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Evaluation of renewal mitigation of negatively reinforced socially significant operant behavior☆

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ABSTRACT

Renewal is a relapse phenomenon that occurs when previously treated target behavior re-emerges as a result of context change. Typically, a target response is reinforced in Context A, extinguished in Context B, and then re-emerges in Context A - despite the continuation of the extinction procedure. In the current study, we initially reinforced inappropriate mealtime behavior or aggression in Context A across three children diagnosed with Autism Spectrum Disorder. Next, therapists either differentially reinforced an alternative response or extinguished responding by terminating the relationship between problem behavior and the reinforcer in Context B. Problem behavior re-emerged upon the return to Context A even though treatments continued. Finally, we tested repeated exposure to Context A and pairing Contexts A and B for mitigating renewal. Results suggested that modification of the training conditions can effectively mitigate renewal of responding.

1. Introduction

In behavioral interventions, clinicians often implement treatments that reduce problem behavior and increase appropriate behavior. From an applied perspective, it is critical that treatment gains persist beyond the initial training conditions and maintain over time. Specifically, clinicians seek treatments that persist despite the passage of time, changes in locations, changes in teachers, and various known treatment challenges (such as inadvertent lapses in treatment integrity; DiGennaro DiGennaro Reed, Reed, Baez, & Maguire, 2011; Peter Pipkin, Vollmer, & Sloman, 2010). This persistence in the face of challenges is referred to as treatment generality (Baer, Wolf, & Risley, 1968).

Treatments can be challenged in a variety of ways. For instance, after a successful implementation of differential reinforcement of alternative behavior (DRA), a caregiver may unintentionally place the alternative response on extinction, producing a resurgence of problem behavior (Lieving, Hagopian, Long, & O'Connor, 2004; Volkert, Lerman, Call, & Trosclair-Lasserre, 2009). Alternatively, caregivers may commit *errors of omission* (not reinforcing a response when one is supposed to) or *errors of commission* (reinforcing a response when one is *not* supposed to; Peter Pipkin et al., 2010). These types of errors can induce *treatment relapse*, which generally refers to the re-emergence of a previously treated target behavior (Pritchard, Hoerger, & Mace, 2014).

Treatment relapse can be produced by a number of procedural variations such as resurgence, reinstatement, and renewal (see

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Podlesnik & Shahan, 2009). Each procedural variation of treatment relapse focuses on different independent variable manipulations that model ways that an intervention might be challenged (see Wathen & Podlesnik, 2018, in press, for review). In the case of renewal, relapse of behavior occurs as a result of changing stimulus conditions (e.g., Bouton, Todd, Vurbic, & Winterbauer, 2011; Kelley, Liddon, Ribeiro, Greif, & Podlesnik, 2015; see Bouton, Winterbauer, & Todd, 2012; Podlesnik, Kelley, Bouton, & Jimenez-Gomez, 2017, for reviews).

In the standard ABA renewal procedure, a target response is reinforced in Context A. Next, the target response is extinguished in Context B. Finally, in the return to Context A, extinction remains in effect for the target response (e.g., Bouton et al., 2011). The second exposure to Context A is the critical phase because the context previously associated with reinforcement for the target response is placed in direct competition with the recent history with extinction in Context B. The renewal effect is characterized by an increase in target responding upon return to Context A despite the continuation of the extinction contingency (see Podlesnik et al., 2017, for review). The relapse of target responding upon returning to Context A is referred to ABA renewal.

This experimental arrangement mimics treatment conditions under which problem behavior is diminished or completely extinguished in a treatment context (e.g., clinic), but problem behavior re-emerges upon returning to the original context where the problem behavior previously was reinforced (e.g., home, school). For example, consider an individual who is removed from school (context A) for engaging in aggressive behavior to receive treatment in a clinic (context B). Once aggression is treated in context B, the individual might return to school (context A), along with the treatment. However, the renewal literature (e.g., Bouton et al., 2011; Kelley et al., 2015) suggests that change in context itself – regardless of whether treatment is conducted with fidelity in the return to Context A – will produce a re-emergence of target behavior.

