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**“Other” Behavior and the DRO: The Roles of Extinction and Reinforcement**

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**Abstract**

Jessel et al. (2015) provided some evidence to suggest that “other” behavior is strengthened in the differential reinforcement of other behavior (DRO). The present study is a systematic replication of the Jessel et al.’s procedures. The effects of DRO and extinction on target responding and other responding (a response with an established history of reinforcement), emitted by children with intellectual and developmental disabilities and children with no known diagnoses were compared. Other behavior increased in at least one DRO condition for each participant, further suggesting that other behavior increases when using DRO, at least initially. Under extinction, target responding and other responding decreased to low rates for three of the five participants; however, rates of nontarget-other responding were elevated compared to the DRO condition. These results suggest that increased rates of target-other responding and nontarget-other responding during the DRO condition may be a result of extinction-induced variability.

*Key words:* differential reinforcement of other behavior, extinction, extinction-induced variability, replication

**“Other” Behavior and the DRO: The Roles of Extinction and Reinforcement**

Differential reinforcement of other behavior (DRO) is a procedure in which a reinforcer is presented contingent on a specified interval of time without the occurrence of a target response (Reynolds, 1961). DRO is used to decrease a specific response and is used as a treatment to decrease problem behavior (Jessel & Ingvarsson, 2016). The causal mechanism, or mechanisms, of DRO remain a subject of academic discourse, and some have noted that speaking of DRO as a reinforcement procedure can be confusing, as the operational characteristics and the range of operations need to be clarified (Poling & Ryan, 1982).

Jessel and Ingvarsson (2016) discussed four processes that may be potential explanations for the efficacy of DRO arrangements. First, the delivery of the reinforcer could create an abolishing operation (i.e., satiation) and temporarily reduce the motivation to engage in the target response. Second, delayed reinforcer delivery contingent on a response could function as punishment. Jessel et al. (2015) noted that a DRO procedure resembles negative punishment (e.g., response cost). Further, results of some studies have shown that when DRO was compared to extinction, DRO produced larger decreases in responding, a response pattern consistent with the effects of punishment (Flory et al., 1977). Third, reductions in target responding under DRO could be a function of extinction due to the discontinuation of the response-reinforcer contingency. Finally, adventitious reinforcement of other behavior could account for reductions in target responding during DRO. Research has shown that fixed-time schedules of reinforcement have led to increases in an alternative response (Roane et al., 2001). Although several studies have directly measured other behavior while conducting DRO in an attempt to more closely examine the causal mechanism(s) of DRO (e.g., Iannaccone et al., 2019; Jessel et al., 2015; Leitenberg et al., 1977; Miller & Jones, 1997; Repp & Deitz, 1974; Rey et al., 2020a;

Rey et al., 2020b; Thompson et al., 2003), these studies have produced mixed results on whether other behavior increased during DRO.

Jessel et al. (2015) empirically evaluated the potential strengthening effects of a DRO procedure on other behavior. Specifically, 13 college students experienced DRO, extinction, and a fixed time (FT) reinforcement schedule on a target response and other response. Jessel et al. used a computer program that presented two clickable squares on a computer screen: the target response and an “other” response. The program was arranged to have unsignaled changes in the reinforcement schedule for the target response, whereas no programmed reinforcement was arranged for the other response. The researchers used a concurrent-schedule arrangement involving a variable-ratio 3 schedule of reinforcement for the target response and extinction for the other response. However, during the last minute of each 5-min session, a probe of either DRO, extinction, or FT schedule of reinforcement for the target response was conducted. Most germane to the current study are findings from the DRO and extinction probes. The researchers were particularly interested in comparing other responding in these probes to systematically determine if the increase in responding in the DRO probe was due to extinction-induced variability. If other behavior increased during the extinction condition as well as the DRO condition, this pattern would provide evidence that the increase in other behavior was due to extinction-induced variability. Alternatively, if other behavior did not increase during the extinction condition, but did increase during the DRO condition, this pattern would suggest that the increase in other behavior was caused by adventitious reinforcement due to the negative contingency in place for the target behavior. Jessel et al. found that a majority of the participants switched responding from the target response to the other response during the DRO probe. In addition, participants engaged in increased rates of other responding during the extinction probe.

However, response rates in the extinction probes were not as high as those recorded during the DRO probe. Thus, other behavior increased during DRO. One limitation of the study conducted by Jessel et al. was that a single other response was measured. Thus, additional behavior may have occurred but gone uncaptured. For example, participants could have clicked outside of the programmed squares or tapped on the table. A second limitation was the population selected for inclusion in Jessel et al. was unlikely to experience DRO as a treatment. Clearly it is important to test the effects of a procedure for the population that will most likely experience it. A third limitation was that the duration of the probes was brief (1 min). In clinical applications of DRO, the procedure is typically arranged for longer durations (e.g., throughout the day, during an activity). Due to the short duration of the probe, participants' responding may not have been representative of patterns of responding that would emerge in clinical application (e.g., it is possible participants never experienced a reinforcer delivery that was not preceded by clicks on the other response). As such, if the duration of the probe had been longer, a decrease in other responding during the DRO probe might have been observed. That is, any observed increases may have been fleeting, and simply an artifact of the probe duration and extinction-induced variability.

The purpose of the current study was to systematically replicate and extend procedural aspects assessed by Jessel et al. (2015) by conducting another behavior assessment that compared the effects of DRO and extinction on target and target-other responses emitted by children diagnosed with intellectual and developmental disabilities and children with no known diagnoses. This study was designed to address three limitations of the study by Jessel et al. by: (a) measuring a wider array of other responses (nontarget-other responses), (b) including participants whom are more likely to experience a DRO procedure as a treatment, and (c)

conducting each probe as a separate condition such that the test conditions (i.e., DRO, extinction conditions) were arranged for longer durations.

## **Method**

### **Participants**

Participants included three individuals admitted to an inpatient hospital for the assessment and treatment of severe problem behavior and two children with no known diagnoses who attended a university-based preschool classroom. Max was a 19-year old male diagnosed with disruptive behavior disorder, autism spectrum disorder, obsessive-compulsive disorder, bipolar disorder, and moderate intellectual disability. Jake was a 10-year old male diagnosed with unspecified conduct disorder, autism spectrum disorder, and moderate intellectual disability. Adeline was a 2-year old female with no known diagnoses. Quinton was a 4-year old male with no known diagnoses. Opal was a 22-year old female diagnosed with unspecified conduct disorder, stereotypic movement disorder with self-injury, autism spectrum disorder, unspecified obsessive-compulsive and related disorder, unspecified attention deficit hyperactivity disorder, severe intellectual disability, DCX gene mutation, Lennox-Gastaut syndrome, and epilepsy. Three additional participants from the inpatient hospital were excused from the current study, because their behavior was not sensitive to the arranged contingencies (see below). Assent was obtained from the participants prior to each session by asking the participants if they wanted to attend. If the participants refused, no session was conducted at that time.

### **Materials and Setting**

Materials included two chairs, a table, two data-collection computers, a plate, a video camera, the items identified as potential reinforcers, and two colored microswitches that produced a sound when pressed (e.g., one red and one blue). The microswitches emitted identical

programmed sounds across conditions for a majority of the participants, which assisted in data collection (see below). Sessions took place in a small room equipped with a one-way window. During the assessments, data collectors collected data from behind a one-way window. All sessions were recorded on a video camera located behind a one-way window.

### **Dependent Variable and Data Collection**

During the preference assessment, data collectors collected data on food/item selection (making contact), consumption (placing the food beyond the lips), expulsion (spitting the food out past the plane of the lips), and finally no selection. No selection was defined as the participant verbally refusing the item or 5 s elapsing after the experimenter instructed the participant to “pick one” without selection.

Data were collected on target responses, target-other responses, and nontarget-other responses. The target response was defined as any instance in which the individual’s body came into contact with one microswitch with enough force to produce the programmed sound and was recorded using a frequency measure. Any other interaction with the microswitch, that did not produce the programmed sound, was not considered a response by the therapist or data collectors (however, see modifications for Max). A target response was associated with specific contingencies across conditions (see below). The target-other response was defined identically, but in relation to another microswitch. This microswitch *was not* associated with any contingencies across conditions (was always ignored). Finally, the nontarget-other response was defined as any response not including microswitch presses that occurred during the sessions.

