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Development of a Reinforcer Dimension Sensitivity Assessment to Inform Differential Reinforcement of Alternative BEhavior Without Extinction Procedures

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DEVELOPMENT OF A REINFORCER DIMENSION SENSITIVITY ASSESSMENT TO INFORM DIFFERENTIAL REINFORCEMENT OF ALTERNATIVE BEHAVIOR WITHOUT EXTINCTION PROCEDURES

by

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DEVELOPMENT OF A REINFORCER DIMENSION SENSITIVITY ASSESSMENT TO INFORM DIFFERENTIAL REINFORCEMENT OF ALTERANTIVE BEHAVIOR WIHTOUT EXTINCTION PROCEDURES

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Differential reinforcement of alternative behavior (DRA) is the most commonly used procedure to treat destructive behavior maintained by social-positive reinforcement (Petscher, Rey, & Bailey, 2009). Several studies have demonstrated that placing destructive behavior on extinction (EXT) during DRA is critical for the reduction of destructive behavior (Fisher et al., 1993; Hagopian, Fisher, Sullivan, Acquisto, & LeBlanc, 1998). Despite the empirical evidence demonstrating the importance of using EXT during DRA, the use of EXT has several limitations. These limitations have resulted in the development of DRA without EXT treatments, during which practitioners manipulate dimensions of reinforcement to favor appropriate responding. The systematic identification of reinforcer dimensions to which an individual's behavior is sensitive for the purpose of informing subsequent DRA without EXT treatments is still relatively new. The purpose of this study was twofold. In Study 1, we developed a reinforcer dimension sensitivity assessment to identify parametric values of reinforcer dimensions to which a participant's behavior was sensitive. We conducted Study 2 with participants whose behavior demonstrated sensitivity during the assessment. In Study 2 we conducted a validation analysis during which we implemented two DRA without EXT procedures to assess if the participants allocated responding towards the response that produced the optimal reinforcer parameter to which he demonstrated sensitivity during the reinforcer dimension sensitivity assessment.

Keywords: differential reinforcement without extinction, sensitivity assessment, concurrent schedules, systematic analysis

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LIST OF ABBREVIATIONS

DRA   Differential reinforcement of alternative behavior

EXT   Extinction

FCT   Functional communication training

IRT   Interresponse time

INTRODUCTION

Treatment of Severe Destructive Behavior

Differential reinforcement of alternative behavior (DRA) is the most commonly used procedure to treat destructive behavior (e.g., tantrums, aggression, property destruction, self-injury, and pica) maintained by social reinforcement (Chowdhury & Benson, 2011; Durand & Carr, 1992; Dwyer-Moore & Dixon, 2007; Hagopian, Fisher, Sullivan, Acquisto, & LeBlanc, 1998; Kurtz, Boelter, Jarmolowicz, Chin, & Hagopian, 2011; Petscher, Rey, & Bailey, 2009; Rooker, Jessel, Kurtz, & Hagopian, 2013; Slocum, Mehrkam, Peters, & Vollmer, 2017; Tiger, Hanley, & Bruzek, 2008; Vollmer & Iwata, 1992). During DRA, the therapist places destructive behavior on extinction (EXT) by withholding the functional reinforcer(s) following destructive behavior and provides the functional reinforcer(s) contingent on alternative behavior (Deitz & Repp, 1983; Carr & Durand, 1985).

Several studies have demonstrated that the EXT component of DRA is critical to reducing destructive behavior (Fisher et al., 1993; Hagopian et al., 1998; McCord, Thomson, & Iwata, 2001; Petscher et al., 2009; Shirley, Iwata, Kahng, Mazaleski, & Lerman, 1997). For example, Fisher et al. (1993) evaluated a type of DRA, functional communication training (FCT), alone and implemented with EXT and/or punishment contingencies for destructive behavior with four participants. The authors found that FCT alone produced clinically significant reductions in destructive behavior for only one participant. For the other three participants, the authors only observed reductions in destructive behavior using FCT with EXT. The most robust and consistent reductions in destructive behavior occurred using FCT plus punishment. Hagopian et al. (1998) replicated the study conducted by Fisher et al. (1993) with a larger sample of participants and found that clinically significant reductions in destructive behavior (i.e., a reduction of at least 90% from baseline levels) only occurred when the FCT treatment included EXT (n=11) or punishment (n=17). These empirical evaluations highlight that EXT is often necessary during DRA to decrease destructive behavior and increase appropriate replacement behavior. Despite the

empirical evidence demonstrating the importance of EXT, the use of EXT can result in untoward side effects that limit its clinical utility (e.g., a temporary increase in the frequency and intensity of destructive behavior; Cowdery, Iwata, & Pace, 1990; Lerman, Iwata, & Wallace, 1999; Goh & Iwata, 1994; Lerman & Iwata, 1996; Zarcone, Iwata, Hughes, & Vollmer, 1993; for a related review, see Lerman et al., 1999). Additionally, there are situations in which it may not be feasible for caregivers and therapists to implement EXT for destructive behavior. For example, EXT may not be feasible if it requires minimizing attention for dangerous (e.g., self-injury, elopement) behavior or if the individuals' destructive behavior is sensitive to small changes in others' behavior (e.g., a therapist flinching in response to aggression; Fisher, Ninness, Piazza, & Owen-DeSchryver, 1996; Kodak, Northup, & Kelley, 2007; Piazza et al., 1999).

Treatment Challenges

Given the challenges associated with EXT-based treatments, researchers have begun investigating DRA treatments that do not arrange for implementation of EXT, yet still produce clinically significant reductions in destructive behavior. Researchers often term these treatments as DRA without EXT (Athens & Vollmer, 2010; Lalli & Casey, 1996; Lalli et al., 1999; Parrish, Cataldo, Kolko, Neef, & Egel, 1986; Piazza et al., 1997; Russo, Cataldo, & Cushing, 1981; for a related review, see MacNaul & Neely, 2017 and Payne & Dozier, 2013). These treatments are often conceptualized as a concurrent choice arrangement in which the individual chooses between two concurrently available responses, either destructive or alternative behavior (Athens & Vollmer, 2010; Borrero et al., 2010). This conceptualization is consistent with the matching law, a quantitative description of response allocation based on reinforcement schedules (Herrnstein, 1961), that suggests an organism will allocate responding to the response that produces the highest reinforcement value (Baum, 1974; Crowley & Donahoe, 2004; Fisher & Mazur, 1997).

An individual's response allocation between two concurrently available responses may be sensitive to a variety of reinforcer dimensions including rate (Horner & Day, 1991; Kelley, Lerman, & Van Camp, 2002; Lalli & Casey, 1996; Vollmer, Roane, Ringdahl, & Marcus, 1999;

Worsdell, Iwata, Hanley, Thompson, & Kahng, 2000), immediacy (Athens & Vollmer, 2010; Horner & Day, 1991), magnitude (Athens & Vollmer, 2010; Briggs, 2016; Dube & McIlvane, 2002; McComas, Hartman, & Jimenez, 2008; Lerman, Kelley, Vorndran, Kuhn, & LaRue, 2002), quality (Athens & Vollmer, 2010; Piazza et al., 1999), and effort (Horner & Day, 1991; Richman, Wacker, & Winborn, 2001).