Two recent studies suggest that renewal may play an important role in the assessment and treatment of problem behavior. Kelley et al. (2015) exposed both pigeons and children diagnosed with Autism Spectrum Disorder (ASD) to ABA renewal arrangements. Participants engaged in responding reinforced on an FR-1 (children) or fixed-interval 10-s (pigeons) schedule in Context A during baseline. Next, children's academic behavior and pigeons' keypecking were placed on extinction in Context B. Finally, in the return to Context A, extinction remained in place. For all subjects, responding re-emerged in the return to Context A, despite the continuation of extinction. Similarly, Pritchard et al. (2016) exposed an adult male diagnosed with an intellectual disability to a two-component multiple schedule in which obtained reinforcement consisted of 120 reinforcers per hour in one component and 30 reinforcers per hour in the second component in Context A. Reinforcement was discontinued during both components in Context B. Next, extinction continued and problem behavior re-emerged in the return to Context A, demonstrating ABA renewal in a clinical setting (see also Saini, Sullivan, Baxter, DeRosa, & Roane, in press). Moreover, problem behavior re-emerged at higher levels and for longer in the component previously associated with the denser reinforcement.

The results of Kelley et al. (2015) and Pritchard et al. (2016) are consistent with previous renewal literature (e.g., Bouton et al., 2011; see Podlesnik et al., 2017, for a review) and suggest human operant behavior maintained by positive reinforcement is susceptible to the renewal effect. Further, the generality of the renewal effect has been demonstrated extensively under a range of respondent conditioning procedures in nonhumans (e.g., Bouton & Bolles, 1979; Laborda & Miller, 2013; see McConnell & Miller, 2014, for a review) and humans (Dibbets, Havermans, & Arntz, 2008; Glautier, Elgueta, & Nelson, 2013). In addition, Alessandri, Lattal, & Cançado, 2015 demonstrated renewal of negatively reinforced operant behavior with human participants. During Phase 1 in Context A (green computer screen), they maintained key pressing on a keyboard in university students according to a variable-ratio (VR) schedule by providing 3-s timeouts from an effortful response of holding a finger on a force cell. During Phase 2 in Context B (blue computer screen), pressing the key no longer provided timeouts (i.e., extinction). During Phase 3, key pressing increased when returning to Context A despite pressing continuing to produce no timeouts comprising the renewal effect.

Understanding renewal of negative reinforcement is important for understanding renewal of problem behavior reduced by behavioral treatments (Geiger, Carr, & LeBlanc, 2010; Iwata, 1987; Piazza et al., 2003). Furthermore, previous assessments of renewal examined a simple extinction contingency as a model of clinical treatment throughout Phases 2 and 3. In contrast, behavioral treatments such as DRA maintain an alternative source of reinforcement contingent upon some appropriate behavior (see Tiger, Hanley, & Bruzek, 2008, for a review). With the exception of instances of threats to treatment integrity, alternative reinforcement is available within and outside the treatment context (see Podlesnik et al., 2017, for a discussion). Therefore, previous demonstrations of renewal are limited in their applicability to behavioral treatments for problem behavior when only assessing extinction of target responding when changing contexts.

The purpose of the current study was threefold. Firstly, we sought to establish a replication of the renewal effect with clinically relevant problem behavior maintained by negative reinforcement. We chose aggression and inappropriate mealtime behaviors (IMB) as common examples of problem behaviors exhibited by children diagnosed with ASD. Secondly, we sought to extend renewal to differential reinforcement (as opposed to extinction alone) for one participant, as it more closely resembles the clinical situation where treatment remains in place during the return to the original context. The final goal of the present study was to assess methods to mitigate renewal of problem behavior while an intervention remained in place.