For all participants, a list of possible behaviors based on topographical features (vocal behavior, hand movements, foot movements, head movements, reaching for the reinforcer) was developed and each potential behavior was operationally defined. For the three participants



admitted to the inpatient hospital, data were collected on the problem behavior targeted for reduction during their admission to the inpatient hospital. Finally, for all participants, if any other behavior occurred that did not meet the operational definitions, the data collector would make a note of the new behavior and the session number. Following that session, the data collectors would note whether the behavior occurred across subsequent sessions. If the behavior occurred across more than one session, the first author would review the sessions and create an operational definition for the new behavior. Subsequently, all previous and subsequent sessions for that participant were reviewed and data were collected on the occurrence of the new behavior. A complete list of responses and operational definitions is included in Table 1. Reinforcer consumption and manipulation were not scored as nontarget-other responding as these responses could not occur during the extinction condition. Additionally, presses on the microswitch that did not produce the programmed sound were not scored as nontargeted-other responding.

For Max, Jake, and Opal, all topographies of nontarget-other responses were recorded using a frequency measure. For the ease of interpretation, data were summed and graphed as the total frequency of all nontarget-other responses. Due to a high rate of hand, foot, and head movements emitted by Adeline and Quinton, data on these responses were collected using a partial-interval method and the data could not be summed. Therefore, data were graphed as the mean number of intervals in which hand, foot, and head movements occurred (e.g., if hand movements occurred during 50% of intervals, foot movements occurred during 90% of intervals, and head movements occurred during 60% of intervals, the mean of the three values, 66.67%, was graphed). This was a practical concession, interpretive challenges associated with averages notwithstanding. Individual figures of each of the more frequently occurring nontarget-other

responses for each participant are provided as supporting information (see Supplemental Materials).

Data were collected using BDataPro™ (Bullock et al., 2017). Data collectors were either employees of the inpatient hospital who had a history of collecting data using the data collection system or graduate and undergraduate students who had undergone training for collecting data. Interobserver agreement (IOA) was evaluated by having two data collectors independently record behavior during 36%, 48%, 35%, 35%, and 42% of sessions for Max, Jake, Adeline, Quinton, and Opal respectively. The partial-agreement within intervals method (Mudford et al., 2009) was used to assess IOA for all responses that were scored as frequency. IOA was calculated by dividing each session into 10-s intervals, Then the smaller number of recorded responses for each interval was divided by the larger number of recorded responses to obtain a score between 0 and 1 for each interval. If neither data collector recorded a response within an interval it was scored as an agreement and given a score of 1. Finally, the scores obtained for each interval were added together and divided by the total number of intervals, and the result was multiplied by 100 to obtain a percentage. The interval-by-interval method (Mudford et al., 2009) was used to assess IOA for all responses that were scored using a partial-interval measure. IOA was calculated by dividing each session into 10-s intervals and dividing the number of intervals in which the two data collectors agreed divided by the total number of intervals and multiplied by 100. An agreement was scored if either (a) both data collectors recorded that a response occurred within a specified interval or (b) neither data collector recorded a response within an interval. Due to the sheer number of responses that could be scored, IOA is reported only for responses that occurred relatively frequently to avoid artificially high IOA scores due to low-rate behavior. Additionally, due to the practical difficulty of recording data for a large number of

behaviors simultaneously, data collectors collected data on nontarget-other responses from recorded videos of sessions. Specifically, data collectors were permitted to watch the video together and discuss instances of nontarget-other responses (although, not all data collectors watched the videos together). Subsequently, the video was replayed, and data collectors recorded data independently as described above. Table 2 depicts the mean agreement for each behavior for all participants.

### **Interobserver Agreement and Treatment Integrity**

Data collectors collected data on procedural integrity for reinforcer delivery during 46%, 21%, 34%, 35%, and 24% of sessions for Max, Jake, Adeline, Quinton, and Opal, respectively. The criterion for reinforcement for the fixed-ratio (FR) condition was after every 5<sup>th</sup> consecutive *target* response. The criterion for reinforcement for the DRO condition was no emission of the target response for a specified amount of time (criterion for the DRO interval is specified below). Errors of omission and commission were calculated for each participant. Errors of omission for the FR condition were defined as any instance in which the experimenter did not deliver the reinforcer within 3 s of  $\pm 1$  of the criterion response. Errors of commission for the FR condition involved provision of the reinforcer if the criterion response was not emitted in the 5 s prior to the delivery of the reinforcer. For the DRO condition, errors of omission were defined as any instance in which the experimenter did not deliver the reinforcer within  $\pm 3$  s of the reinforcement criterion response and errors of commission involved the provision of the reinforcer if the criterion for the reinforcer delivery (a specified time without the target response) did not occur 5 s prior to the delivery of the reinforcer. The DRO interval was reset after every target response. Errors of omission were not applicable to the extinction condition. Errors of commission for the extinction condition were defined as any instance in which the reinforcer was

delivered. Errors of omission were calculated as the mean of correct implementation for each condition and errors of commission were calculated as the mean responses per minute for each condition. The mean of correct implementation for all participants across all conditions was 96.54% (range: 81-100%). The mean rate of errors of commission for all participants across all conditions was .09 rpm (range: 0 rpm-1 rpm). Overall, the procedures were implemented as intended (condition specific data available upon request).

## **Design and Procedures**

### ***Experimental Design***

A concurrent schedule embedded within a reversal design was used to demonstrate experimental control during the other behavior assessment. Conditions included FR, DRO, and extinction (see descriptions below).

### ***Procedures***

**Color Preference Assessment.** The purpose of the color preference assessment (Luczynski & Hanley, 2009) was to identify two moderately preferred colors to use in the reinforcer and other behavior assessments. A multiple-stimulus-without-replacement (MSWO) preference assessment as described by DeLeon and Iwata (1996) was conducted with each participant to identify the moderately-preferred colors from an array of four colored microswitches. This assessment was conducted three times. The two colors identified as moderately preferred (i.e., ranked second and third) were used for the subsequent sessions (data not presented).

**Edible Preference Assessment.** Before the start of the first session of the day, one brief five item MSWO preference assessment similar to that as described by DeLeon and Iwata (1996) was conducted with each participant to identify potential edible reinforcers. The item identified

as most preferred was used for that day (data not presented). The items included in the MSWO were identified by interviewing staff who were familiar with the participants.

**Reinforcer Assessment.** Before the start of the other behavior assessment, a reinforcer assessment (Pace et al., 1985) was conducted. The reinforcer assessment was conducted in a concurrent schedules design. The purpose of the reinforcer assessment was to identify whether behavior was sensitive to the arranged contingencies. In this and the other behavior assessment, sessions were 5 min, conducted at least 1 hr after the conclusion of a meal. Between one and five sessions were conducted per day, and at the start of each session, the participant was prompted to sit in the chair and the experimenter sat approximately 90 degrees to the right or left of the participant.

Prior to the start of each session, the experimenter designated one microswitch as the target response and the other microswitch as the target-other response by random selection. This allowed for each microswitch to have a probabilistically equal history of reinforcement and extinction (see below). Thus, target responses and target-other responses were conceptualized as analogs to problem behavior, both responses could be conceptualized as different forms of problem behavior within the same response class. Nontarget-other responses were scored to identify the potential strengthening effects of the DRO procedure. Further, before the session began, the experimenter randomly selected the location of the microswitches. This allowed for the location of each microswitch to have a probabilistically equal history of reinforcement and extinction (see below).

Next, pre-session exposure was conducted. The experimenter prompted the participant using a three-step prompting hierarchy (i.e., verbal, model, and physical prompt) to press the

target microswitch five times and delivered the reinforcer after the fifth response. The experimenter also prompted the participant to press the target-other microswitch five times.

Following this exposure, the session began. During the session, a concurrent schedule was programmed: target responses produced the most preferred item on an FR 5 schedule and target-other responses were ignored. The experimenter placed the edibles on a plate in front of the participant when the specific criterion was met. This process continued until differentiation in responding was observed. If behavior was not sensitive to the contingencies and a participant continued to respond on the microswitch not associated with reinforcement, the participant was excluded from the study. Criteria for terminating a session were established based on indices of distress (e.g., whining, crying, protesting) or problem behavior (e.g., aggression or self-injury). No participant met the termination criteria.