Numerous studies have found that sensitivity to dimensions of reinforcement varies across individuals (Dube & McIlvane, 2002; Kunnavatana, Bloom, Samaha, Slocum, & Clay 2018; Neef & Lutz, 2001a, 2001b; Neef, Mace, & Shade, 1993; Neef, Shade, & Miller, 1994; Perrin & Neef, 2012). For example, Vollmer, Borrero, et al. (1999) implemented DRA without EXT with two participants who engaged in destructive behavior maintained by access to tangible and edible items. The therapist provided immediate access to a low-magnitude reinforcer contingent on destructive behavior or delayed access to a high-quality reinforcer contingent on a communication response. Participants continued to allocate responding towards destructive behavior under these conditions, suggesting that participants' behavior was more sensitive to immediacy compared to quality of reinforcement. Another study conducted by Neef et al. (1993) examined participants' response allocation when therapists manipulated several dimensions of reinforcement (i.e., immediacy, quality, and rate) following completion of math problems. Results indicated participants were not equally sensitive to reinforcer dimensions. For example, one participant's response allocation suggested sensitivity to the immediacy dimension, whereas another participant's responding suggested sensitivity to quality. This growing body of literature suggests that individuals may not be equally sensitive to reinforcer dimensions. Given this, it may be important that practitioners identify parametric values of reinforcer dimensions to which an individual's behavior is sensitive prior to implementing DRA without EXT.

Reinforcer Dimension Sensitivity Assessments

The idiosyncratic results of published DRA without EXT treatment data highlight the importance of assessing individual sensitivity to parametric values of reinforcer dimensions to

guide the development of efficacious DRA without EXT treatments. The systematic pre-identification of reinforcer parameters and dimension(s) to which an individual's behavior is sensitive may (a) result in more rapid response reallocation from destructive to alternative behavior, (b) produce leaner schedules of reinforcement for alternative behavior during schedule thinning, and (c) increase procedural integrity due to less complex treatments. Despite the relevance for the systematic pre-identification of parametric values of reinforcer dimensions to which an individual's behavior is sensitive, these types of assessments are still in their infancy with a few notable exceptions.

Athens and Vollmer (2010) assessed the influence of reinforcer dimensions (i.e., quality, immediacy, or magnitude) on the responding of five participants who engaged in destructive behavior maintained by social-negative reinforcement, social-positive reinforcement, or both. Therapists conducted 10-min DRA without EXT sessions during which they used a concurrent operants arrangement to reinforce participants' responding on variable-interval reinforcement schedules. Participants displayed a decrease in destructive behavior and increase in alternative behavior when therapists manipulated a reinforcer dimension to which the participant's behavior was sensitive to favor alternative behavior relative to destructive behavior. However, as Athens and Vollmer (2010) note, the response patterns produced by variable-interval schedules may require clinicians to elongate assessment conditions to achieve stability in responding, which may extend the duration of this type of assessment to identify sensitivity to parametric values of reinforcer dimensions. Thus, the procedures in this study may have limited utility in clinical settings in which efficient assessment and quick implementation of treatment is warranted.

Kunnavatana et al. (2018) furthered this line of research by using arbitrary responses to identify three participants' sensitivity to quality, magnitude, and immediacy parameters. Therapists conducted 10-trial sessions in which they presented two buttons and instructed the participant to "pick one." The participant's selection produced the corresponding consequence. Results of their sensitivity assessments indicated all three participants were most sensitive to

quality and least sensitive to magnitude. In a subsequent validation analysis, the authors implemented a DRA without EXT condition during which therapists manipulated magnitude, the reinforcer dimension to which the individual demonstrated the least sensitivity during the preassessment, to favor alternative behavior relative to destructive behavior. During this condition, all three participants' destructive behavior decreased to zero or near-zero rates, limiting the conclusions that can be drawn regarding the validation of their preassessment to identify parametric values of reinforcer dimensions to which an individual's behavior may be sensitive.

To date, studies examining individual sensitivity to reinforcer parameters have arbitrarily assigned programmed parameters during the assessment. For example, when assessing magnitude, Kunnavatana et al. (2018) provided 15-s or 90-s access to the reinforcer. Two of three participants did not demonstrate sensitivity to these programmed magnitude parameters. For both participants, the authors degraded the magnitude parameter to 180-s and observed one participant demonstrated sensitivity to this parameter. Similarly, when assessing immediacy with two participants, Athens and Vollmer programmed a 0-s delay following alternative behavior and a 30-s delay following destructive behavior. Neither participant consistently reallocated responding towards alternative behavior under this arrangement. The authors further degraded the delay to 60 s and observed both participants reallocate responding towards alternative behavior. While this type of approach allows practitioners to identify if an individual is sensitive to the programmed parameter, it does not allow practitioners to identify the exact point at which response reallocation (i.e., sensitivity) occurs. Having a more precise, systematic analysis to identify the exact point at which an individual reallocates responding may significant clinical utility when assess individual sensitivity to reinforcer dimensions with individuals who engage in severe destructive behavior. For example, this approach may limit the occurrence of destructive behavior, which may be particularly important when an individual engages in high-risk behavior, such that even low rates of behavior pose a significant risk of harm to oneself or others.

The purpose of the current study was to develop a reinforcer dimension sensitivity assessment to systematically identify parametric values of reinforcer dimensions to which an individual is sensitive and subsequently validate these results using a DRA without EXT procedure. Therefore, in Study 1 of the current evaluation, we conducted a reinforcer dimension sensitivity assessment during which we exposed participants to parametric arrangements of reinforcer dimensions and systematically evaluated presence or absence of sensitivity (i.e., differential response patterns). We conducted this study in a translational and clinical arrangement. We conducted Study 2 with participants who demonstrated sensitivity during Study 1. In Study 2, we conducted a validation analysis during which we assessed participants' allocation of responding across two DRA without EXT conditions. During these DRA without EXT conditions, target and alternative responses produced either an optimal reinforcer or a suboptimal reinforcer at the parametrically degraded value at which the participant's behavior demonstrated sensitivity in Study 1. We conducted this study in a translational arrangement.

CHAPTER 1: GENERAL METHODS

Participants and Setting

We recruited a total of six participants. Four individuals who engaged in zero to low rates of destructive behavior participated in the translational application of this study. Isaiah, a 6-year-old boy diagnosed with autism spectrum disorder, communicated using single words or short phrases. Abigail, a 6-year-old girl diagnosed with autism spectrum disorder, was nonverbal, and primarily communicated using a Dynavox speech device. Anna, a neurotypical 5-year-old girl, communicated using sentences. Cooper, a neurotypical 3-year-old boy, communicated using sentences.

