO condition, whereas no reduction was seen in the no rule DRO condition. Targeting toy play seems like a compelling analog to better understand the mechanisms controlling the DRO procedure; however, targeting a socially significant behavior as it relates to rules and DRO is the next step for understanding how rules control behavior.

In addition, because the reinforcer is not immediately tied to a response in DRO procedures, additional verbal stimuli may prove useful. Therefore, because a rule stating the DRO contingency appears to be effective as an antecedent verbal stimulus correlated with the DRO schedule (Watts et al., 2013), it is also possible that a consequent verbal stimulus could add to the efficacy of the DRO schedule. That is, a statement delivered contingent on target responding might also facilitate DRO schedule control. Whereas a rule refers to a stimulus specifying a contingency, the term *rule* traditionally refers to an antecedent stimulus. Thus, in the present study, the consequent verbal stimulus is referred to separately as a *statement of reinforcer loss* (SRL).

The first purpose of the present experiment was to replicate the procedures of Watts et al. (2013) with participants who engaged in severe problem behavior (aggression, SIB, disruptive behavior). This was accomplished by comparing a DRO with rules to a DRO without rules. The second purpose of the current study was to compare the effectiveness of consequent SRL in DRO procedures to only an antecedent rule. This second purpose was to test a novel procedure based on the same principle, that verbal stimuli can facilitate schedule control.

Method

Participants

Three children aged 9–16 years old who were admitted to an inpatient facility for the assessment and treatment of severe problem behavior participated in this study. Seth was a 10-year-old male diagnosed with disruptive behavior disorder—not otherwise specified, stereotypic movement disorder with self-injury, obsessive compulsive disorder, autism spectrum disorder, and intellectual disability of unspecified severity. Jeffery was a 16-year-old male diagnosed with disruptive behavior disorder, expressive language delays, autism spectrum disorder, and intellectual disability of unspecified severity. Jude was a 9-year-old male diagnosed with attention deficit hyperactivity disorder, autism spectrum disorder, and severe intellectual disability. All participants engaged in aggression, SIB, and disruptive behavior. These problem behaviors were maintained by positive reinforcement in the form of access to tangible items as shown by a functional analysis. Seth's

problem behavior was maintained by both tangible reinforcement and automatic reinforcement.

All participants were evaluated on the Peabody Picture Vocabulary Test (PPVT, 3rd (Dunn, 1997) and 4th eds. (Dunn & Dunn, 2007)). Seth's age equivalence on the PPVT-IV was 6 years, 9 months; Jeffery's age equivalence on the PPVT-III was 1 year, 9 months; and Jude's age equivalence on the PPVT-IV was 2 years, 6 months. According to the American Speech-Language-Hearing Association, a child between 1 and 2 years old should be able to follow simple commands and understand simple questions (American Speech-Language-Hearing Association, 2015). A speech-language pathologist (SLP) was consulted prior to including participants in the current study. Based on the PPVT and the SLP's professional opinion, it was determined that each participant's receptive verbal skill level was high enough to understand rules.

Materials

Materials necessary for the preference assessment and DRO comparison were edible or nonedible stimuli, chairs, and a table. Colored posters and shirts were also used to help participants discriminate between conditions in the DRO comparison. Last, computers with data collection software were used to collect data throughout the study.

Setting

For Seth and Jude, padded session rooms with a one-way window on an inpatient unit were used throughout the study. Due to a food allergy, Jeffery had to remain in an allergy-friendly bedroom on the unit; therefore, his sessions were conducted there. No more than four sessions were run within a 1-hr session block; a maximum of three session blocks occurred in 1 day. Throughout the course of the study, no more than eight sessions were conducted in 1 day.

Measurement

The primary dependent variable was problem behavior, which included aggression, SIB, and disruption. Problem behaviors were defined individually for each participant. *SIB* included attempting to or successfully hitting or punching oneself with one's own hand, arm, or an object with force; self-scratching; skin picking; self-biting; or head banging. *Aggression* included attempting to or successfully grabbing, pushing, hitting, punching, pinching, scratching, kicking, pulling hair, or throwing objects within half of a meter of a person. *Disruption* included attempting to or successfully biting, ripping, breaking, or tearing objects; swiping objects from surfaces; hitting or kicking objects from a distance of 15 cm or greater; or knocking over or throwing objects or furniture not within half of a meter of a person.