**Other Behavior Assessment.** In this assessment, no pre-session exposure was arranged. At the start of session, the experimenter said, “You can do whatever you want.” The experimenter delivered the reinforcer by placing the item on a plate in front of the participant when the specific criterion was met for each condition. The reinforcer was present and in view in all conditions to increase the likelihood that the discriminative properties of the food were kept constant (Castillo et al., 2014). Target-other and nontarget-other responses emitted by the participant were ignored throughout the assessment.

**FR.** During the FR condition, a concurrent schedule was arranged, in which target responses were reinforced on an FR 5 schedule. A fixed consecutive response requirement (FCRR) was used (Mendres & Borrero, 2010) for Max, Adeline, and Quinton, in which five consecutive target responses were required to produce a reinforcer. Additionally, the FCRR was added at session 28 for Jake. The FCRR is analogous to the change-over delay (Herrnstein,

1961) that is commonly implemented under concurrent variable interval schedules to minimize superstitious switching between alternatives. Target-other and nontarget-other responses were ignored. This condition was conducted until differentiation in responding was observed.

**DRO.** During the DRO condition, a concurrent schedule was arranged, in which the omission of target responses was reinforced according to a resetting, fixed-interval DRO. The experimenter delivered a reinforcer when no target responses occurred for a specified amount of time. For Max, Jake, and Opal, the DRO interval was 50% of the mean inter-reinforcement-interval (IRI) for the last three sessions in the previous FR condition. Selecting an interval that was shorter than the mean interresponse time was used due to the clinical validity of the method (Cooper et al., 2007). However, for some participants these intervals were extremely short. Therefore, the DRO interval for Adeline and Quinton was set at the mean IRI for the last three sessions in the previous FR condition. Because the DRO intervals changed per participant per DRO condition, the DRO intervals are specified in the condition labels on the graphs (Figures 1-5). Target-other and nontarget-other responses were ignored. This condition was conducted until stability in responding was observed.

**Extinction.** During the extinction condition, target, target-other, and nontarget-other responses were ignored. This condition was conducted until stability in responding was observed.

### ***Procedural Modifications***

**Max.** Two notable modifications were made to the procedures for Max. First, during the first FR condition (session 3), the sound on the microswitches was disabled because it was hypothesized that the sound produced by pressing the microswitches was automatically reinforcing Max's behavior (*cf.*, Justin in Rooker et al., 2011). This concern arose only for Max

because he frequently entered the session room and immediately began pressing both microswitches while smiling and dancing. This response was not observed for other participants. Subsequent to disabling sound on the microswitches, the operational definition of a switch press was revised such that data collectors scored target and target-other responses when the microswitch was pressed with enough force that a faint click noise was emitted (the click noise was a direct result of the internal mechanism of the microswitch and reliably occurred when depressed). Second, Max allocated responding to the target response option during the FR condition at an extremely high rate, such that reinforcement was delivered approximately every 4-6 s. Therefore, the FR requirement was increased from five to 10 during the fourth implementation of the FR condition in an attempt to increase the inter-reinforcement time.

**Jake.** Procedural modification to the method of reinforcer selection was made for Jake due to concerns that the MSWO results did not identify his most preferred edible. Jake frequently vocally requested items identified as least preferred by the MSWO to be used in upcoming sessions. That is, it appeared that during the MSWO assessments, he was “saving the best for last.” Therefore, pre-session MSWO assessments were discontinued after Session 7, and Jake was prompted to vocally request an item to be used as a reinforcer prior to each session. This pattern of behavior was not observed in the MSWO for colors.

**Adeline.** During the fourth implementation of the FR condition, a pattern of systematic response switching across consecutive sessions was observed. That is, Adeline would allocate responding exclusively to one microswitch during the first session of a block of sessions then would allocate responding exclusively to the other microswitch during the next session. Therefore, blocks of consecutive sessions were discontinued beginning on session 39 such that all sessions were separated by at least 1 hr of each other for the remainder of the assessment.



**Opal.** During the first FR condition, Opal exclusively responded to the target-other microswitch. Therefore, pre-session exposure to the contingencies and a rule were provided beginning with session 4 to ensure that Opal had sufficient exposure to the differential contingencies for the response options in the upcoming session. The rule stated the contingency for each microswitch across conditions. During the first DRO condition, Opal continued to respond exclusively on the target microswitch. Therefore, pre-session exposure was discontinued beginning with session 13, but rules prior to each session continued to be provided. During the initial sessions of the extinction condition, Opal allocated exclusive responding to the target response option (session 41) and then the target-other response option (session 42). Therefore, an additional rule was added at session 43 to further clarify the extinction contingencies (i.e., the therapist said, “You can press the microswitches if you want to, but you don’t have to”).

### *Across-Case Analysis*

Similar to Jessel et al. (2015) the mean proportion of responding during the DRO and extinction conditions was compared to the FR condition, across the entire assessment, for each participant. Unlike Jessel et al., the level of target-other and nontarget-other responses and the results at an individual level were compared. The proportion-of-responding results provide a quantitative analysis of mean responding in the two test conditions compared to the FR condition. To calculate the proportion of the mean observed rate of responding, the mean rate of responding (i.e., target-other responses or nontarget-other responses) across all implementations of the DRO or extinction condition was divided by the mean rate of responding (i.e., target-other responses or nontarget-other responses) across all implementations of the FR condition. Additionally, the proportion of responding was calculated for each individual session. To calculate the proportion of the mean observed rate of responding for each session, the mean rate

of responding (i.e., target-other responses or nontarget-other responses) for each DRO or extinction session was divided by the mean rate of responding (i.e., target-other or nontarget-other) across all implementations of the FR condition.

### ***Contingency-Strength Analysis***

As in Jessel et al. (2015), a post-hoc contingency-strength analysis for nontarget-other responding was conducted for Max, Jake, and Opal using the methods described by Luczynski and Hanley (2009). The contingency-strength analysis provides a quantitative analysis of contingencies for the nontarget-other responses that were not programmed experimentally for the DRO condition. The contingency strength continuum ranged from 1 to -1 and described contingencies in terms of positive, neutral, and negative (see Jessel et al. for additional details). The contingency-strength analysis was not conducted for Adeline or Quinton, because nontarget-other responding was scored using a partial-interval measure and could not be calculated.

The first index described the response conditional probability, which was defined as the frequency of the nontarget-other responses that occurred within 3 s of a reinforcer being delivered divided by the total frequency of the nontarget-other response. This yielded a score between 0 and 1. If no nontarget-other responses occurred throughout a session a 0 was assigned, as reinforcers being delivered without the emission of the other response would represent a negative contingency.

The second index described the reinforcer conditional probability which was defined as the number of times a reinforcer was delivered that was not preceded within 3 s by a nontarget-other response and dividing that number by the total frequency of reinforcer deliveries. This equation yielded a score between 0 and 1.

The reinforcer conditional probability index was subtracted from the response conditional probability index and yielded a contingency strength value between 1 and -1. The larger the contingency-strength value, the stronger the contingency between a response and a reinforcer. The smaller the contingency-strength value, the weaker the contingency.

### **Results**

All participants emitted relatively higher rates of target responding as compared to target-other responding during the reinforcer assessment (data available upon request). These results support the conclusion that edibles served as reinforcers for target responding and that the participants' behavior was sensitive to the arranged contingencies.

Figures 1-5 depict the results for each participant. The top panel depicts the rate of the target responses (closed circles) and target-other response (open circles), whereas the bottom panel depicts the rate of combined nontarget-other responding (open square) for Max, Jake, and Opal and the rate of the combined nontarget-other responding excluding hand, foot, and head movements (closed square) and the mean percentage of intervals with hand, foot, and head movements (open squares) for Adeline and Quinton. Target responding during the FR condition was consistently elevated relative to target-other responding for all participants (although some variability in responding was observed). Nontarget-other responding was low across all exposures to the FR condition for Max, Jake, and Opal. The mean percentage of intervals with hand, foot, and head movements were high and variable throughout all implementations of the FR condition for Adeline and Quinton.