Two children referred for the assessment and treatment of destructive behavior for whom EXT-based treatment procedures were not appropriate participated in the clinical evaluation. Ian, a 12-year-old boy diagnosed with autism spectrum disorder, stereotypic movement disorder with self-injurious behavior, and disruptive mood dysregulation disorder, displayed aggression and

self-injury. Ian's aggression frequently produced tissue damage to others and his caregivers reported difficulties implementing EXT due to his physical stature. Ian communicated primarily by guiding adults to preferred materials or using single words. Timothy, a 10-year-old boy diagnosed with autism spectrum disorder, unspecified disruptive, impulse-control and conduct disorder, and stereotypic movement disorder with self-injurious behavior, displayed property destruction and self-injury. Timothy's self-injury frequently produced breaks in the skin and moderate to severe swelling. Both participants attended an intensive outpatient clinic five days per week for six-hour appointments and were on stable medication regimens throughout the study. We conducted all study procedures under the oversight of a pediatrics institutional review board and followed client-specific session termination criteria. We prematurely terminated one session with Timothy due to meeting termination criteria (i.e., one instance of high-intensity self-injury or three instances of self-injury within 5 s). Therapists wore protective equipment such as arm guards, protective helmets, gloves, shin guards, and compression shirts to maintain staff and patient safety.

We conducted sessions in 3-m by 3-m padded or unpadded therapy rooms or cubes that contained a table, chairs, and condition-specific stimuli (e.g., colored poster board). Some of the therapy rooms were equipped with a two-way intercom and a one-way observation mirror. Additionally, we padded the furniture in Timothy's room due to Timothy engaging in self-injury directed at hard surfaces.

Response Measurement

At the start of the concurrent choice trial, data collectors used laptop computers to score participants' selection of either the target or alternative response. For participants in the translational evaluation, the *target response* consisted of either depressing a button (Abigail) or touching a cloth pad (Isaiah, Anna, and Cooper). For participants in the clinical evaluation, the *target response* consisted of destructive behavior defined as aggression (i.e., grabbing, pushing, scratching, hitting, biting, and hair-pulling), property destruction (i.e., overturning, hitting,

kicking, swiping, and throwing furniture or objects), and self-injury (i.e., head-banging, hitting, biting, eye poking, body slamming, hair pulling, scratching, choking, and pinching). Therapists taught participants an *alternative response* in the form of a touching a card with the palm of the hand (Timothy, Isaiah, Anna, and Cooper), handing a card to the therapist (Ian), or depressing a button on a speech communication device (Abigail). Alternative responses were approximately 5-cm by 7-cm and depicted a photograph of the programmed reinforcer.

Pre-Experimental Procedures

Stimulus Preference Assessment

Therapists conducted a paired-stimulus preference assessment (Fisher et al., 1992) with each participant to identify tangible items to include in the functional analysis (clinical participants only) and the reinforcer dimension sensitivity assessment. We selected items to include in the preference assessment based on an interview with the child's caregiver and clinical team (when applicable). For participants whose paired-stimulus preference assessment results did not display a clear distribution of preference or whose results displayed equal distribution of preference across two or more tangible items that were of the five most frequently selected, we conducted a multiple stimulus without replacement (DeLeon & Iwata, 1996) or free operant assessment (Roane, Vollmer, Ringdahl, & Marcus, 1998) to identify a hierarchy of the five most preferred tangibles.

Functional Analysis (clinical participants only)

To identify environmental variables maintaining Ian and Timothy's destructive behavior, we conducted a functional analysis using procedures similar to those described by Iwata et al. (1982/1994). We modified the functional analysis to screen for automatic reinforcement (Querim et al., 2013) and increase differential responding across multielement conditions (Hammond, Iwata, Rooker, Fritz, & Bloom, 2013; Conners et al., 2000).

Functional analysis sessions were 5 min in duration. The *minimized attention* condition served as a screening tool for automatically reinforced behavior during which the participant did

not have access to toys or materials and the therapist did not deliver differential consequences following participant behavior. In the *attention* condition, the therapist provided presession access to preferred forms of attention to the participant for at least 60 s. Sessions began with the therapist redirecting his or her attention towards a magazine while the participant had access to a low-preferred toy. Therapists delivered 20 s of attention contingent on destructive behavior. In the *tangible* condition, the therapist provided pression access to the most highly preferred item for at least 60 s. At the start of session, the therapist removed the tangible item and returned the tangible item to the participant for 20 s following destructive behavior. In the *escape* condition, therapists delivered instructions using sequential vocal, model, and physical prompts with approximately 5 s between each prompt. Therapists provided praise (e.g., "great job working!") if the participant complied with the therapist's instruction following the initial instruction or model prompt. The therapist guided the participant to complete the instruction if the participant did not comply following the model prompt. Contingent on destructive behavior, the therapist provided a 20-s break. The *toy play* condition consisted of the therapist providing noncontingent attention at least every 30 s while the participant had continuous, noncontingent access to his or her most highly preferred tangible item. The therapist did not provide any programmed consequences for destructive behavior. Results suggested that both participants' destructive behavior was multiply controlled by access to tangibles, attention, and escape (data available upon request of the first author). We targeted the tangible function of each participants' destructive behavior in the current study due to caregivers or clinical team members reporting this function was the most problematic or evocative.

Target Response Pretraining

In the translational preparation, therapists taught participants to engage in a target response as analogous to engaging in destructive behavior. Each session consisted of 10 trials. Therapists taught the participants to engage in the target response using a progressive-prompt delay (0 s, 2 s, 5 s, 10 s, 20 s) similar to the procedures described by Charlop, Schreibman, and

Thibodeau (1985). We increased the delay between the removal of the preferred item and the implementation of physical guidance for the target response following two consecutive sessions at each prompt delay. We continued to increase the prompt delay until the participant engaged in the target response independently for at least 80% of trials comprising each training session. For participants in the clinical preparation, we did not conduct target response pretraining due to the target response (i.e., destructive behavior) already occurring in the individual's repertoire.

Alternative Response Pretraining

Therapists taught all participants to engage in an alternative response using the procedures described above for target response pretraining. For five of six participants, during alternative response pretraining, we continued to reinforce the target response on a fixed-ratio 1 reinforcement schedule to emulate procedures that would likely occur in clinical settings when EXT-based procedures are not safe or feasible. For one clinical participant, Timothy, therapists taught the alternative response, during which target responses produced EXT, prior to his enrollment in the current study. Additionally, one translational participant, Cooper, did not acquire the alternative response when the target response continued to produce reinforcement. Therefore, therapists placed the target response on extinction after nine pretraining sessions and this resulted in Cooper acquiring the alternative response in four sessions. During alternative response pretraining sessions, therapists implemented a changeover delay (Herrnstein, 1961) to prevent adventitious reinforcement if the alternative response occurred within 3 s of the target response.

CHAPTER 2: REINFORCER DIMENSION SENSITIVITY ASSESSMENT

The purpose of the reinforcer dimension sensitivity assessment was to examine initial response allocation between concurrently available responses (baseline) and subsequent response allocation or sensitivity when we systematically manipulated parameters of isolated reinforcer dimensions (i.e., quality, magnitude, and immediacy) associated with each response.