Data were also collected on nontargeted behaviors, collectively referred to as “other” behavior hereafter. This was accomplished by having data collectors make a note of any behavior other than targeted problem behavior that occurred and then collecting frequency data on these behaviors going forward. Other behaviors for Seth included reaching, walking, vocalizations, jumping, hand flapping, dropping, rocking, touching objects, touching himself, object mouthing, climbing, and spinning. Other behaviors for Jeffery included touching himself, vocalizations, playing with shoes, playing with a lanyard, inappropriate sexual behavior, and touching the therapist. Other behaviors for Jude included walking, jumping, touching himself, reaching, and vocalizations. Data were collected on other behavior to examine whether nontargeted responses increased during DRO interventions, which other studies reported (e.g., Jessel, Borrero, & Becraft, 2015). Frequency data were collected for problem behavior and other behavior on computers and response rate, expressed as responses per minute (RPM), was calculated.

Procedures and Experimental Design

A preference assessment was conducted in a paired-choice format for each participant to identify preferred edible or non-edible reinforcers (Fisher et al., 1992). Highly preferred items from the preference assessment were identified by caregivers or clinical therapists as potentially problematic when removed or access to them was denied. For Jude, a multiple stimulus without replacement preference assessment (DeLeon & Iwata, 1996) was conducted after a potential side bias was discovered in the paired-stimulus preference assessment. The highest preferred items were white-cheddar-cheese crackers for Seth, a tablet for Jeffery, and jellybeans for Jude. Because Jude was earning a large amount of a high-sugar-content food, his jellybeans were cut into quarter pieces.

The highest preferred item was used in the functional analysis and DRO comparison for two participants (Jeffery and Jude). For Seth, the highest preferred item identified in the preference assessment was different from the item used to identify the tangible function of his problem behavior in the functional analysis; this was done in the interest of not interfering with the treatment evaluations being conducted simultaneously with his clinical team. Due to the high rates of problem behavior obtained in baseline of the DRO comparison (described next), as well as information from caregivers and therapists, it was determined that Seth also, at least in part, engaged in problem behavior to gain access to the white-cheddar-cheese crackers.

Baseline During baseline, individuals were provided with access to a preferred item contingent on targeted problem behavior. First, participants were given pre-session access to the tangible item. For edibles (Seth and Jude), the pre-session

access consisted of one piece of the edible. Pre-session access to a nonedible (Jeffery) consisted of 2 min of playing with the item. After this access, the tangible was removed and the session began. Contingent on one occurrence of problem behavior, the item was delivered to the participant (20 s of access for nonedible or one piece of food). These sessions were associated with blue stimuli (a poster board displayed in the session room and the therapist’s shirt).

No rule DRO During this condition and all other DRO conditions, a whole-interval resetting DRO was used. In this condition, the therapist wore a red shirt and a red poster was displayed in the session room to signal the no rule DRO condition. The therapist was present in the room and delivered a preferred edible or 20 s of access to a preferred toy at the end of the interval if the participant did not engage in problem behavior. This amount of time was different for each participant and was half of the mean interresponse time based on mean baseline responding. The DRO intervals were 9 s, 13 s, and 4 s for Seth, Jeffery, and Jude, respectively. Furthermore, there was no response cost; once the participant had the tangible item, he kept it until consumed or for 20 s regardless of problem behavior. Occurrences of problem behavior did not produce the tangible edible or nonedible. The therapist did not interact with the participant other than to deliver the reinforcer.

Rule DRO The therapist wore a yellow shirt and a yellow poster was displayed in the room to signify the rule DRO condition. This condition was identical to the no rule DRO condition except that a rule specifying the DRO contingency was stated prior to the start of a session (i.e., “If you don’t [list of problem behaviors] you get a(n) [reinforcer].”). For example, “If you don’t hurt yourself, me, or anything else, you get a jellybean.”