2. Method

2.1. Participants and setting

Participants included three boys diagnosed with Autism Spectrum Disorder (Drew, aged 3 years; Stephen and Jules, aged 5 years) who presented problem behavior maintained by negative reinforcement. Stephen and Jules were monozygotic twins, and were also diagnosed with Avoidant/Restrictive Food Intake Disorder (ARFID). Stephen and Jules's pediatrician ruled out any general medical

conditions that could have explained drinking from a bottle and not from a cup. All three boys displayed deficits associated with ASD and received services in an early intensive behavioral intervention clinic. In addition, therapists exposed Drew to a pre-assessment functional analysis (Iwata, 1994; Iwata, Duncan, Zarcone, Lerman, & Shore, 1982/94) to determine the variables related to aggression. We chose to expose Drew to a functional analysis to specifically determine the variables contributing to the occurrence and maintenance of aggression. We chose not to expose Jules and Stephen to functional analyses based on several factors. One, inappropriate mealtime behaviors are most often maintained by escape from eating (Piazza et al., 2003). Secondly, all anecdotal information, including observation, were consistent with previous research in that inappropriate behavior occurred when others were likely to remove the liquids contingent on problem behavior, suggesting negative reinforcement and the maintaining variable.

2.2. Response measurement and interobserver agreement

Drew's target responses consisted of *compliance* (engaging in behavior consistent with a vocal instruction within 5 s of the instruction) and *aggression*, which consisted of hitting, kicking, scratching, throwing objects, hair pulling, and biting the therapist. Stephen's and Jules' target behaviors consisted of IMB, defined as head turns and batting at the spoon when presented with a bite of food. Inappropriate mealtime behavior was calculated by dividing the number of responses by the amount of relevant session time. Relevant session time was defined by the time that the spoon was held at the participants' lips. When this study was initiated, Stephen and Jules did not consume any solid foods; they consumed 100% of their daily calories via bottle feedings. The bottle feedings consisted of Ensure® mixed with whole milk (per the manufacturer's recommendations).

Two observers simultaneously and independently collected data across all phases. For Drew, interobserver agreement (IOA) data were calculated by dividing the number of intervals with exact agreement on the occurrence of aggression and compliance by the total number of intervals per session, multiplying by 100, and converting to a percentage for each session. The mean IOA score was calculated by averaging all IOA scores. IOA for Drew was calculated for 32% of sessions. Mean agreement for aggression was 92% (range, 85%–100%) and for compliance was 100%. For Stephen and Jules, IOA data were collected on all target responses for 39% and 33% of sessions, respectively. Each session was separated into 10-s intervals, and an agreement was scored per interval if both observers recorded the occurrence or non-occurrence of a response. Interobserver agreement was calculated by dividing the sum of agreements by the sum of agreements plus disagreements and converting this ratio into a percentage. Mean interobserver agreement across all sessions for quick acceptance was 94% (range, 75%–100%) and 92% (range, 50%–100%) for Stephen and Jules, respectively. Mean IOA across all sessions for mouth clean was 86% (range, 44%–100%) and 98% (range, 80%–100%) for Stephen and Jules, respectively.

2.3. Pre-assessment procedures

2.3.1. Preference assessments (Drew only)

Therapists conducted a multiple-stimulus without-replacement preference assessment (DeLeon & Iwata, 1996) to identify moderately preferred toys with which the participant could interact during breaks from demands.

2.4. Functional analysis (Drew only)

Therapists exposed Drew to functional analysis procedures consistent with those described by Iwata, Dorsey, Slifer, Bauman, and Richman (1994), Iwata et al. (1982/1994), with modifications described by Fisher, Piazza, & Chiang, 1996; Conners et al. (2000), and Hammond, Iwata, Rooker, Fritz, & Bloom, 2013. In the *tangible* condition, the therapist withheld preferred items. Contingent on aggression, the therapist provided 20-s access to the items. In the *attention* condition, the therapist withheld attention. Contingent on aggression, the therapist provided 20-s access to attention. In the *demand* condition, the therapist issued instructions using 3-step graduated guidance. Contingent on aggression, the therapist provided 20-s access to escape from demands. In the *ignore* condition, the therapist was present in the room with Drew, but did not provide any interaction or other consequence contingent on aggression. In the *control toy play* condition, the therapist provided continuous attention, access to preferred items, and did not deliver instructions. The therapist did not deliver programmed consequences for aggression. Results for Drew's functional analysis (displayed