Materials

Session materials included the target (translational participants) and alternative (translational and clinical) response materials as described above, programmed tangible items, and specific color-correlated stimuli to enhance condition discriminability (i.e., colored poster boards).

Interobserver Agreement

A second observer independently collected data on participants' response allocation (i.e., target or alternative response) for at least 24% of trials. We scored an agreement if both observers recorded the same number of responses within 10-s intervals (i.e., exact agreement within interval). We calculated interobserver agreement by summing the number of agreement intervals, dividing by the total number of intervals, and converting the resulting quotient into a percentage. Coefficients during the reinforcer dimension sensitivity assessments averaged 99% (range, 84% to 100%) for Isaiah, 97% (range, 83% to 100%) for Abigail, 99% (range, 75% to 100%) for Anna, 98% (range, 78% to 100%) for Cooper, 99% (range, 83%-100%) for Ian, and 99% (range, 91% to 100%) for Timothy.

Experimental Procedures

Experimental Design

We used a trial-based, concurrent operant schedules design to examine response allocation, or sensitivity, to parametric values of isolated reinforcer dimensions. At the start of each trial, participants could choose between two concurrently available responses (i.e., target or alternative response). Each selection resulted in the participant experiencing the relevant consequence associated with that response. During phase A (baseline) of the reinforcer dimension sensitivity assessment, target and alternative responses produced the most optimal programmed reinforcer (i.e., immediate access to the participant's most preferred tangible for 120 s). In subsequent phases of each assessment (i.e., phases B, C, D, and E) we systematically degraded parametric values of a reinforcer dimension such that either target or alternative responses

produced a suboptimal reinforcer while the other response continued to produce the optimal

reinforcer programmed in baseline.

Table 1 outlines the degradation progression of parameters during the quality, magnitude,

and immediacy assessments. We evaluated sensitivity to quality, magnitude, and immediacy in

this order for all participants.

	Reinforcer Dimension Sensitivity Assessment		
Phase	Quality	Magnitude	Immediacy
A	Most frequently selected/consumed	120 s	0 s
B	Second frequently selected/consumed	90 s	Median interresponse time (IRT)
C	Third frequently selected/consumed	60 s	Median IRT X 2
D	Fourth frequently selected/consumed	30 s	Median IRT X 3
E	Fifth frequently selected/consumed	10 s	Median IRT X 4

Table 1. Summary of Programmed Reinforcer Parameters.

Method

Patterns of responding promoted by concurrent operant schedules include (1) consistent

allocation of responding towards one response relative to the other (i.e., exclusive responding

towards one response relative to the other), (2) inconsistent allocation between responses (i.e., the

individual allocates responding between target and alternative responses), or (3) consistently

abstaining from responding towards either response (i.e., the individual stops responding towards

the target and alternative response). None of the participants in the present evaluation engaged in

response pattern 3. We degraded reinforcer parameters for either the target or alternative response

relative to allocation of responding observed in phase A.

Response pattern 1. For individuals who engaged in response pattern 1 (i.e., consistent allocation of responding towards one response), we terminated phase A and initiated phase B once the participant allocated responding towards one response for four consecutive trails. For these individuals, we degraded the reinforcement parameter for the response he or she consistently allocated towards in phase A and continued to degrade the reinforcer parameter until we observed a shift in response allocation for four consecutive trials towards the response that produced the optimal reinforcer (i.e., baseline parameters of reinforcement) or inconsistent response allocation between the target and alternative response for nine trials. Of note, for the first participant, we observed inconsistent response allocation persist for 15 trials during phase B prior to terminating the phase. To circumvent extended periods with inconsistent response allocation, we set a trial-cap of nine trials per degradation phase for subsequent participants.

Response pattern 2. For individuals who engaged in response pattern 2 (i.e., inconsistent allocation between responses), we terminated phase A and initiated phase B following inconsistent response allocation between the target and alternative response for nine trials, such that four consecutive target or alternative responses never occurred. For these individuals, we degraded the reinforcement parameter for either the target or alternative response across subsequent phases. We continued to systematically degrade reinforcer parameters until we observed a shift in response allocation towards the response that produced the optimal reinforcer for four consecutive trials.

We followed these degradation procedures for all participants until we exhausted all degradation steps or identified the point at which the individual reallocated responding as described above. For individuals who reallocated responding, we conducted an ABA reversal comparing the concurrent arrangement at the point of response reallocation to the most recent phase in which we observed consistent response allocation. If we observed a reversal in responding, we concluded the participant demonstrated sensitivity to the programmed reinforcer parameter at which we observed response reallocation.

Procedure

Each trial started when the therapist removed the participant's tangible item and ended after the reinforcement interval corresponding to the selected response elapsed or 120 s elapsed with no selection. Before each phase, we conducted two forced-choice exposure trials (forced-choice trial data are available upon request from the first author) during which the therapist removed the preferred tangible item, immediately guided the participant to engage in the alternative response and then provided the programmed consequence. Given the target response in the current study was analogous to destructive behavior, we never conducted forced-choice trials with the target response given this would not occur in clinical settings with individuals who engage in destructive behavior. Therapists delivered the programmed consequence for the first response that occurred in the trial and did not deliver any programmed consequences for subsequent responses. If the participant simultaneously engaged in the target and alternative response, therapists did not deliver any programmed consequences until the participant engaged in an isolated response. We implemented a changeover delay (Herrnstein, 1961) to prevent adventitious reinforcement if the target or alternative response occurred within 3 s of each other.

Quality sensitivity assessment. We rank ordered the stimuli in descending order according to percentage of selections (Koehler, Iwata, Roscoe, Rolider, & O'Steen, 2005) or duration of consumption (Roane et al., 1998). The most selected/consumed was identified as the optimal quality stimulus. We identified the remaining four stimuli by the percentage of selection or consumption during the preference assessment with the 2nd highest selected/consumed stimulus ranked as the 2nd high-quality stimulus, 3rd highest ranked as the 3rd high-quality stimulus, etc. If two or more stimuli had equal preference values (e.g., two stimuli selected 60% of trials), we conducted a brief multiple stimulus without replacement or free operant assessment with those items to allow us to rank preference. During the quality sensitivity assessment, therapists immediately (i.e., 0 s) delivered the tangible for 120 s, thus keeping magnitude and immediacy parameters constant throughout the evaluation.
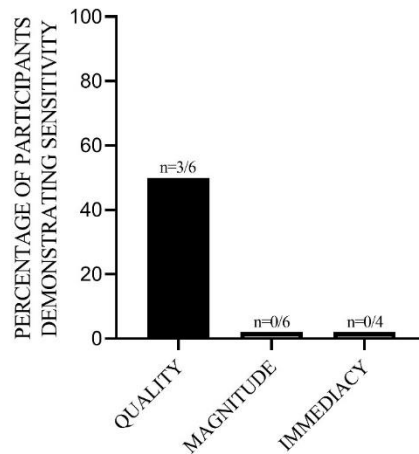
Magnitude sensitivity assessment. The optimal magnitude parameter was 120-s access to the reinforcer. We determined subsequent degradation steps by subtracting 30 s from the previous value (i.e., 120 s, 90 s, 60 s, 30 s, 10 s), resulting in the smallest magnitude parameter producing 10-s access to the programmed reinforcer. We selected these parameters because they represent a range of reinforcer intervals investigators have used in applied research (Trosclaire-Lasserre, Lerman, Call, Addison, & Kodak, 2008). When assessing sensitivity to magnitude, we immediately (i.e., 0 s) provided the individual's highest quality reinforcer, thus keeping quality and immediacy parameters constant throughout the evaluation.