Rule DRO with SRL The therapist wore a green shirt and a green poster was displayed in the session room to signify the rule with SRL condition. This condition was identical to the rule DRO condition except that the therapist also delivered an SRL contingent on problem behavior (i.e., “You don’t get [reinforcer] because you hurt yourself/hurt me/[type of disruption].”). For example, “You don’t get a jellybean because you hurt yourself.” This SRL was delivered in a neutral tone.

These conditions were evaluated using a multielement design across treatment phases. Additionally, for Seth and Jeffery, all sessions in this DRO comparison were 10 min. Due to the potential to consume a large amount of a high-sugar-content food, sessions were shortened to 5 min for Jude.

Social validity questionnaire After the study, but before results were shared with caregivers, a brief questionnaire was given to each participant’s primary caregiver to assess social validity. The questionnaire consisted of closed- and open-ended

questions about the satisfaction with and preference for the different treatment conditions. Items included in the questionnaire can be found in the Appendix Table 3. A 5-point Likert-type scale was used in closed-ended questions, with a 5 indicating agreement with a statement and a 1 indicating disagreement with a statement.

Interobserver Agreement and Treatment Integrity

A second observer simultaneously but independently collected data for 100% of preference assessment sessions for all participants and 34.1%, 41.9%, and 41.9% of DRO comparison sessions for Seth, Jeffery, and Jude, respectively. In preference assessment sessions, agreements were defined as both observers recording the same edible or non-edible choice for a given trial. Interobserver agreement (IOA) for these sessions was calculated by dividing the number of agreements by the sum of agreements plus disagreements and converting this number to a percentage. IOA for the preference assessments was 100% for all participants. With respect to the DRO comparison, IOA was calculated using the partial agreement within intervals method. Sessions were divided into 10-s intervals, and the mean was taken of the quotients of the lower number of responses divided by the higher number of responses in each interval. This number was then converted into a percentage. IOA in the DRO comparison was 95.96% (range 88.98%–100%), 97.33% (range 94.21%–99.44%), and 99.73% (range 97.78%–100%) for target behaviors and 86.99% (range 80.34%–93.31%), 90.99% (range 87.22%–94.79%), and 93.07% (range 87.27%–97.02%) for other behaviors for Seth, Jeffery, and Jude, respectively.

Treatment integrity during the DRO comparison was measured during 36.4%, 41.9%, and 41.9% of sessions for Seth, Jeffery, and Jude, respectively. Data were collected on correct reinforcer delivery, rule delivery, and SRL loss delivery. Correct reinforcer delivery was defined as the therapist delivering edible or nonedible reinforcers after problem behavior in baseline sessions and after the DRO interval expired if problem behavior did not occur within the interval during DRO conditions. Correct rule delivery was defined as the therapist stating the DRO contingency at the beginning of the session in the rule DRO condition and rule with SRL condition. Correct SRL delivery was defined as the therapist briefly stating that the participant did not earn an edible or nonedible reinforcer and why within 3 s of problem behavior only in the rule with SRL condition. Reinforcer delivery was implemented with 97.6%, 100%, and 100% integrity for Seth, Jeffery, and Jude, respectively. Rule delivery was implemented with 100% integrity for all participants. SRL delivery was also implemented with 100% integrity across all participants.

Results

Results for Seth during the DRO comparison are presented in Fig. 1. Seth engaged in high and variable rates of problem behavior in baseline sessions throughout the study ($M = 6.89$; range 0.3–13.9 RPM). In the comparison between rule DRO and no rule DRO, Seth engaged in high and variable rates of problem behavior in both conditions ($M = 8.64$; range 3.8–12.9 RPM and $M = 13.44$; range 4.1–28.3 RPM, respectively). After experiencing the rule with SRL DRO condition, Seth engaged in low rates of problem behavior in both the rule DRO and rule with SRL DRO conditions ($M = 4.21$; range 0–20.4 RPM and $M = 0.73$; range 0.1–2.2 RPM, respectively). Seth engaged in the lowest and most stable rates of problem behavior in the rule with SRL DRO condition. Seth's other behaviors remained variable across all conditions, with little differentiation ($M = 35.84$; range 17.6–58.9 RPM in baseline, $M = 42.88$; range 15.9–67.4 RPM in the no rule DRO condition, $M = 38.4$; range 5.6–71.8 RPM in the rule DRO condition, and $M = 48.1$; range 20.9–72.6 RPM in the rule with SRL DRO condition).