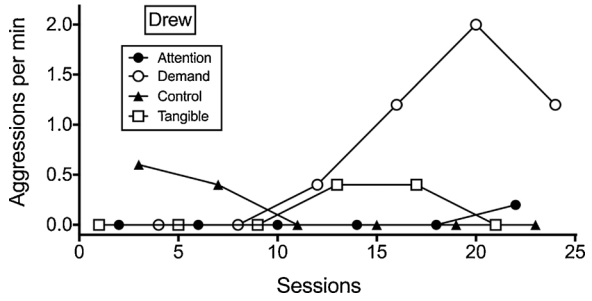

Fig. 1. Results of the functional analysis of aggression for Drew, depicting aggressions per min across sessions. Each symbol represents the different conditions arranged as consequence for engaging in aggression.

in Fig. 1) showed that aggression was maintained by negative reinforcement in the form of escape from demands.

2.5. Renewal procedures

For all participants, new phases were always implemented during a day's session. That is, the first session of the return to context A was conducted on the same day as the last session of the previous condition to control for spontaneous recovery (Kelley et al., 2015). The purpose of this control was to ensure that behavior during any exposure to a new phase could be attributed to context change, and not another variable, such as spontaneous recovery. Sessions lasted 5 min in duration for Drew, and for 5 bolus presentations or 20 min, whichever came first, for Stephen and Drew. We considered a change in behavior to be consistent with a Renewal effect if problem behavior reemerged within the first 5 sessions of the return to Context A at a higher rate than the rate of problem behavior in the last 5 sessions of Context B.

2.6. Drew

2.6.1. Baseline (context A)

Context A consisted of demands in the form of echoics (e.g., say *mama*) and receptive actions (e.g., stand up) issued by a therapist in the classroom every 30 s. Contingent on aggression, the therapist delivered 20 s of escape from demands.

2.6.2. Differential reinforcement of compliance (context B)

For Drew, Context B consisted of differential reinforcement of compliance (DRC) implemented by a different therapist in a small therapy room. The therapist delivered 20-s access to escape contingent on compliance, and continued with a graduated guidance sequence contingent on non-compliance of receptive actions or occurrence of aggression. Only Drew and the therapist were in the room, which was adjacent to an observation room with a one-way window where a secondary observer collected IOA data.

2.6.3. Differential reinforcement of compliance (context A)

The return to Context A consisted of the therapist from Context A implementing DRC (described in Context B above) in the classroom.

2.6.4. Renewal mitigation

Therapists exposed Drew to Contexts B and A after the initial ABA context exposure to assess the effects of repeated exposure to the DRC treatment across contexts. In addition, novel therapists were introduced in the final exposure to Context A to assess whether treatment effects generalized to novel therapists and the participant's mother.

2.7. Stephen and Jules

2.7.1. Baseline (context A)

Context A consisted of bites of food, held consistent across all presentations throughout the study, delivered by their mother. Each bite consisted of a pea-sized amount (approximately 1.75 cc) presented on a small maroon spoon. Foods presented consisted of pureed proteins (e.g., ground beef), starches (e.g., cereal, sweet potato), vegetables (e.g., carrot, squash), and fruits (e.g., pear, banana) that were targeted by the twins' parents for consumption. All food types and presentations were held constant throughout the study. During the Context A condition, the mother removed the bite of food contingent on IMB (Piazza et al., 2003).