Immediacy sensitivity assessment. The optimal immediacy value for all participants was a 0-s delay. For clinical participants, we derived the median IRT from the last three sessions of the participant's respective functional analysis tangible test condition. For translational participants, prior to conducting the immediacy assessment, we conducted three 5-min sessions during which only the target response was available to simulate a test condition during a traditional functional analysis. During these sessions, therapists replicated the contingencies of the tangible test condition in a functional analysis (i.e., contingent on the participant engaging in the target response, the therapist provided the participant access to his or her highest quality tangible for 20 s). For all participants, we calculated the median IRT for target behavior during these sessions and calculated degradation steps by multiplying the IRT by 2, 3, etc. For participants whose median IRT was less than 2 s during these sessions, we set the initial delay at 2 s. During the immediacy sensitivity assessment, we provided the individual's highest quality reinforcer for 120 s thus keeping quality and magnitude parameters constant throughout the evaluation.

Results and Discussion

Figure 1 depicts the summarized results from the reinforcer dimension sensitivity assessment across translational and clinical participants. We conducted a total of six quality, six magnitude, and four immediacy assessments. Prior to conducting the immediacy assessment, we

experienced attrition with one translational participant (Anna) and withdrew one clinical

participant (Timothy) due to an increase in the intensity of target behavior (i.e., self-injury). Three

participants demonstrated sensitivity to programmed reinforcer parameters during the quality

assessment. Zero participants demonstrated sensitivity to programmed reinforcement parameters

during the magnitude or immediacy assessment.

Figure 1. Aggregated Results from the Reinforcer Dimension Sensitivity Assessment.
Percentage of participants whose behavior demonstrated sensitivity during quality, magnitude,
and immediacy assessments.

Figure 2 depicts results for the participants whose behavior demonstrated sensitivity

during the quality reinforcer dimension sensitivity assessment (data for all participants from the

reinforcer dimension sensitivity assessments are available upon request of the first author). The

top panel depicts data for Isaiah, the middle panel depicts data for Cooper, and the bottom panel

depicts data for Anna. With the exception of one trial, Isaiah (top panel) consistently allocated

responding towards the target response during phase A. In phase B, we degraded the quality

parameter of Isaiah's tangible reinforcer following target responses and observed inconsistent

allocation of responding or nonresponding for nine trials. In phase C, we further degraded the

quality parameter of Isaiah's tangible reinforcer following target responses and observed Isaiah

reallocate responding towards the alternative response which produced the optimal reinforcer for

four consecutive trials. We then conducted a brief CAC reversal during which we observed Isaiah

inconsistently allocate responding for nine trials in phase A and then reallocate responding towards the alternative response for four consecutive trials in Phase C.

Cooper (middle panel) allocated responding towards target responses for four consecutive trials during phase A. In phase B, we degraded the quality parameter of Cooper's tangible reinforcer following target responses and observed continued allocation towards target responses. In phase C we further degraded the quality parameter of Cooper's tangible reinforcer and observed inconsistent response allocation for nine trials. We then briefly reversed to phase B during which we observed Cooper reallocate responding towards target responses for four consecutive trials.

Anna (bottom panel) consistently allocated responding towards target responses during phase A. In phases B and C, we degraded the quality parameter of Anna's tangible reinforcer following target responses and observed continued allocation towards the target response. We then further degraded the quality parameter of Anna's tangible in phase D. Following this degradation step, she initially allocated responding towards the target response and then shifted response allocation towards the alternative response for four consecutive trials. We then conducted a brief reversal to phase C during which we observed Anna reallocate responding towards the target response for four consecutive trials.
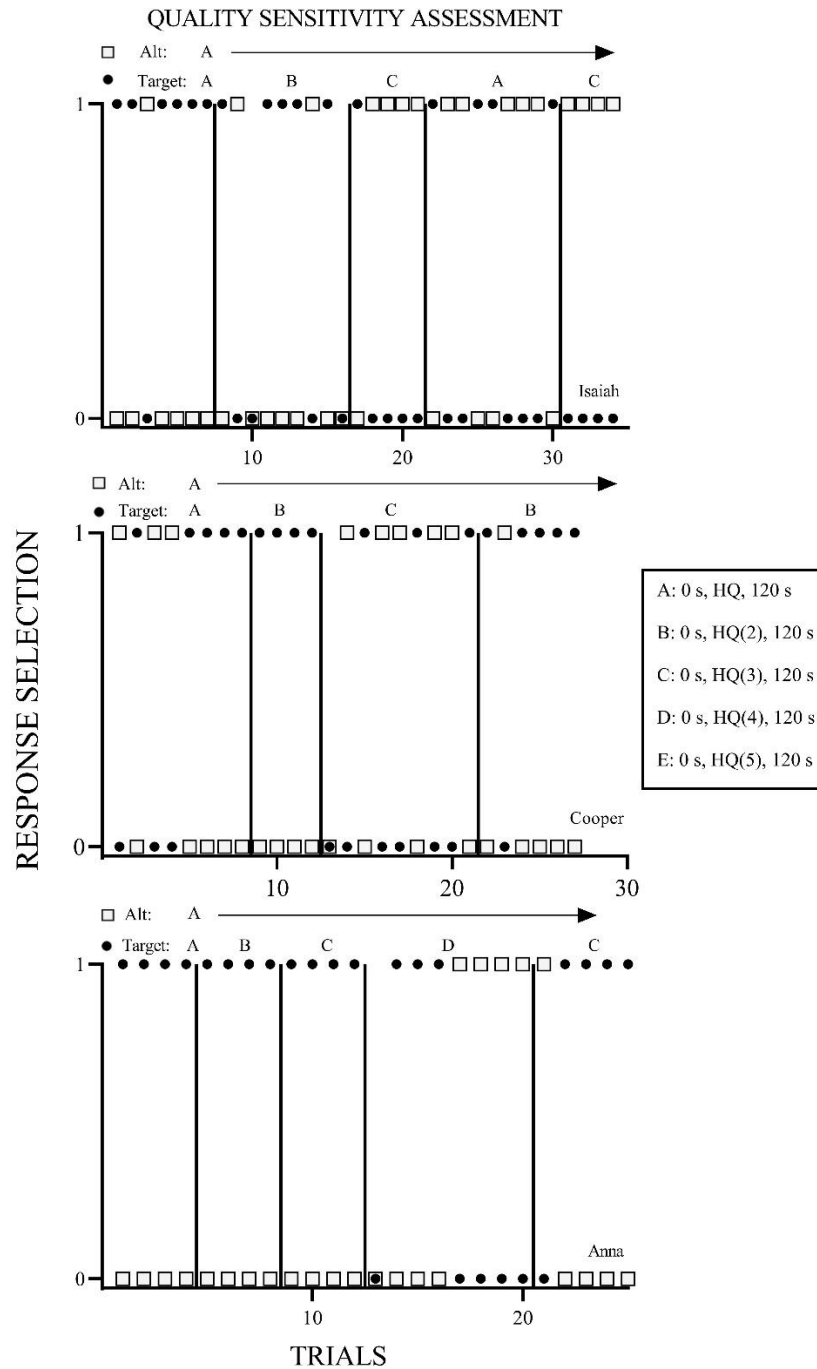
Figure 2. Quality Reinforcer Dimension Sensitivity Assessment. Results of the quality dimension sensitivity assessment for Isaiah (top panel), Cooper (middle panel), and Anna (bottom panel). Closed circles denote target responses and open squares denote alternative responses.