The results of the DRO comparison for Jeffery are presented in Fig. 2. Jeffery engaged in stable rates of problem behavior in baseline sessions throughout the comparison ($M = 2.27$; range 1.5–2.6 RPM). In the comparison between rule DRO and no rule DRO conditions, Jeffery engaged in rates of problem behavior comparable to that observed in baseline ($M = 3.9$; range 1.9–10 RPM and $M = 3.88$; range 1.5–7.8 RPM, respectively). In the second comparison between rule DRO and rule with SRL DRO, Jeffery engaged in the lowest rates of problem behavior in the rule with SRL DRO condition ($M = 0.6$; range 0.1–1.5 RPM). Rates of problem behavior in rule DRO sessions were generally unchanged, but a slightly decreasing trend was observed at the end of the analysis ($M = 2.24$; range 0.8–5.4 RPM). Rates of other behaviors during DRO conditions were slightly higher ($M = 20.68$; range 11.4–50.9 RPM in the no rule DRO condition, $M = 18.77$; range 10–33.6 RPM in the rule DRO condition, and $M = 32.4$; range 14.7–58.6 RPM in the rule with SRL DRO condition) than baseline ($M = 10.67$; range 0.7–37.6 RPM) but did not increase over time. Increases in other behaviors were observed toward the end of the analysis, but most in the rule with SRL DRO condition.

Results from the DRO comparison for Jude are presented in Fig. 3. High rates of problem behaviors were observed in baseline sessions throughout the study ($M = 13.75$; range 9–21.4 RPM). A decrease in problem behavior was observed in both the no rule DRO and rule DRO conditions ($M = 10$; range 32.6–1.6 RPM and $M = 3.72$; range 0.6–7.6 RPM respectively); however, a more rapid decrease was observed in the rule DRO condition. In the comparison between rule DRO and rule with SRL DRO, a substantial decrease was observed in both conditions with the lowest rates of problem behavior

Fig. 1. Problem behaviors per minute in the top panel and other behaviors per minute in the bottom panel during baseline, when no rule was in place (no rule DRO), when a rule was given at the start of session

(rule DRO) and when a rule was given both at the start of session and when the reinforcer was lost (rule DRO + SRL) for Seth

Fig. 2. Problem behaviors per minute in the top panel and other behaviors per minute in the bottom panel during baseline, when no rule was in place (no rule DRO), when a rule was given at the start of session

(rule DRO) and when a rule was given both at the start of session and when the reinforcer was lost (rule DRO + SRL) for Jeffery

Fig. 3. Problem behaviors per minute in the top panel and other behaviors per minute in the bottom panel during baseline, when no rule was in place (no rule DRO), when a rule was given at the start of session

(rule DRO) and when a rule was given both at the start of session and when the reinforcer was lost (rule DRO + SRL) for Jude

observed in the rule with SRL DRO condition ($M = 1.6$; range 0.4–3.4 RPM and $M = 0.5$; range 0–0.4 RPM respectively). Similar to Jeffery, Jude engaged in higher rates of other behaviors during DRO conditions ($M = 25.36$; range 7.8–45.8 RPM in the no rule DRO condition, $M = 32.89$; range 8.2–60.8 RPM in the rule DRO condition, and $M = 77.75$; range 38.8–56 RPM in the rule with SRL DRO condition) compared to baseline ($M = 6.35$; range 2–18.8 RPM). The highest rates of other behaviors were observed during both DRO conditions after the rule with SRL DRO condition was initiated.

The mean rates of reinforcement during the DRO comparison for all participants are reported in Table 1. The rule with SRL DRO condition was associated with the highest reinforcement rate for two of three participants, Seth and Jeffery. The reinforcement rate for Jude was slightly higher in the rule DRO condition.

Table 1 Reinforcement Rate During DRO Comparison

	No Rule DRO	Rule DRO	Rule With SRL DRO
Seth	1.72	2.48	3.73
Jeffery	1.12	1.15	1.42
Jude	3.84	4.78	4.3

Note. Mean reinforcer deliveries per minute in no rule DRO, rule DRO, and rule with SRL DRO.