2.7.2. Extinction (context B)

For Stephen and Jules, Context B consisted of escape extinction implemented by a trained therapist (in the same room as Context A). The therapist held the spoon in front of the participants' mouths and attempted to deposit the bolus of food into the mouth at any opportunity (Piazza et al., 2003). Any instances of packing resulted in the therapist redistributing the food in the participant's mouth. The therapist attempted to scoop any expelled food into the participant's mouth; at times, the therapist needed to deposit a fresh bolus (e.g., if the expelled bolus landed on the floor).

2.7.3. Extinction (context A)

The return to Context A consisted of their mother implementing escape extinction (described in Context B above). Before implementing the protocol with Jules and Stephen, their mother watched sessions while trained therapists described the protocol and procedures. Next, trained therapists role-played with the mother in the session room, while providing immediate feedback until she was implementing the procedures with 100% accuracy for three consecutive sessions (i.e., the mother did not require feedback for 3 consecutive sessions). Finally, the mother implemented extinction while wearing a "bug-in-the-ear" device so the staff could provide any corrective feedback in situ. The mother conducted extinction with 100% treatment integrity (i.e., she did not require feedback during the implementation of extinction).

2.7.4. Renewal mitigation (context A)

During this condition, the therapist and the mother were paired during escape extinction sessions. That is, the mother sat next to the therapist while the therapist implemented escape extinction.

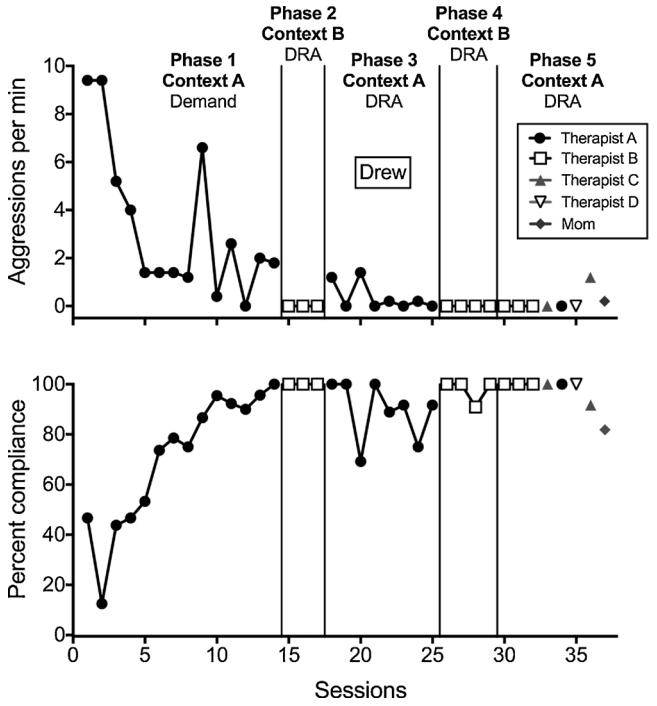

Fig. 2. Aggression rate and percent compliance across sessions, in which contingency for compliance (demand or break/DRA) and therapist changed between Context A (classroom) and B (treatment room).

3. Results

Fig. 2 shows Drew's rate of aggression (top panel) and percentage of trials with compliance (bottom panel). During Phase 1 in Context A, Drew initially engaged in aggression at high levels, followed by decreases and stabilization by the end of the phase. In contrast, compliance increased over the course of the phase. During Phase 2 in Context B, problem behavior decreased to zero levels and compliance stabilized at 100%. In the return to Context A during Phase 3, despite no changes in contingency for compliance, aggression re-emerged and compliance became less stable, indicating renewal defined as context-induced disruption of treatment effects despite continuing the intervention. During Phases 4 and 5, the results of exposure to Contexts B and A were replicated with little problem behavior and high compliance with Therapist B. In addition, during Phase 5 in Context A, multiple novel therapists conducted sessions including the participant's mother. Problem behavior re-emerged and compliance was less stable in 2 of the 5 therapists compared to sessions conducted in Context B.