In summary, results of the reinforcer dimension sensitivity assessment indicate three of the six participants demonstrated sensitivity to a programmed quality parameter. None of the participants demonstrated sensitivity to programmed magnitude and immediacy parameters. These results extend previous findings suggesting that quality of reinforcers may be an important dimension of reinforcement to promote response allocation towards a specific response during concurrent operant schedules (e.g., Athens & Vollmer, 2010; Kunnavatana et al., 2018; Neef, Mace, Shea, & Shade, 1992; Piazza et al., 1997). For the three participants who demonstrated sensitivity to programmed quality parameters, we demonstrated experimental control of response allocation using an ABA reversal design.

One recommendation to strengthen the experimental control for this assessment would be to conduct an ABAB reversal. However, it is likely these procedures would be utilized with individuals with whom EXT-based procedures are not feasible (i.e., individuals who engage in severe destructive behavior). Given this, researchers and practitioners should continue to carefully weigh the necessity of demonstrating robust experimental control and brevity in assessment to decrease the risk of injury to oneself and others, as well as allow quicker implementation of treatment procedures.

During Isaiah's quality sensitivity assessment, we first observed inconsistent response allocation in phase B when we degraded the quality parameter following target responses. When we further degraded the quality parameter in phase C, we observed consistent reallocation of responding towards the alternative response that produced the optimal reinforcer. Due to the necessity of increasing the brevity of these types of assessment, we assessed if this pattern of responding (i.e., inconsistent response allocation) could be used to determine sensitivity. Therefore, when we observed this response pattern with Cooper in phase C, we reversed to the previous phase B and observed Cooper again reallocate his responding towards target responses.

We observed this pattern of inconsistent response allocation following degradation of the reinforcer parameter with two of three participants (Isaiah and Cooper). For the third participant (Anna), we observed a clear reallocation of responding for four consecutive trials when we manipulated quality parameters across phases. Future studies may consider examining if either of these response patterns are more predictive of demonstrating sensitivity or if a reversal in responding across phases is more likely.

CHAPTER 3: VALIDATION ANALYSIS

We designed the validation analysis for individuals who demonstrated sensitivity during the reinforcer dimension sensitivity assessment. The purpose of the validation analysis was to assess participants' allocation of responding during two DRA without EXT conditions during which target and alternative responses produced either an optimal (i.e., immediate access to the participants highest quality tangible for 120 s) or suboptimal reinforcer. The parameters for the suboptimal reinforcer were selected based on the results of the participants' reinforcer dimension sensitivity assessment.

Participants and Materials

We conducted a validation analysis with Isaiah and Cooper. We did not complete a validation analysis with Anna due to attrition. Materials were the same as those described for the reinforcer dimension sensitivity assessment. For each DRA without EXT condition, we used colored stimuli (e.g., colored t-shirts, light colors) to enhance condition discriminability. Color-correlated stimuli in the validation analysis were different than colors used in previous assessments. For Isaiah, we added an additional discriminative stimulus in the form of a 5-cm by 7-cm picture of a tangible item fixed to the target response to increase the discriminability of the consequence for target and alternative responses.

Interobserver Agreement and Procedural Integrity

We calculated interobserver agreement calculations using the same procedures described above in Study 1. A second observer independently collected data for 42% and 50% of sessions

in the validation analysis for Isaiah and Cooper, respectively. We scored an agreement if both observers recorded the same number of responses or seconds of the response within each 10-s interval (i.e., exact agreement within the interval). We calculated interobserver agreement by summing the number of agreement intervals, dividing by the total number of intervals, and converting the resulting quotient into a percentage. Coefficients during the validation test averaged 99% (range, 96% to 100%) and 99% (range, 95% to 100%) for Isaiah and Cooper, respectively.

An independent observer collected procedural integrity using paper and pencil data for 30% and 50% of DRA without EXT sessions for Isaiah and Cooper, respectively. The observer denoted whether the therapist correctly or incorrectly delivered the programmed consequence (i.e., optimal or suboptimal reinforcer) for the target and alternative response based on the results of the participant's reinforcer dimension sensitivity assessment and the type of DRA without EXT condition. For both participants, we defined the optimal reinforcer as the therapist immediately providing the participants most-preferred tangible for 120 s. We defined the suboptimal reinforcer as the therapist immediately (i.e., 0-s delay) providing the participants third preferred tangible for 120 s. We calculated procedural integrity by summing the number of correct therapist responses, dividing the total number of correct and incorrect therapist responses, and converting the quotient to a percentage. Procedural integrity for both participants was 100%.

Experimental Procedures

Experimental Design

We used a reversal design to compare two DRA without EXT conditions. In the DRA without EXT (target response) condition, we provided the optimal reinforcer contingent on target responses and the suboptimal reinforcer (i.e., the qualitatively degraded reinforcer to which the individual demonstrated sensitivity during the assessment) contingent on alternative responses. In the DRA without EXT (alternative response) condition, we programmed the inverse relation such that target responses produced the suboptimal reinforcer and alternative responses produced the

optimal reinforcer. We randomized the sequence of DRA without EXT conditions across participants. We conducted at least two sessions per phase and used visual inspection to determine when to progress to the next phase. All sessions were 10 min.

Procedures

DRA without EXT (target response). During this condition, therapists manipulated the parameter of reinforcement to which the individual's behavior was sensitive during the reinforcer dimension sensitivity assessment to favor target responses. For both participants, contingent on the target response, the therapist provided the optimal reinforcer (i.e., immediate access to the child's highest quality tangible for 120 s). Contingent on the alternative response, the therapist provided the suboptimal reinforcer (i.e., immediate access to the participant's third preferred tangible for 120 s).

DRA without EXT (alternative response). During this condition, therapists manipulated the reinforcer parameter to which the individual's behavior was most sensitive during the reinforcer dimension sensitivity assessment to favor alternative responses. For both participants, contingent on the target response, the therapist provided the suboptimal reinforcer (i.e., immediate access to the participant's third preferred tangible for 120 s). Contingent on the alternative response, the therapist provided immediate access to the optimal reinforcer (i.e., immediate access to the child's highest quality tangible for 120 s).