Results from the social validity questionnaire are summarized in Table 2. One parent of each participant completed the questionnaire. Parents reported that they would be the most satisfied with the rule with SRL DRO being a part of their child's treatment and the least satisfied with the no rule DRO. Parents also strongly agreed that the rule with SRL DRO was simple to use. The rule with SRL DRO was also rated the most effective treatment by all parents. When asked which treatment they would prefer as part of their child's treatment, all parents reported that they would prefer the rule with SRL DRO. When asked which DRO procedure was the most socially acceptable, all parents answered the rule with SRL DRO. Last, when asked if there were any DRO procedures they would not use, two of three parents reported the no rule DRO, and one parent reported that there were no procedures she would not use.

Discussion

Results of the current study suggest that antecedent rules and especially consequent statements may enhance the effectiveness of DRO in the treatment of severe problem behavior. The results from one participant, Jude, replicated the findings of Watts et al. (2013) in that a faster reduction from baseline was

Table 2 Summary of Social Validity Results

	No Rule DRO	Rule DRO	Rule With SRL DRO
I am satisfied with this treatment.	3.7	3.7	5
This treatment is simple to use.	3.7	3.7	5
This treatment is effective.	3.3	3.3	4.7

Note. Mean responses on a 1–5 scale of agreement with statements about no rule DRO, rule DRO, and rule with SRL DRO.

achieved when a rule, as compared to no rule, was stated at the beginning of the session. For two of three participants, there was no differentiation between rule DRO, no rule DRO, and baseline. However, when an SRL was provided contingent on problem behavior, a substantial reduction from baseline was achieved for the remaining two participants. The rule with SRL DRO condition was associated with the lowest rates of problem behavior for all three participants. Furthermore, the reinforcement rate was highest when an antecedent or antecedent with consequent statement was used. This adds to the evidence that verbal stimuli describing contingencies, presented either as antecedents or consequences, can enhance the efficacy of DRO procedures, conceivably by facilitating schedule control via verbal mediation.

It is important to note that Seth's problem behavior was multiply maintained by access to tangibles and automatic reinforcement. It is possible that because of the automatic function, Seth engaged in more variable rates of problem behavior, and thus his problem behavior was more resistant to treatment. This is consistent with findings that automatically maintained problem behavior can be treated with the same interventions used to treat socially maintained problem behavior but that these treatments often require more training or additional components to make them effective (Phillips, Iannaccone, Rooker, & Hagopian, 2017). Additionally, whereas this treatment was effective with one case of multiply maintained problem behavior, the rule with SRL DRO condition may not be effective for participants with functions to their problem behavior other than tangible and automatic reinforcement. For example, the rule with SRL DRO condition may not be effective for participants with problem behavior maintained by attention due to the consequence of problem behavior being a form of attention.

It is also important to mention that the targeting of behavior maintained by access to tangibles is unique to this study, as compared to the study by Watts et al. (2013). The decision to target problem behavior maintained by tangible reinforcement, as opposed to automatic reinforcement (alone), was twofold: (a) to avoid treatment resistance often associated with identifying effective treatments for automatically maintained problem behavior and (b) to utilize a functional reinforcer in the DRO comparison. Another unique aspect of this study was

the use of a resetting DRO instead of a non-resetting DRO. It is possible that the difference in results obtained in this study, as compared to the study by Watts et al. (2013), is at least in part due to these differences in methodology.

Results from the social validity questionnaire showed that parents of participants gave the rule with SRL DRO condition the highest ratings with respect to satisfaction with the treatment, the ease of implementation, and the effectiveness. All parents reported that they would prefer to include the rule with SRL DRO into their child's treatment package instead of other DRO conditions. This increases the social validity of the SRL.