During the DRO condition, two patterns of responding were observed: other behavior was consistently elevated, or other behavior was not consistently elevated. For Max, Jake, and Adeline overall low levels of target and target-other responding were observed; however,

variability in responding was observed for all participants. Additionally, nontarget-other responding was low across all exposures to the DRO condition for Max, Jake, and Adeline; whereas, the mean percentage of intervals with hand, foot, and head movements was high and variable for Adeline. For Quinton and Opal, high rates of target-other responding and low rates of the target response were observed during the DRO condition; however, variability in responding was observed. Most notably, for Opal, the second exposure to the DRO condition resulted in highly variable but consistent alternation between target and target-other responding. The second exposure to DRO was terminated before demonstrating control by the contingencies. Additionally, nontarget-other responding was low and variable across all exposures to the DRO condition for Quinton and Opal; whereas, the mean percentage of intervals with hand, foot, and head movements was high and variable for Quinton.

During the extinction condition, two patterns of responding were observed: target and target-other responses decreased to low rates, or target or target-other responses continued to occur (behavior did not extinguish). For Max, Jake, and Adeline overall low levels of target and target-other responding were observed; however, variability in responding was observed for all participants. Additionally, nontarget-other responses increased substantially during the extinction condition for Max and Adeline. Moreover, the mean percentage of intervals with hand, foot, and head movements increased slightly for Adeline. For Quinton and Opal, high rates of either the target response or the target-other response were observed during the extinction condition (i.e., no extinction effect was produced). Notably for Quinton, in the first and fourth presentation, following the FR contingency, undifferentiated responding was observed. However, for the second and third presentation of the extinction condition, following the DRO contingency, elevated target-other responding, relative to the target response was observed. Additionally,

nontarget-other responding increased slightly for Quinton and Opal. Moreover, the mean percentage of intervals with hand, foot, and head movements also increased slightly for Quinton.

Figure 6 shows the mean of nontarget-other responding during the DRO and extinction conditions as a proportion of the mean observed rate of nontarget-other responding in the FR condition. The closed circles denote the proportion of responding for each session during the DRO and EXT conditions compared to the mean observed rate of responding in the FR condition. The horizontal line denotes the equivalent response rates of nontarget-other responding in the FR condition. The mean proportion of nontarget-other responding during extinction was higher for all participants, relative to the DRO condition. However, these results are preliminary based on two limiting aspects of the design (discussed below).

Figure 7 displays the mean of target-other responding during the DRO and extinction conditions as a proportion of the mean observed rate of target-other responding in the FR condition. The closed circles denote the proportion of responding for each session during the DRO and EXT conditions compared to the mean observed rate of responding in the FR condition. The horizontal line denotes the equivalent response rates of target-other responding in the FR condition. The mean proportion of target-other responding during DRO was higher for Max, Quinton, and Adeline, relative to the FR condition. However, this pattern of responding may be due to the initial increase in target-other responding that did not maintain over time for Max and Adeline. Similar to the previous finding, results of this analysis are preliminary based on the two limiting aspects of the design.

The results of the contingency-strength analysis suggest there was a negative contingency-strength value for a majority of sessions for Max ( $M = -0.32$ ;  $SD = 0.50$ ), Jake ( $M = -0.47$ ;  $SD = 0.32$ ), and Opal ( $M = -0.39$ ;  $SD = 0.45$ ).

### Discussion

A systematic replication of Jessel et al. (2015) was conducted by comparing the effects of DRO and extinction on a target response, target-other response, and nontargeted-other responses emitted by participants diagnosed with intellectual and developmental disabilities and children with no known diagnoses. This study extended Jessel et al. by (a) measuring a wider array of other responses (nontarget-other responses) emitted by the participants, (b) including participants whom are more likely to experience a DRO procedure as a treatment, and (c) by increasing the exposure to the procedures. Overall, our results replicate the findings of previous research by demonstrating that the DRO procedure suppressed the target response and produced slight, but fleeting increases in the target-other response. Specifically, target-other responding increased in at least one of the DRO conditions for each participant suggesting that other behavior may increase when using DRO, at least initially. However, in some conditions, other behavior (target or nontarget) was not observed suggesting that either: (a) other behavior *did* occur but was not measured, or (b) other behavior does not always increase when using a DRO. The results of the DRO condition were not consistent across participants or across subsequent DRO conditions with the same participant. For three participants, responding toward the target-other response never occurred, or it decreased to zero rates suggesting that increases in other behavior may be fleeting. Perhaps more notably, the frequency of nontarget-other behavior was uniformly higher for all participants in the extinction condition, relative to the DRO condition, though this finding is best characterized as preliminary. Although a large increase in nontarget-other responding was observed during the extinction condition, it is probable that these responses were maintained by other sources of reinforcement. Overall, these findings suggest that any increases in other

behavior observed during the DRO condition may be a direct effect of the extinction component embedded within the DRO procedure.

However, uncontrolled aspects of the design could also have contributed to these findings. One potential explanation for the higher rates of nontarget-other responding observed during the extinction condition compared to the DRO and FR conditions involves the consumption of reinforcers. The reinforcers could be consumed or manipulated immediately after delivery, during session. Consumption and manipulation of the reinforcer were not scored as nontarget-other responding as these responses were not possible during the extinction condition and would artificially increase the rate of nontarget-other responses in the DRO and FR condition. It is possible that consumption and manipulation of the reinforcer during the DRO condition competed with some nontarget-other responses that emerged during the extinction condition. Due to the short duration of the DRO intervals, it is possible that a majority of DRO intervals was spent consuming the edible item, decreasing the amount of time available for the participant to engage in nontarget-other responses.

The effects of the DRO condition on target and target-other responses were compared to the extinction condition. During the extinction condition, for Max, Jake, and Adeline, both the target and target-other response eventually decreased to near zero. Additionally, extinction-induced variability was observed for all three participants. Quinton's and Opal's target and target-other responses did not extinguish during the extinction condition. It is possible that their responding may have been rule-governed behavior (e.g., during these sessions, I must press a button). However, for Opal, the addition of a rule that stated she did not have to press the microswitch did not eliminate responding. Therefore, another explanation is that the sound the

microswitch produced was automatically reinforcing or that the participants pressed the microswitches to “pass the time.”

Additionally, it is unclear what effect having some individuals experience extinction in only one phase had on the differences observed between DRO and extinction across cases. The effects of extinction have been shown to be transitory for some individuals (e.g., Lerman et al., 1999) and there is some research to suggest that repeated exposure to extinction may change response patterning (Clark & Taylor, 1960). Thus, it is possible that the proportion of nontarget-other responding during extinction would have decreased had a second extinction condition been conducted.

These results provide evidence that other behavior may increase when using DRO; however, the form of the other behavior engendered cannot yet be reliably predicted. In other words, other behavior may take the form of socially appropriate or socially inappropriate behavior. Participants could engage in the target response, in the target-other response, or in a nearly infinite universe of nontarget-other responses. Although attempts were made to measure as much participant behavior as possible, it remains possible that other behavior increased or was not measured. Subtle movements were not measured; therefore, the possibility that other unmeasured behavior increased during all DRO conditions cannot be eliminated. As such, the conceptualization of choice as time allocation appears highly relevant (Baum & Rachlin, 1969). If a decrease in target responses were observed, that time must be filled with some other behavior. Thus, mathematical models of choice may place a quantitative point on what is otherwise a multifarious measurement conundrum. Future research could be designed to assess response allocation in the context of procedures used in this study by way of the single alternative formulation of the matching equation (Herrnstein, 1970), with application-specific



recommendations offered by McDowell (1988). However, practical and technological constraints may make such an analysis difficult. Responses were categorized to record instances of nontarget-other responding—a strategy that has proven useful in related research (Iannaccone et al., 2019). However, it is possible that two different topographies of behavior that have different functions could have been recorded as the same behavior; therefore, artificially increasing the frequency of a specified nontarget-other response. Future research could be designed to measure other behavior and attempt to break down other behavior into smaller categories thereby more accurately measuring the effects on a specific other behavior.

This present study is not without limitations. Visual inspection of data characteristics such as level, trend, and variability were used to make decisions regarding the stability of responding under the various experimental conditions. Reliance on visual inspection is common in clinical research and practice. However, a potential limitation of the study was the exclusive use of visual inspection to evaluate stability without supplemental visual aids or structured criteria that may have strengthened reliability. The use of visual inspection directly affects the finding in Figures 6 and 7, because the mean across condition was used to calculate the proportion of responding.