<div align="center">

Results and Discussion

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Figure 3 displays the results of the validation analysis for Isaiah (top panel) and Cooper (bottom panel). For Isaiah, we implemented the DRA without EXT (target response) condition first. During this condition, we observed Isaiah engage in elevated rates of alternative responses and low-to-zero rates of target responses. However, during these sessions, we observed that Isaiah continued to engage in target and alternative responses during reinforcement intervals. We hypothesized that, despite accessing the specified reinforcer, Isaiah may have had difficulty discriminating between the contingencies available for target and alternative responses and/or an

establishing operation remained in place during the reinforcement interval. Therefore, at session 6, therapists fixed a 5 cm by 7 cm picture to the target response signaling what tangible item the target response would produce. This modification resulted in a visual depiction of the programmed tangible for the target and alternative response. This modification produced an immediate increase in target responses, decrease in alternative responses, and zero instances of responding during reinforcement intervals. During the DRA without EXT (alternative response) condition, Isaiah quickly shifted responding to the alternative response and engaged in high rates of alternative responses relative to target responses. In a reversal to the DRA without EXT (target response) condition, Isaiah's target responses increased, and alternative responses decreased. In the final reversal to DRA without EXT (alternative response) condition, Isaiah's alternative responses increased, and target responses decreased.

During DRA without EXT (alternative response), Cooper engaged in elevated rates of alternative responses relative to target responses. When we reversed the contingencies in DRA without EXT (target response), we observed an increase in target responses relative to alternative responses. We then reversed back to the DRA without EXT (alternative response) condition and observed an increase in alternative responses and decrease in target responses. In the final reversal to DRA without EXT (target response), Cooper's target behavior increased, and alternative behavior decreased.
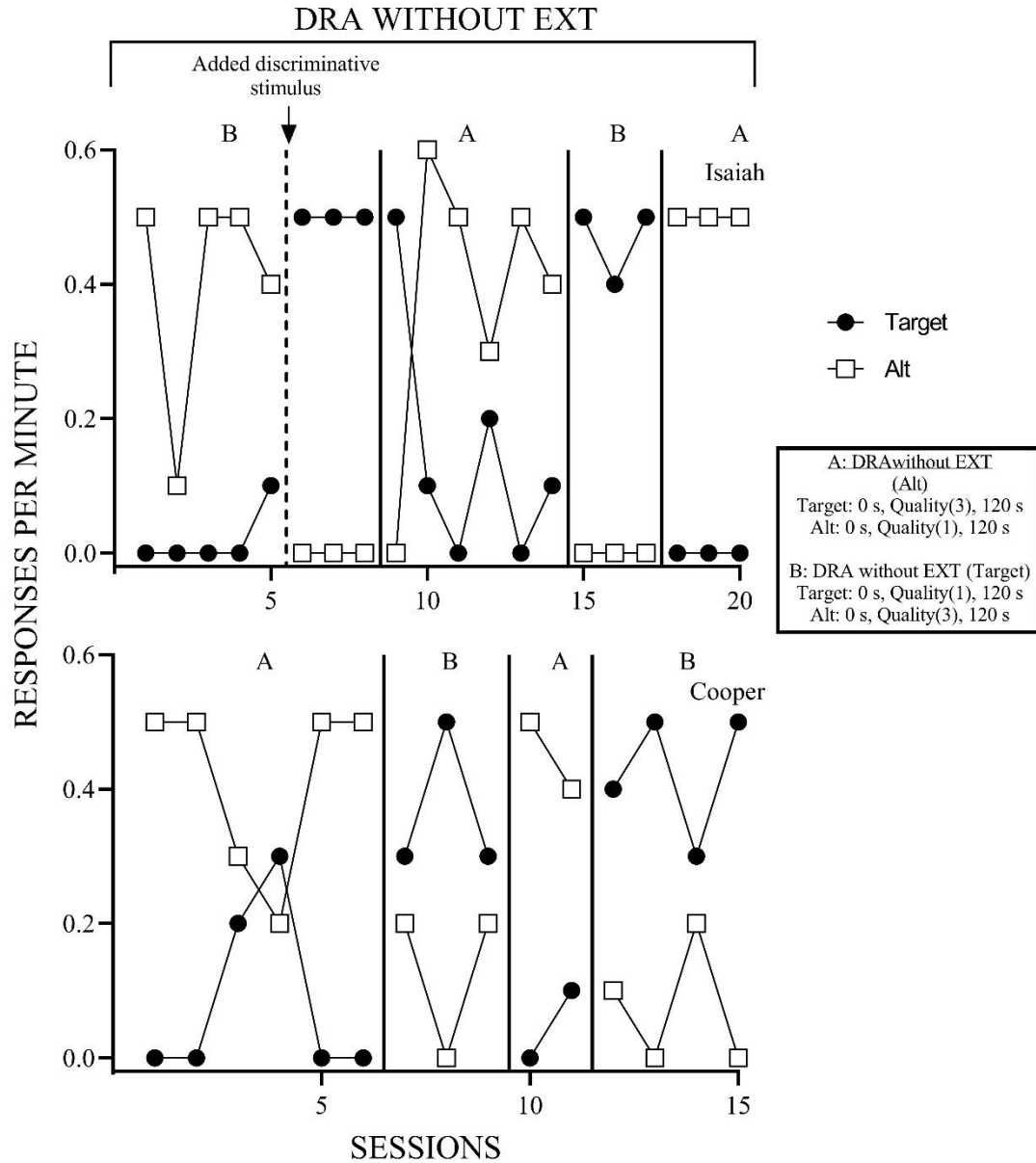
Figure 3. Validation Analysis. Response per minute of target and alternative responses during the validation analysis for Isaiah (top panel) and Cooper (bottom panel). Closed circles denote target responses and open squares denote alternative responses. The quality number depicts the rank order of the tangible item. The qualitative parameter favored alternative responses in the DRA without EXT (alternative response) condition and target responses in the DRA without EXT (target response) condition.

In summary, the results of the reinforcer dimension sensitivity assessment informed the development of two different DRA without EXT conditions during which we programmed the participant's suboptimal reinforcer following either target or alternative responses. Both

participants allocated responding towards the response that produced the optimal reinforcer relative to the response that produced the suboptimal reinforcer. These results validate that the reinforcer dimension sensitivity assessment empirically identified a dimension and parameter of reinforcement to which Isaiah and Cooper's behavior was sensitive. This study provides preliminary evidence that practitioners may be able to quickly assess parametric values of reinforcer dimensions to determine individual sensitivity and subsequently apply this information during a DRA without EXT procedure to encourage responding towards appropriate behavior when it is not feasible to implement EXT.

Of note, the addition of a discriminative stimulus during Isaiah's validation analysis immediately decreased responding during reinforcement intervals and resulted in consistent allocation of responding towards the response that produced the optimal reinforcer. It remains unclear why we observed this pattern of responding for Isaiah during the validation analysis, but not during the reinforcer dimension sensitivity assessment. Future research may consider exploring procedural variations to provide clear signals for the consequences associated across response options.