Fig. 3 shows Stephen's (top panel) and Jules's (bottom panel) results, which were similar for both boys. During Phase 1 in Context A, both boys engaged in IMB. During Phase 2 in Context B, IMB eventually decreased to low levels for both boys with the therapist's implementation of escape extinction, although effects initially were more variable for Jules. In the return to Context A during Phase 3 with mom delivering bites of food and continuing the extinction procedure, IMB re-emerged to levels equal to or greater than those observed in the initial Context A during Phase 1. In the return to Context B during Phase 4, both boys' IMB decreased to low levels but the effects initially were more variable for Stephen. When mom sat with the therapist implementing escape extinction during Phase 5, food refusal stayed at low levels for both participants. Finally, IMB remained at low or zero levels in the return to Context A during Phase 6 for the majority of sessions.

4. Discussion

We extended the literature on renewal in three important ways. Firstly, we demonstrated the renewal phenomenon for the first time with three participants with clinically relevant target behaviors maintained by negative reinforcement. Secondly, we showed renewal while maintaining common behavioral treatments for aggression and food refusal. Specifically, the present findings revealed renewal effects beyond implementation of a simple extinction contingency, which is the traditional manipulation conducted during the second phase of a renewal study (see Bouton et al., 2011). Finally, we assessed two preliminary techniques for mitigating the renewal of clinically relevant problem behavior by pairing aspects of the treatment context (i.e., therapists) within contexts demonstrated to produce renewal of problem behavior. Therefore, the present findings demonstrate the generality of renewal effects for understanding and treating clinically relevant problem behavior.

The demonstration of renewal of clinically relevant operant behavior in the present study is an important extension of the literature on renewal. The vast majority of demonstrations of renewal have been with respondent conditioning in human and

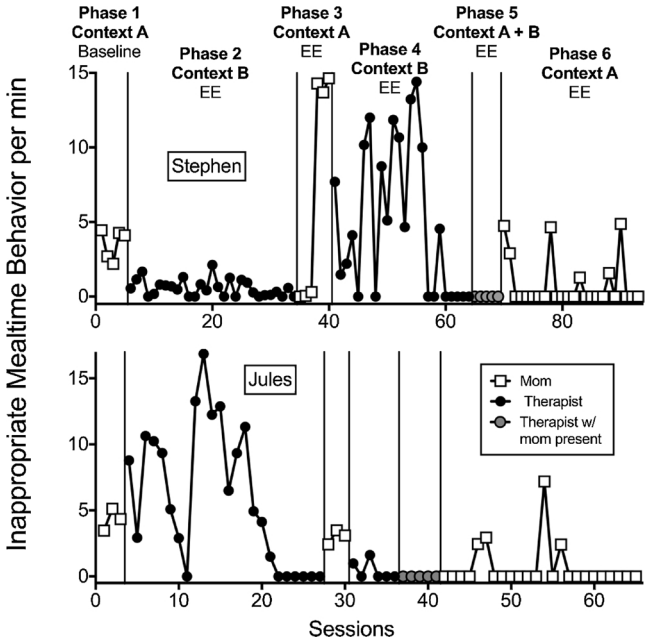

Fig. 3. Rate of IMBs across sessions, in which context changed between Context A (mom) and B (therapist) and treatment implemented was escape extinction (EE).