The underlying process responsible for the effects observed in DRO schedules is a recently explored topic in the literature (Jessel & Ingvarsson, 2016). One argument against simply classifying DRO as a positive reinforcement procedure is the fact that it is generally unknown if other behaviors increase as a result of the presentation of the reinforcer. The current study adds unique information to the literature on DRO by reporting the effects of DRO on nontargeted behaviors (i.e., other behaviors). An increase in other behaviors was observed during DRO conditions as compared to baseline for two of three participants, which could suggest that DRO adventitiously reinforces one or multiple nontargeted behaviors, resulting in a positive reinforcement procedure. However, it is also possible that in a concurrent arrangement, the punishment of one response can increase an alternative nonpunished response (Lerman & Vorndran, 2002). Seth engaged in variable rates of other behaviors across all conditions, suggesting DRO may have functioned as a negative punishment procedure in his case. Additionally, the decrease in target responding observed in DRO could be due to the disruption between the response and the reinforcer; this has also been suggested to be occurring in noncontingent reinforcement as well. More research is needed to further examine the operative behavioral mechanisms working in a DRO paradigm.

Additionally, although the current study assessed the effects of DRO on other behaviors, these other behaviors were not separated into appropriate and inappropriate behavior. For example, one other behavior for Jeffery was inappropriate sexual behavior. Because of the nature of the present study, it is unknown if Jeffery's inappropriate sexual behavior increased during DRO conditions or remained constant. Future research should assess the effects of DRO on the individual frequency and appropriateness of these other behaviors.

One potential limitation of the current study is the order of the conditions for each participant. It is possible that the lower rates of target behavior observed in the final phase of the experiment (rule DRO and rule with SRL DRO comparison) were due to repeated exposure to the DRO in the previous phase. Another limitation is that the DRO intervals were fairly short and the reinforcement schedule was not thinned. In addition to extinction, another potential explanation for the

treatment effects observed in DRO procedures is an attenuated motivating operation. That is, satiation could affect the outcome of DRO procedures (Jessel & Ingvarsson, 2016). Future research can assess the efficacy of the different DRO conditions when reinforcement is less frequent. An additional limitation of the study is that, whereas PPVT scores and input from an SLP were obtained, no formal assessment was conducted to assess the participants' level of ability to "understand" the rules. Future research regarding receptive language skills related to rule following would add to the strength of the study by assuring participants have the necessary repertoire. Last, although verbal stimuli were effective for all participants of the current study, it is important to note their verbal skill levels were high enough to understand rules. Future research should include assessing the efficacy of rules in participants with a wider range of verbal skills.

The results of this study systematically replicate the findings by Watts et al. (2013) and extend them by applying the different DRO conditions to problem behavior. This study helps to further evaluate the mechanisms by which a DRO can work to reduce behavior and perhaps enhance its efficacy.

Implications for Practice

- Findings of the current study show that providing antecedent rules and consequent SRL enhance the efficacy of DRO in the treatment of severe problem behavior.
- Providing only antecedent rules may not be as effective as when they are combined with a consequent statement in DRO procedures.
- Nontargeted (other) behavior may increase during DRO procedures.
- Findings of the current study show that DRO procedures with antecedent rules combined with consequent SRL have strong social validity.

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Compliance with Ethical Standards

Conflict of interest Julia Iannaccone declares that she has no conflict of interest. Louis Hagopian declares that he has no conflict of interest. Noor Javed declares that she has no conflict of interest. John Borrero declares

that he has no conflict of interest. Jennifer Zarcone declares that she has no conflict of interest.

Ethical approval All procedures in studies involving participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

Appendix

Table 3 Items Included in the Social Validity Questionnaire

Closed-Ended Questions: Rated 1 (*Strong Disagreement*) to 5 (*Strong Agreement*)

Regarding DRO without rules

- I am satisfied with this treatment for my child.
- This treatment is simple to use.
- This treatment is effective.

Regarding DRO with rules

- I am satisfied with this treatment for my child.
- This treatment is simple to use.
- This treatment is effective.

Regarding DRO with rules and SRL

- I am satisfied with this treatment for my child.
- This treatment is simple to use.
- This treatment is effective.

Open-Ended Questions

- Which treatment would you prefer to be in your child's final treatment package?
- Which treatment do you think is the most socially acceptable?
- Were there any treatments you would not use? If so, which one(s)?