General Discussion

The current evaluation developed and validated a method for assessing individual sensitivity to parametric values of reinforcer dimensions to shift response allocation in a concurrent operants arrangement, such as a DRA without EXT procedure. This methodology, informed by theoretical concepts of the matching law, extends previous findings suggesting that practitioners can manipulate parametric values and dimensions of reinforcement during DRA without EXT to influence response allocation (e.g., Athens & Vollmer, 2010; Kunnavatana et al, 2018). In Study 1, the reinforcer dimension sensitivity assessment identified sensitivity to programmed quality parameters for three of six participants. Two of the participants who displayed sensitivity during Study 1 participated in the validation analysis. In the validation analysis, we observed both participants allocate responding towards the response that produced

an optimal reinforcer and away from the response that produced the suboptimal reinforcer identified during their respective assessments.

This study is the first to investigate the use of a reinforcer dimension sensitivity assessment that allows practitioners to systematically expose an individual to parametric arrangements of reinforcer dimensions. This type of systematic analysis allows practitioners to evaluate the point at which an individual's behavior demonstrates sensitivity (i.e., the parametric value at which the individual reallocates his or her responding away from the response that produces a suboptimal reinforcer and towards the response that produces an optimal reinforcer). This systematic approach may also allow practitioners to identify the point at which a reinforcer may lose potency (e.g., the individual selects, but does not consume the reinforcer; destructive behavior emerges during the reinforcement interval). This type of fine-grain analysis may have utility for clinical situations in which an individual engages in high-risk behavior such that even low rates of behavior pose a significant risk of harm to oneself or others.

Another important contribution of the current study is that we validated the use of the reinforcer dimension sensitivity assessment by demonstrating that during DRA without EXT, participants allocated responding towards the response that produced the optimal reinforcer relative to the response that produced the suboptimal reinforcer identified in their respective reinforcer dimension sensitivity assessment. However, these results are preliminary and additional research is needed to identify the utility of these results with a clinical population to inform the development of efficacious DRA without EXT treatments to treat severe destructive behavior.

The present findings should be interpreted relative to their limitations and important questions left unanswered. In the present study, none of the participants' behavior demonstrated sensitivity to programmed magnitude and immediacy parameters during the reinforcer dimension sensitivity assessment. These results are similar to previous studies that have examined individual sensitivity to parametric manipulations of magnitude and immediacy (Athens & Vollmer, 2010;

Kunnavatana et al., 2018). We may have observed individual sensitivity to these dimensions of reinforcement if we had further degraded magnitude and immediacy parameters. For example, two of the three participants in Kunnavatana et al. (2018) did not consistently allocate responding towards the response that produced the optimal magnitude reinforcer. The authors made subsequent manipulations to the programmed magnitude parameter (i.e., increased the reinforcement interval from 90 s to 180 s) which then produced consistent response allocation towards the response that produced the optimal magnitude value for one of two participants. While in the current investigation we programmed parametric values that are commonly found in the literature or by individually identifying parametric values, additional research may be warranted to empirically identify parameters that should be used during reinforcer dimension sensitivity assessments.

Alternatively, it is possible we did not observe sensitivity to programmed magnitude and immediacy parameters due to poor discriminability of reinforcer degradation across phases. Specifically, the systematic degradation of a reinforcer dimension across phases (i.e., A → B → …E) may have simulated reinforcement schedule thinning and decreased the likelihood of participants' discriminating degradation of the reinforcer parameter. An individual's ability to discriminate between varying parameters of reinforcement is a critical prerequisite for assessing allocation of responding between concurrently available reinforcement alternatives (Rachlin & Green, 1972). As such, future researchers may consider systematically degrading parameters of a reinforcer dimension such that participants are exposed to baseline (phase A) followed by the phase with the most degraded parameter (phase E). If participants do not reallocate responding during phase E, practitioners could quickly determine that a participant is not sensitive to that dimension of reinforcement at the most degraded programmed parameter. If the participant reallocates responding, then practitioners could reverse back to phase A and then expose the participant to phase D and continue in this manner until the participant has experienced all phases or no longer reallocates responding when exposed to the programmed reinforcer parameters (i.e.,

A → E → A → D, → A → C, etc.). Future research may also consider utilizing additional discriminative stimuli to further increase the saliency of reinforcer degradation across phases. (e.g., timer to signal delay intervals).

In Study 1 of the current evaluation, we used a trial-based format to assess response allocation across concurrently available responses. Some participants continued to engage in target and/or alternative responding during programmed reinforcement intervals. This pattern of responding may be particularly problematic in clinical settings for practitioners and caregivers who cannot safely manage severe destructive behavior or minimize consequences for destructive behavior that occurs during reinforcement intervals. As such, researchers may consider alternative preparations to assess sensitivity to reinforcer dimensions that allows individuals to contact programmed reinforcer contingencies for all responses that occur during a trial.

Four of five participants acquired the alternative response during pretraining, despite target responses continuing to produce reinforcement. For one translational participant, Cooper, we placed target responses on EXT after he did not acquire the alternative response when both alternative and target responses produced reinforcement. It remains unclear the prevalence of acquisition of alternative responses during FCT pretraining procedures during which target responses continue to produce reinforcement. Future research should examine procedural variations to promote acquisition of alternative responses when it may not be safe or feasible to place target responses on EXT.

One significant question that remains unanswered is the impact of isolating versus combining dimensions of reinforcement during DRA without EXT treatments. Prior investigations have shown that combining multiple dimensions of reinforcement produces rapid and clinically significant reductions in destructive behavior compared to when a single dimension of reinforcement is manipulated (Athens & Vollmer, 2010; Peck et al., 1996). However, combining dimensions of reinforcement could have important implications on the feasibility and longevity of treatment effects. For example, some recent translational research has found that

manipulating dimensions of reinforcement for alternative responding during DRA (i.e., rate and magnitude) affects the elimination and resurgence of target responses (Craig, Browning, Nall, Marshall, & Shahan, 2017; Sweeney & Shahan, 2013). Additional research in this area is needed to determine the feasibility and longevity of DRA with and without EXT treatments during which practitioners are manipulating single or combinations of reinforcer dimensions.

In summary, relative to DRA with EXT treatments, DRA without EXT treatments often do not produce clinically significant reductions in destructive behavior (Fisher et al., 1993; Hagopian et al., 1998). The systematic pre-identification of parametric values of reinforcer dimensions to which an individual's behavior is sensitive may allow practitioners to develop more efficacious DRA without EXT treatments. As such, the present study developed and validated a reinforcer dimension sensitivity assessment to efficiently identify individual sensitivity to parametric values of reinforcer dimensions. Results showed three participants were sensitive to quality parameters and we subsequently validated these results using a DRA without EXT procedure for two participants. We hope that the present evaluation extends the utility of reinforcer dimension sensitivity assessments and contributes to developing efficacious DRA without EXT procedures for situations in which it is not safe or feasible to implement EXT in clinical settings.

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