Responding on the target-other microswitch decreased to low or zero rates for two participants during the DRO conditions, and these results may have been due to the dense schedule of reinforcement delivered during the DRO condition (e.g., DRO intervals ranged from 2-10 s). The present study extends upon the work of Jessel et al. (2015) by: (a) increasing the duration of exposure to each DRO interval from 1-to 5-min (also see Rey et al., 2020b), and (b) increasing the number of exposures to each DRO interval. Although reinforcement was delivered on a dense schedule of reinforcement, the schedule of reinforcement was consistent

with previous research (*cf.* Thompson et al., 2003). Given a longer DRO interval (i.e., a leaner schedule of reinforcement), it is possible that more robust and sustained increases in target-other responding or nontarget-other responding may have occurred. For three of the participants, the DRO interval was identified by halving the mean of the IRI due to the clinical validity of selecting an interval that was shorter than the mean interresponse time (Cooper et al., 2007), thereby increasing the likelihood that the participant's behavior would come into contact with the contingency. Because the very short IRI might have affected responding, the entire IRI was used for the final two participants. Researchers interested in the role of DRO-interval size on the likelihood of target-other and nontarget-other responding may wish to design parametric evaluations with interval size as a primary focus. The evaluation in the current study suggests that other behavior may increase when exposed to DRO contingencies, but that these increases may be a function of the extinction component embedded within the DRO. This study was designed as a systematic replication of procedures studied in the human operant laboratory (Jessel et al., 2015), so that we might take one step away from the bench, and one step toward the bedside. The pragmatist might suggest that the occurrence of other behavior under DRO contingencies is relevant to the extent that it produces additional behavior in need of clinical intervention. We do not challenge the pragmatist's assessment. However, in the spirit of conceptual systematization (Baer et al., 1968), an understanding of the direct effects and side effects of our behavioral interventions is warranted.

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**Table 1***Operational Definitions for Nontarget-other Behavior*

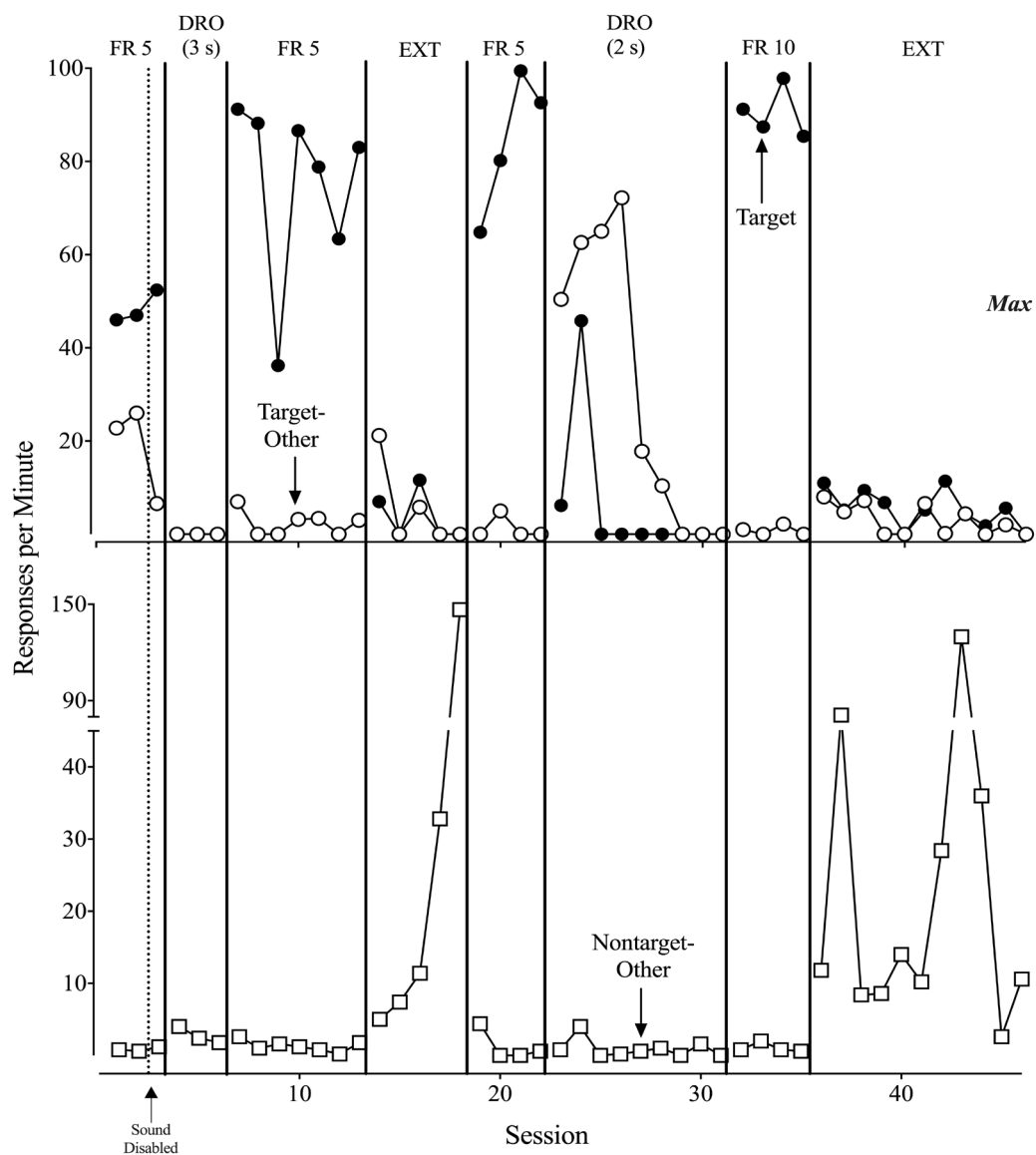
Participant(s)	Behavior	Operational Definition
Max, Jake, Adeline, Quinton & Opal	Hand movement	Each instance the participant moved his/her hands more than 2.5 cm (e.g., finger crawling, playing with hair, tapping, knocking, scratching)
	Foot movement	Each instance in which his/her foot moved more than 7.62 cm (e.g., walking, tapping, jumping)
	Head movements	Each instance in which the participant moved his/her head more than 7.62 cm (e.g., looking different directions, head tilting, laying head on table, chewing, flipping hair)
	Vocal behavior	Each instance in which the participant emitted a vocal sound not including appropriate requests.
	Reaching for the reinforcer	Each instance in which the participant engages in behavior that could result in injury to another individual (e.g., hitting, kicking, scratching) hand within 15 cm of container that holds the reinforcer.
Jake, Adeline, Quinton & Opal	Request	Each instance in which the participant emitted a vocal request or sign for the edible item
Max, Jake, & Opal	Aggression	Each instance in which the participant engages in behavior that could result in injury to another individual (e.g., hitting, kicking, scratching)
	Disruption	Each instance in which the participant engages in behavior that could result in damage to property (e.g., flipping tables, throwing materials)
	Self-injurious Behavior	Each instance in which the participant engages in behavior that could result in injury to oneself (e.g., face or body hitting, self-scratching, head banging)
Max & Jake	Facial expression	Each instance in which the participant moved his/her mouth or eyes to make a facial expression (e.g., smiling, frowning, raising eyebrows, opening/closing mouth, sticking out tongue)
Quinton	Sighing	Each instance in which the participant exhaled air with enough force that a sound was emitted (lips must not be pursed) may include shrugging shoulders and eye rolling
	Blowing	Each instance in which the participant pursed his lips and air was released from his mouth