References

- American Speech-Language-Hearing Association. (2015). *One to two years*. Retrieved July 12, 2015, from <http://www.asha.org/public/speech/development/12.htm>
- Catania, A. C. (2013). *Learning* (5th ed.p. 438). Cornwall-on-Hudson, NY: Sloan Publishing.
- Dunn, Lloyd M. (1997). PPVT-III: Peabody picture vocabulary test. Circle Pines, MN: American Guidance Service.
- Dunn, Lloyd M., & Dunn, Douglas M. (2007). PPVT-IV: Peabody picture vocabulary test. Minneapolis, MN: Pearson Assessments.
- DeLeon, I. G., & Iwata, B. A. (1996). Evaluation of a multiple-stimulus presentation format for assessing reinforcer preferences. *Journal of Applied Behavior Analysis*, 29, 519–533. <https://doi.org/10.1901/jaba.1996.29-519>.
- Fisher, W., Piazza, C. C., Bowman, L. G., Hagopian, L. P., Owens, J. C., & Slevin, I. (1992). A comparison of two approaches for identifying reinforcers for persons with severe and profound disabilities.

- Journal of Applied Behavior Analysis*, 25, 491–498. <https://doi.org/10.1901/jaba.1992.25-491>.
- Jessel, J., Borrero, J. C., & Becraft, J. L. (2015). Differential reinforcement of other behavior increases untargeted behavior. *Journal of Applied Behavior Analysis*, 48, 402–416. <https://doi.org/10.1002/jaba.204>.
- Jessel, J., & Ingvarsson, E. T. (2016). Recent advances in applied research on DRO procedures. *Journal of Applied Behavior Analysis*, 49, 991–995. <https://doi.org/10.1002/jaba.323>.
- Lerman, D. C., & Vorndran, C. M. (2002). On the status of knowledge for using punishment: Implications for treating behavior disorders. *Journal of Applied Behavior Analysis*, 35, 431–464. <https://doi.org/10.1901/jaba.2002.35-431>.
- Matson, J. L., Shoemaker, M. E., Sipes, M., Horovitz, M., Worley, J. A., & Kozlowski, A. M. (2011). Replacement behaviors for identified functions of challenging behaviors. *Research in Developmental Disabilities*, 32, 681–684. <https://doi.org/10.1016/j.ridd.2010.11.014>.
- Mazaleski, J. L., Iwata, B. A., Vollmer, T. R., Zarcone, J. R., & Smith, R. G. (1993). Analysis of the reinforcement and extinction components in DRO contingencies with self-injury. *Journal of Applied Behavior Analysis*, 26, 143–156. <https://doi.org/10.1901/jaba.1993.26-143>.
- Phillips, C. L., Iannaccone, J. A., Rooker, G. W., & Hagopian, L. (2017). Noncontingent reinforcement for the treatment of severe problem behavior: An analysis of 27 consecutive applications. *Journal of Applied Behavior Analysis*, 49, 1–20. <https://doi.org/10.1002/jaba.376>.
- Poling, A., & Ryan, C. (1982). Differential reinforcement of other behavior schedules: Therapeutic applications. *Behavior Modification*, 6, 3–21. <https://doi.org/10.1177/01454455820061001>.
- Ringdahl, J. E., Andelman, M. S., Kitsukawa, K., Windorn, L. C., Barretto, A., & Wacker, D. P. (2002). Evaluation and treatment of covert stereotypy. *Behavioral Interventions*, 17, 43–49. <https://doi.org/10.1002/bin.105>.
- Sundberg, M. L. (2008). *VB-MAPP: Verbal behavior milestones assessment and placement program*. Concord, CA: AVB Press.
- Watts, A. C., Wilder, D. A., Gregory, M. K., Leon, Y., & Ditzian, K. (2013). The effects of rules on differential reinforcement of other behavior. *Journal of Applied Behavior Analysis*, 46, 680–684. <https://doi.org/10.1002/jaba.53>.
- Whitaker, S. (1996). A review of DRO: The influence of the degree of intellectual disability and the frequency of the target behaviour. *Journal of Applied Research in Intellectual Disabilities*, 9, 61–79. <https://doi.org/10.1111/j.1468-3148.1996.tb00098.x>.

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