nonhuman animals (see Bouton et al., 2012; McConnell & Miller, 2014; Vervliet, Craske, & Hermans, 2013, for reviews). Although the number of studies of renewal of operant behavior are increasing (see Podlesnik et al., 2017; Wathen & Podlesnik, 2018, in press, for reviews), we know of only six examples of renewal of operant behavior demonstrated with human participants – university students (Alessandri et al., 2015; King & Hayes, 2016) and individuals with developmental disabilities (Kelley et al., 2015; Liddon, Kelley, Rey, Liggett, & Ribiero, 2018, in press; Pritchard et al., 2016; 2018Saini et al., in press). Furthermore, all of these studies but Pritchard et al. and Saini et al. used arbitrary responses rather than clinically relevant behavior. Therefore, our study represents one of the first experimental confirmations of the renewal effect using humans and responses of social significance. Furthermore, much of the laboratory assessment of renewal demonstrates that renewal is a predictable, yet often short-lived phenomenon (e.g., Kuroda, Mizutani, Cançado, & Podlesnik, 2017; Nakajima, Tanaka, Urushihara, & Imada, 2000; Podlesnik & Shahan, 2009). However, there are at least two critical reasons to examine renewal mitigation. Firstly, some topographies of severe problem behavior, such as aggression or self-injury, may be too dangerous to be tolerable at any level. Secondly, any occurrence of a previously extinguished response runs the risk of contacting reinforcement (see Falcomata, Hoffman, Gainey, Muething, & Fienup, 2013; Podlesnik & Shahan, 2009) with intentional or inadvertent reinforcement of problem behavior. Therefore, keeping severe problem behavior as infrequent as possible is important for long-term treatment maintenance. These data are consistent with a growing literature suggesting that basic research on treatment phenomenon such as resurgence, reinstatement, renewal, and spontaneous recovery is indeed relevant for assessment and treatment of applied behavior problems (e.g., Falcomata et al., 2013; Fisher, Greer, Fuhrman, & Querim, 2015; Fuhrman, Fisher, & Greer, 2016; Liddon et al., 2018 in press; Kelley et al., 2015; Pritchard et al., 2016; Thrailkill, Kimball, Kelley, Craig, & Podlesnik, 2018).

Demonstrating renewal with socially significant behavior maintained by negative reinforcement also is an important demonstration of the generality of renewal effects. Clinically relevant behavior maintained by negative reinforcement is common. Negative reinforcement accounts for 29.7% of functional analysis outcomes in the published literature in general (Beavers, Iwata, & Lerman, 2013), for 26% of functional analysis outcomes in important clinical environments such as schools (Mueller, Nkosi, & Hine, 2011), and for 90% of interpretable functional analyses of inappropriate mealtime behavior (Piazza et al., 2003). Schools or home often serve as “Context A” for inadvertent clinical renewal arrangements when students obtain therapy in a clinic or center (Context B). Thus, gaining understanding about the role of context changes on the relapse of problem behavior maintained by negative reinforcement and potential mitigating strategies can be informative for planning clinical interventions. Our data add to the growing literature on best practices for assessing and treating problem behavior, and for preparing for untoward effects of clinical intervention, such as relapse (see Podlesnik & Kelley, 2017, for a relevant discussion).

Differential reinforcement operations are among the most commonly used clinical interventions (Petscher, Rey, & Bailey, 2009), and are less susceptible than a standard extinction procedure to common indirect effects such as extinction bursts that can compromise implementing treatment with full integrity (Lerman & Iwata, 1995). The findings with Drew demonstrated renewal while implementing treatment consisting of differential reinforcement of compliance, a type of differential reinforcement of alternative behavior (DRA). Generally, increases in problem behavior with treatment in place is attributed to compromised treatment integrity (see Schieltz, Wacker, Ringdahl, & Berg, 2017). The present study shows directly that problem behavior can return when changing

context without accompanying reductions in treatment integrity (see Hagopian, González, Rivet, Triggs, & Clark, 2011; Schindler & Horner, 2005, for related findings).