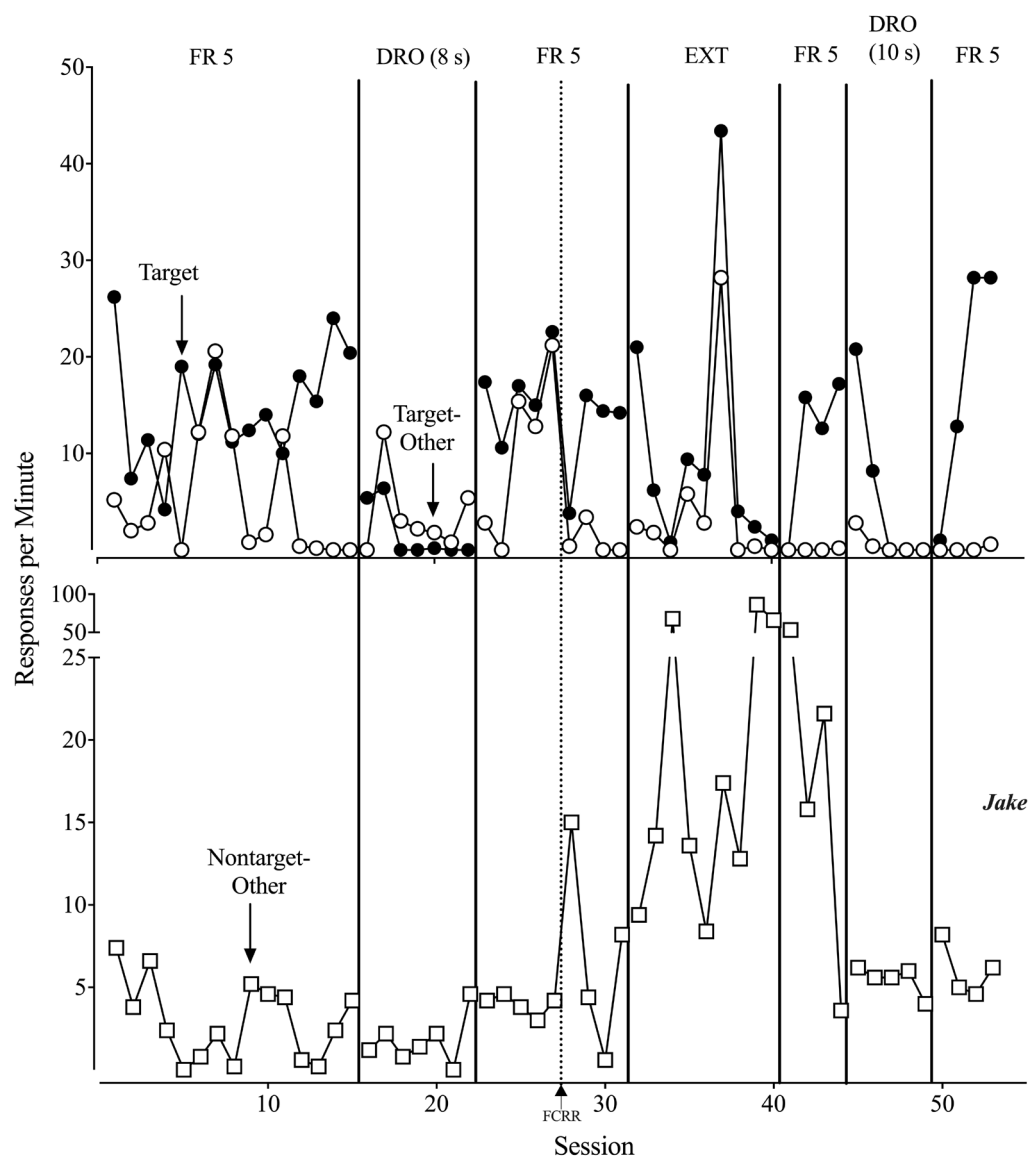
Table 2

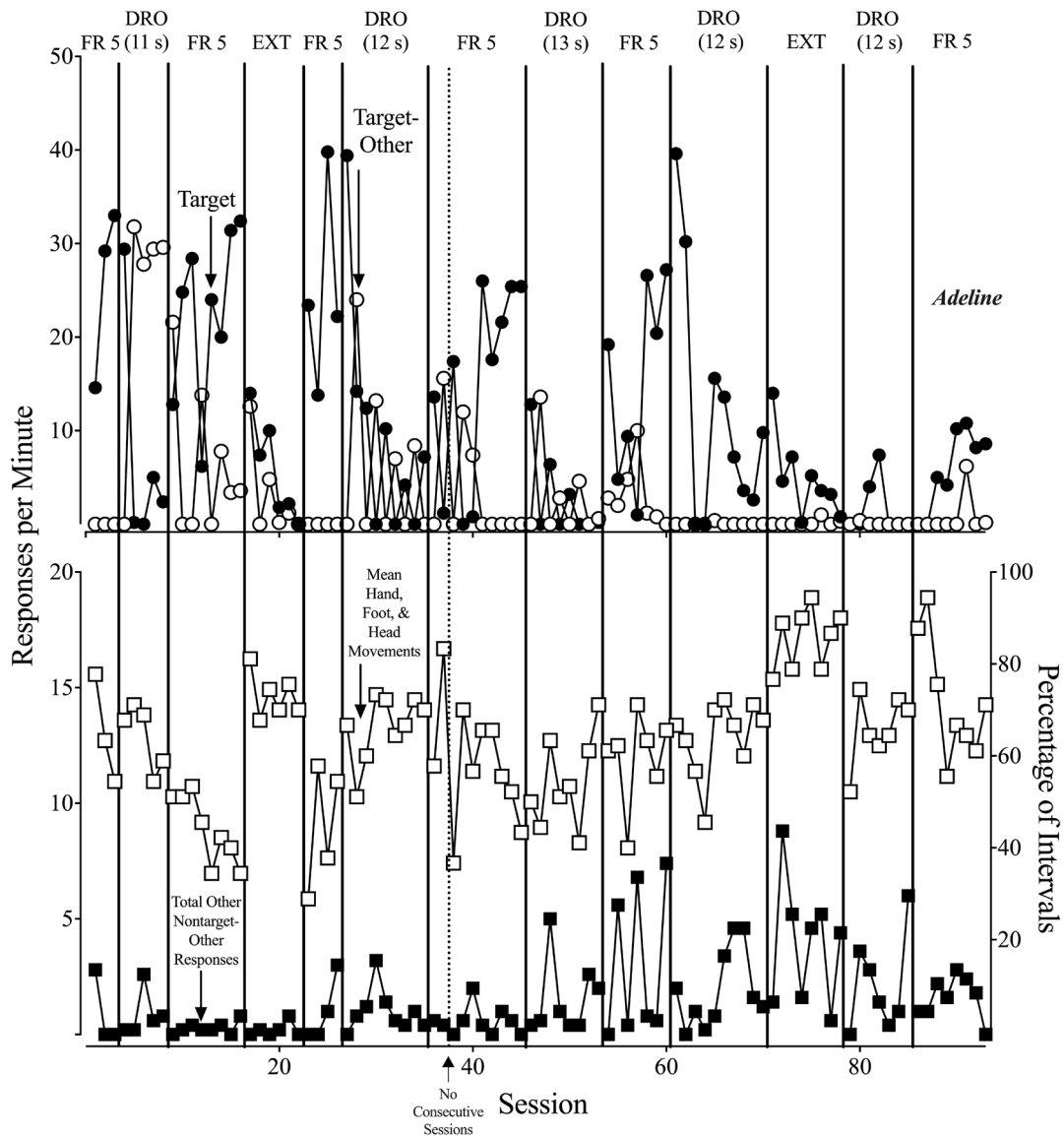
Mean IOA for the Other Behavior Assessment

Participant	Responses										
	Target response	Target-Other response	Hand movements	Foot movements	Head movements	Vocal behavior	Facial expression	Reaching for SR	Requests	Sighing	Blowing
Max	95.44%	96.93%	88.01%	98.14%	89.91%	N/A	94.46%	99.58%	N/A	N/A	N/A
Jake	90.46%	95.75%	87%	96.3%	77.06%	98.61%	96.46%	N/A	N/A	N/A	N/A
Adeline	95.87%	97.79%	76.27%	82.45%	78.82%	92.44%	N / A	N/A	99.12%	N/A	N/A
Quinton	92.36%	88.32%	83.75%	88.75%	83.47%	98.96%	N/A	N/A	N/A	99.17%	99.4%
Opal	97.27%	97.53%	91.06%	100%	87.56%	N/A	N/A	N/A	N/A	N/A	N/A

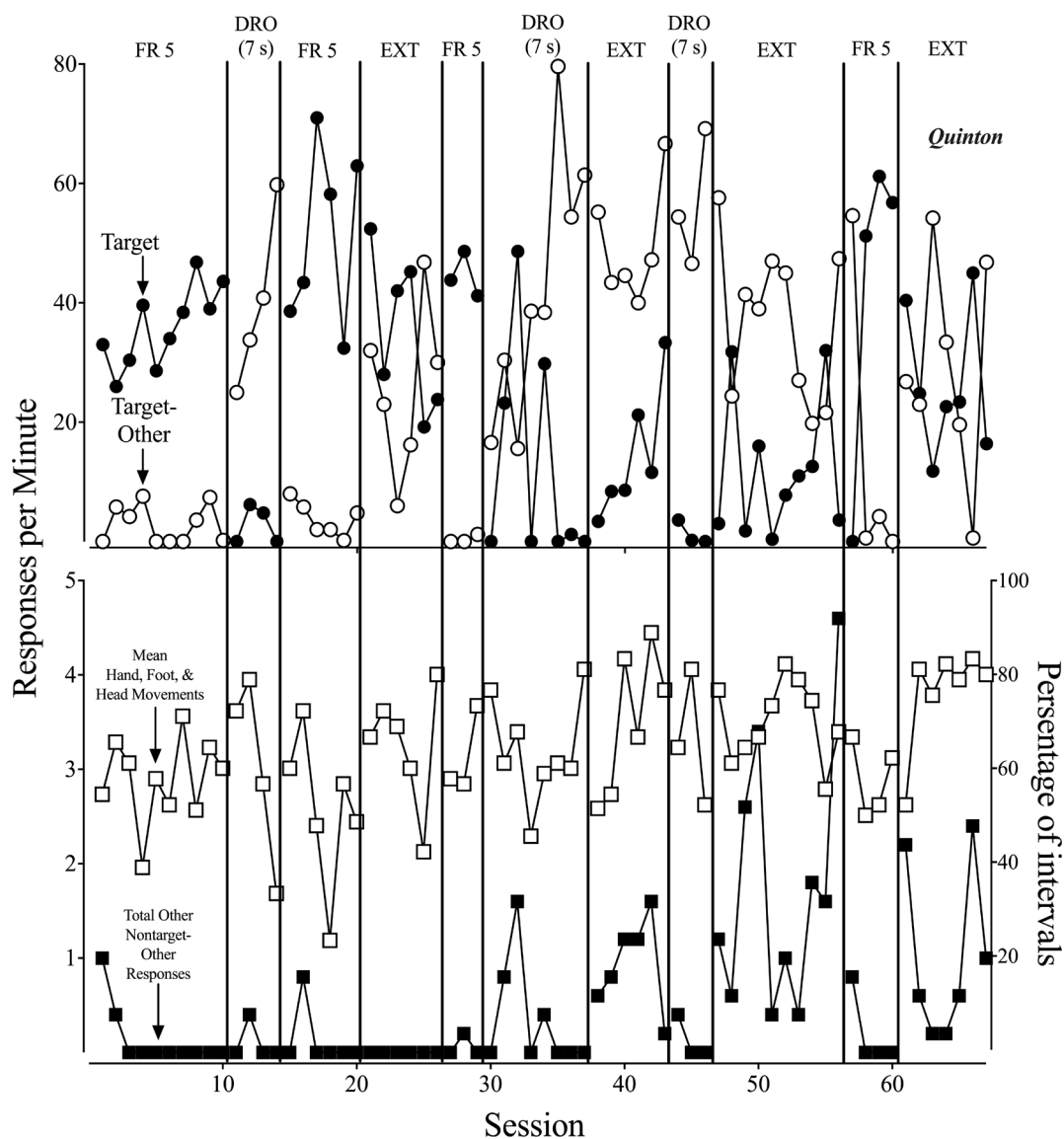


**Figure 1***Rate of Responding in the Other Behavior Assessment for Max**Note.* The y-axes are scaled differently.

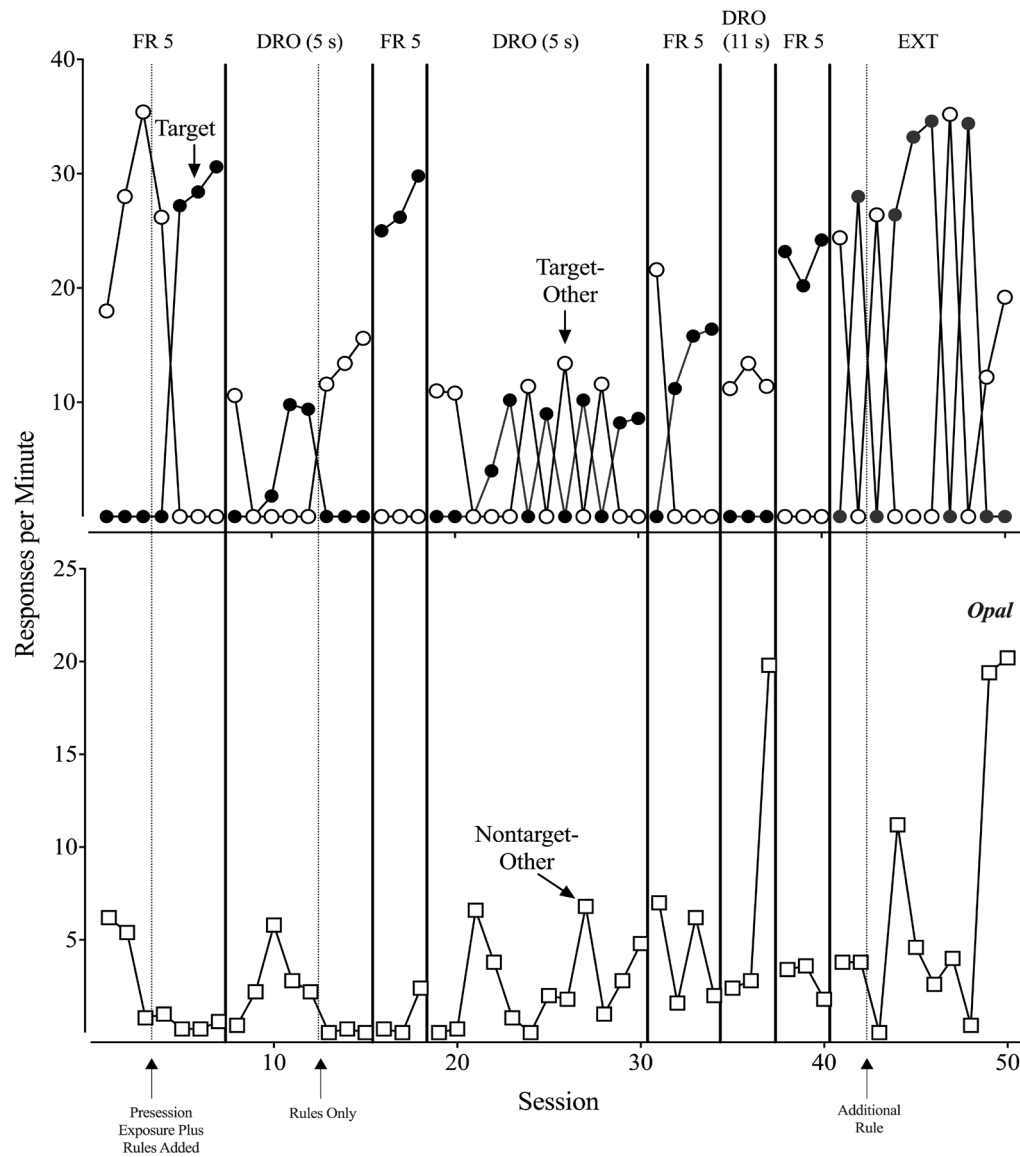
**Figure 2***Rate of Responding in the Other Behavior Assessment for Jake**Note.* The y-axes are scaled differently.