Another novel contribution of the present study is the assessment of potential strategies for mitigating renewal of clinically relevant behavior. After demonstrating renewal of problem behavior while maintaining behavioral treatments, we observed reduced levels of renewal of problem behavior when maintaining some aspect of the treatment context. We retained the therapist providing treatment upon returning to the training context (Fig. 1) and paired the therapist providing treatment with the original therapist (Client's mother) before reinstating treatment with the original therapist only (Fig. 2). These strategies were based on previous studies of renewal revealing that maintaining cues associated with an extinction context reduce renewal relative to the absence of such cues (Brooks & Bouton, 1994; Collins & Brandon, 2002; Dibbets et al., 2008; Nieto, Uengoer, & Bernal-Gamboa, 2017; Vansteenwegen et al., 2006; Willcocks & McNally, 2014; see also Fisher et al., 2015). These studies typically interpret the mitigation of renewal with cues paired with treatment being due to the cues developing inhibitory control over target responding during treatment (see Bouton, 2014; Podlesnik et al., 2017, for reviews). The present findings are the first to replicate the mitigation of renewal while maintaining behavioral treatment for clinically relevant problem behavior. These findings suggest maintaining common elements from the extinction and renewal-testing contexts (see also Bandarian Balooch & Neumann, 2011; Podlesnik & Miranda-Dukoski, 2015; Todd, Winterbauer, & Bouton, 2012) could underlie an approach to mitigating renewal of problem behavior during clinical interventions using DRA procedures (see Podlesnik et al., 2017, for a discussion).

A limitation to the mitigation strategies tested here is they were arranged only after originally assessing renewal in the absence of the mitigation strategy. Thus, it is possible the reduction in renewal might have been at least partly due to repeated testing, which has been shown to reduce resistance to extinction and relapse effects in other studies (see cf. Bai & Podlesnik, 2017; da Silva, Maxwell, & Lattal, 2008; Doughty, da Silva, & Lattal, 2007; Sweeney & Shahan, 2013). An additional limitation of these data are the limited experimental control over aggression and compliance with Drew's behavior. Although aggression was maintained during Phase 1, responding was on a downward trend while compliance was on an upward trend. Therefore, the present study provides a useful approach for implementing mitigation strategies for reducing relapse of clinically relevant problem behavior but further assessment of these strategies is warranted. Future researchers also could focus on a component analysis to determine the necessary and sufficient conditions to produce mitigation of renewal. Finally, we did not collect treatment integrity data during implementation of the intervention by Jules and Stephen's mother. However, we conducted behavioral skills training and a "bug-in-the-ear" device to increase the probability of accurate implementation of the procedures during the study. Future researchers might evaluate the necessary and sufficient training conditions to ensure high levels of treatment integrity by caregivers.

Understanding the impact of renewal may provide insight for how practitioners approach exporting treatments to contexts in which problem behavior has historically been reinforced. This point underscores the relevance of demonstrating renewal with humans and socially important behaviors and contexts. Consider a student who engages in aggression in a school (Context A). Intervention might occur in a facility specializing in assessment and treatment of problem behavior (Context B). Next, after all relevant personnel receive training on the intervention, the school personnel implement the treatment in Context A. Practitioners should expect that problem behavior will re-emerge in the return to Context A, and plan for the re-emergence accordingly. This recovery appears to be similarly predictable to phenomena such as extinction bursts (Lerman & Iwata, 1995), spontaneous recovery (Lerman, Iwata, & Wallace, 1999), or behavioral contrast (Reynolds, 1961). That is, practitioners often forewarn parents and caregivers that problem behavior sometimes gets worse before it gets better (extinction burst), not to reinforce problem behavior should it re-emerge (spontaneous recovery), and that problem behavior may get worse at home when treatment is implemented in a clinic (behavioral contrast). Practitioners might similarly prepare parents and caregivers for the likelihood of renewal. That preparation might include procedures for ensuring maintenance of treatment integrity during the return to Context A after treatment in Context B as well as implementation of mitigation strategies. Thus, parents and caregivers would be provided with sufficient support to withstand the relapse attributable to the context change so problem behavior has an opportunity to come under the control of the intervention contingencies in Context A.

In summary, our data add to the growing translational and applied data on treatment relapse. Treatment relapse represents a costly problem for clinicians, parents, and teachers (see Podlesnik & Kelley, 2017, for a discussion). Understanding the conditions under which renewal is likely to occur and ways to mitigate renewal represent valuable avenues of research to improve clinical practice based on research on fundamental learning processes.

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