**Figure 3***Rate of Responding in the Other Behavior Assessment for Adeline*

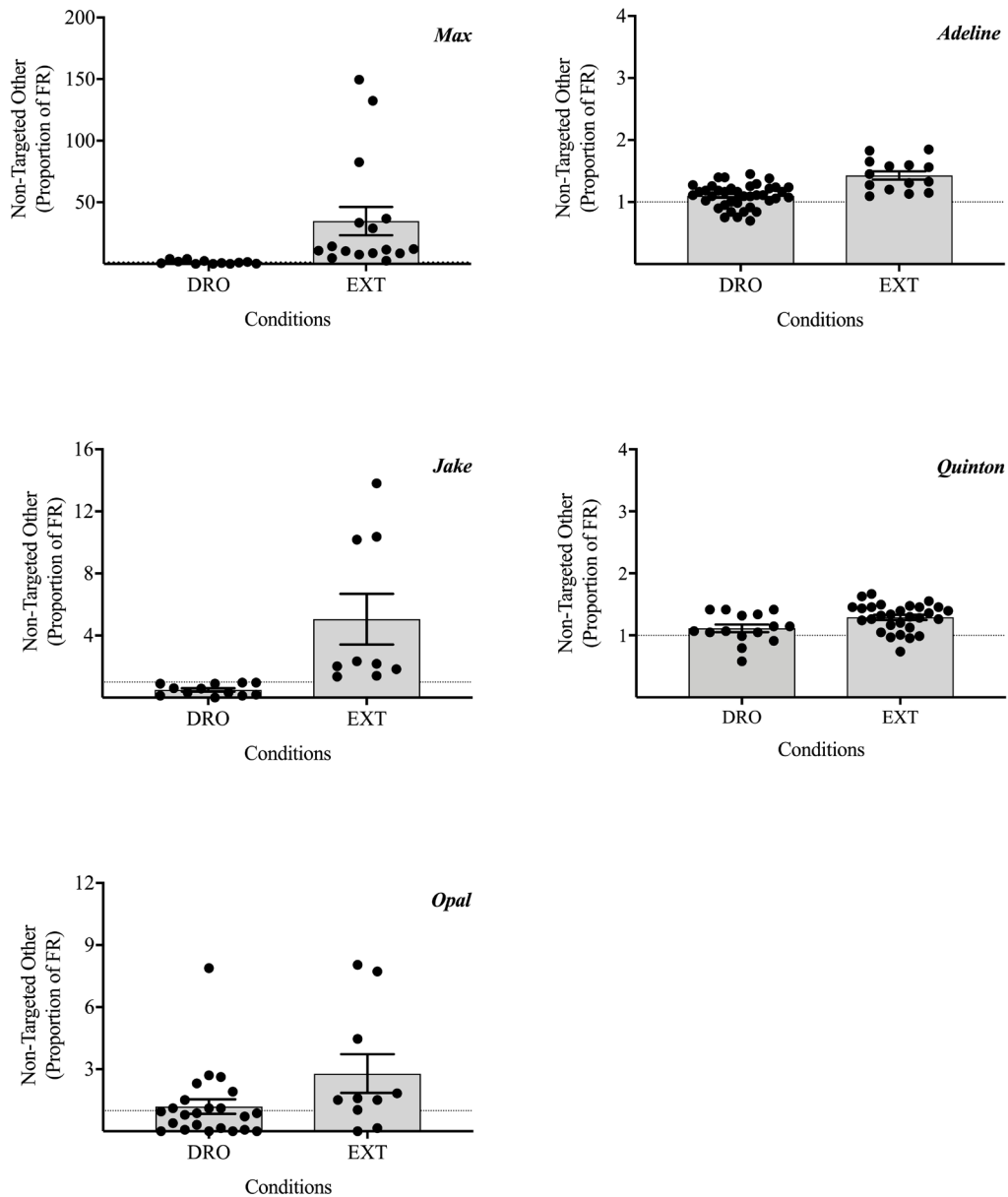
*Note.* The total other nontargeted responding is scaled to the left y-axis and the mean percentage of intervals with hand, foot, and head movements is scaled to the right y-axis. The dotted phase change line denotes a change in procedure. The text below the x-axis specifies the change. The y-axes are scaled differently.

**Figure 4***Rate of Responding in the Other Behavior Assessment for Quinton*

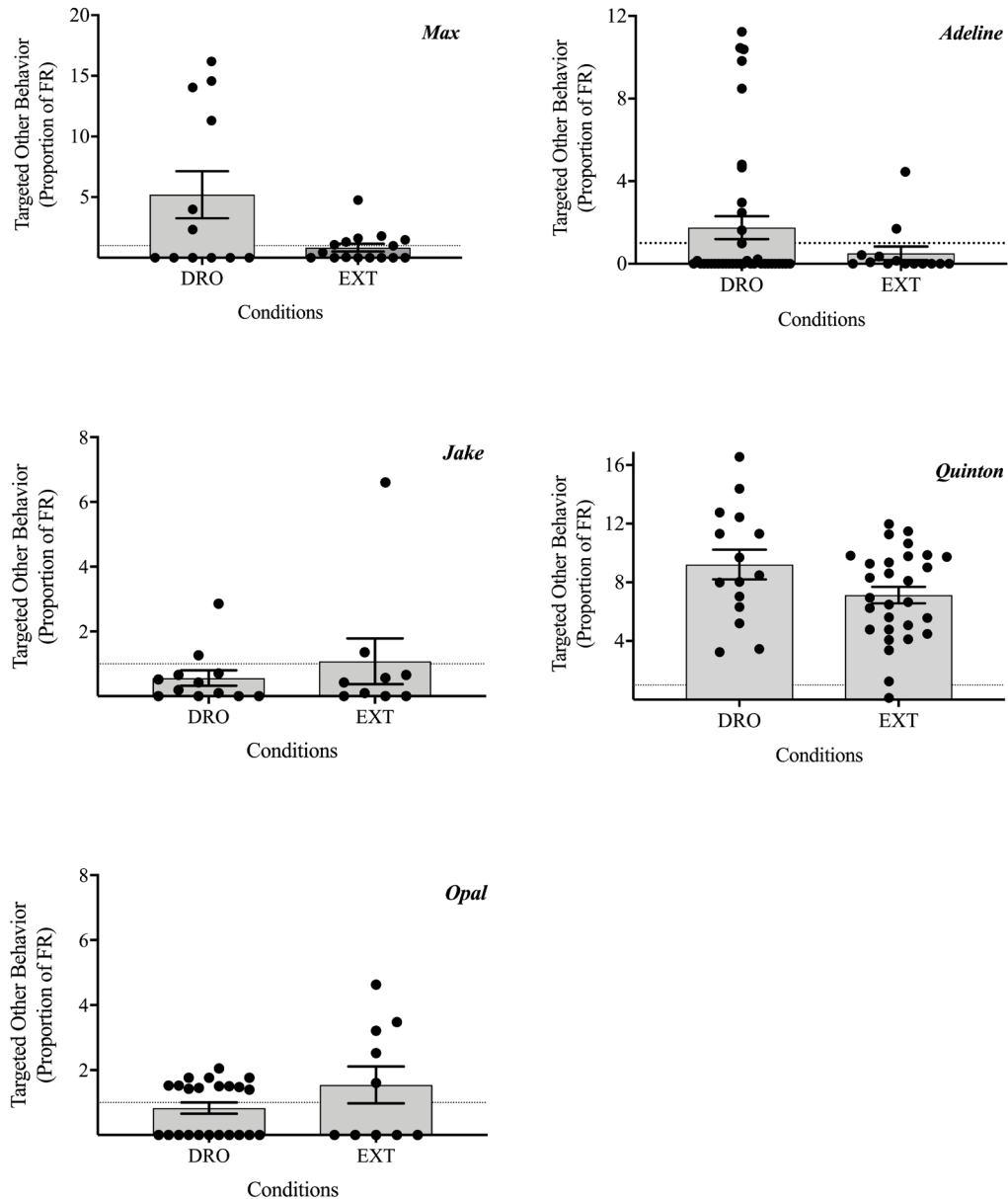
*Note.* The total other nontargeted responding is scaled to the left y-axis and the mean percentage of intervals with hand, foot, and head movements is scaled to the right y-axis. Note the y-axes are scaled differently.

**Figure 5***Rate of Responding in the Other Behavior Assessment for Opal*

*Note.* The dotted phase change line denotes a change in procedure. The text below the x-axis specifies the change. The y-axes are scaled differently.

**Figure 6***Proportion of Nontarget-Other Responding During the DRO and EXT Conditions*

*Note.* The proportion of nontarget-other responding during the DRO and EXT conditions is compared to the mean observed rate of responding in the FR condition. The horizontal line denotes the equivalent response rates in the FR condition, the closed data points denote each session, and the height of the grey bar denotes the mean of nontarget-other responding. Note the y-axes are scaled differently.

**Figure 7***Proportion of Other Responding During the DRO and EXT Conditions*

*Note.* The proportion of other responding during the DRO and EXT conditions is compared to the mean observed rate of responding in the FR condition. The horizontal line denotes the equivalent response rates in the FR condition, the closed data points denote each session, and the height of the grey bar denotes the mean of nontarget-other responding. Note that the y-axes are scaled differently.