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Does Training Multiple Alternative Responses Mitigate Resurgence?

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by

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Abstract

Title: Does training multiple alternative responses mitigate resurgence?

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Resurgence is a type of treatment relapse that occurs when an extinguished behavior reappears once a more recently reinforced behavior is placed on extinction. Resurgence of problem behavior often occurs when treatment-integrity errors are made during the implementation of differential reinforcement of alternative behavior (DRA). Training multiple alternative responses shows a promise in mitigating resurgence of problem behavior compared to training only a single response. The current study used laboratory methods to systematically replicate previous studies comparing the effects of more typical-DRA training with serial-DRA training on the magnitude of resurgence. Extensions included children as participants, topographically different target and alternative responses, and counterbalanced independent conditions. Participants were exposed to a control (typical) condition and a serial condition. Each condition consisted of three phases: reinforcement, elimination, and a resurgence phase. The reinforcement phase was identical for both conditions in which a target response was trained. For the elimination phase within the control condition, the target response was placed on extinction and a single alternative response was trained. Whereas, within the test condition, the target response was placed on extinction and three alternative responses were sequentially trained. In the resurgence phase for both conditions all responses previously trained were placed on extinction. For only one of three participants was resurgence less in the serial condition, differing from previous research. This study helps establish and refine potential methods for mitigating resurgence when DRA treatment is implemented in the treatment of problem behavior.

Keywords: resurgence; relapse; serial DRA; translational research; children; treatment integrity errors

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Dedication

I dedicate this thesis to my parents, Jean and John, and my sister, Cailey. Thank you for your unconditional love and support.

Introduction

Autism Spectrum Disorder (ASD) is a diagnosis for individuals with complex brain development disorders. Individuals are diagnosed based on impairments in three categories of behavior including; communication, social situations, and stereotypic behavior described by the diagnostic statistical manual (DSM-V). Scheuermann and Webber (2002) describe the characteristics of ASD being categorized as either behavioral deficits (e.g. lack of language, daily living skills, eye contact) or behavioral excesses. These behavioral excesses can include a multitude of problem behaviors (e.g. crying, hitting, biting, self-injury) which can range from mild to severe. Due to the prevalence of maladaptive (problem) behavior in children with ASD, there has been an abundance of research on developing strategies and technologies to reduce or eliminate them (Campbell, 2003; Heyvaert, Saenen, Campbell, Maes, & Onghena, 2014; Matson, & LoVullo, 2008).

One behavior reduction strategy effective at reducing unwanted behavior is differential reinforcement of alternative behavior (DRA; Carr & Durand, 1985; Hagopian, Kuhn, Long & Rush, 2005; Hanley, Iwata, & Thompson, 2001; Vollmer, Roane, Ringdahl, & Marcus, 1999). DRA typically involves withholding reinforcers contingent on problem behavior (i.e. extinction) and providing reinforcers contingent on some appropriate, alternative response (St. Peter Pipkin, Vollmer, & Sloman, 2010). For example, a DRA treatment for hitting that is maintained by attention might involve withholding all attention when the individual engages in hitting, and delivering attention when the individual communicates appropriately, e.g., says “Look at me!” Petscher, Rey, and Bailey (2009) found that DRA is empirically supported to reduce severe problem behavior, and replaces the unwanted response with an appropriate one. In doing so, the individual’s quality of life can be enhanced. DRA may be a more preferred procedure when compared with other decelerative procedures (e.g., extinction alone) due to it providing the individual with an appropriate behavior to earn putative reinforcers. Additionally, DRA aids in the mitigation of extinction-induced side effects (e.g. emotional responding, aggression, variability) (Rolider & Van Houten, 1990).

Although DRA is an effective treatment, there are some variables that can affect the success of the treatment. Research suggests that treatment integrity, the extent to which the treatment was implemented with precision (Peterson, Homer, & Wonderlich, 1982), can affect the success of the treatment (Hoffman & Falcomata, 2014; Marsteller & St. Peter, 2014; St. Peter Pipkin et al., 2010). Poor treatment integrity is often observed when transferring treatment from highly trained professionals working with an individual to caregivers implementing the same procedure (Lieving, Hagopian, Long, & O'Conner, 2004). Threats to treatment integrity include commission and omission errors. Commission errors are all instances in which problem behavior occurs and is reinforced. Omission errors are all instances in which the alternative behavior is not reinforced. Both lapses in treatment integrity can result in relapse of problem behavior that was previously eliminated through DRA. The present study will focus specifically on relapse due to omission errors (e.g., Volkert, Lerman, Call, & Trosclair-Lasserre, 2009; Wacker et al., 2013).

An abundance of basic and translational studies have examined resurgence to model omission errors. Extinction-induced resurgence is typically defined as the reoccurrence of a previously reinforced behavior when a more recently reinforced behavior is placed on extinction (Doughty & Oken, 2008; Lieving et al., 2004; Podlesnik & Kelley, 2014). Figure 1 illustrates resurgence using hypothetical data (Doughty & Oken, 2008). The term resurgence was first coined by Epstein and Skinner (1980) using respondent methods with pigeons. The first phase consisted of presenting a moving dot that was followed response independently by food presentations – keypecking increased in the presence of the dot. In the second phase, food was delivered intermittently but was no longer correlated with the moving dot, therefore putting key pecking on extinction. Key pecking decreased to low rates. Finally, in the third phase, food was withheld completely and key pecks in the presence of the dot recovered to high rates, exhibiting resurgence. Epstein (1983) replicated this study using operant methods, in which key pecking was reinforced then extinguished in the first phase. In the second phase wing flapping was reinforced. The third phase consisted of wing flapping being placed on extinction. Although reinforcement was withheld for both responses, key pecking reemerged. Since these early studies (see also Leitenberg, Rawson, & Bath, 1970; Leitenberg, Rawson, & Mulick, 1975), there are have been numerous basic and translational research studies replicating resurgence using the three-phase procedure (Lattal & St. Peter Pipkin, 2009; Lieving & Lattal, 2003; Reed & Morgan, 2006).

Applied research has also demonstrated resurgence of problem behavior in clinical populations. Volkert et al. (2009) demonstrated this behavioral phenomenon when they implemented functional communication training (FCT), a type of DRA, with three children diagnosed with developmental disabilities. In the first phase, the reinforcer maintaining the problem behavior was delivered contingent on that specific behavior. During the second phase, experimenters trained an appropriate mand (i.e. request) and problem behavior was no longer reinforced. The last phase consisted of reinforcement being withheld for both problem behavior and the trained communicative response. During the last phase, resurgence of problem behavior was demonstrated for 2 of the 3 participants. As the literature expands, researchers continue to replicate these basic methods across a range of species and experimental situations, as well as demonstrating the generality of these effects in clinical populations (Bloom & Lambert, 2015; Lieving et al., 2004; Hoffman & Falcomata, 2014; Kestner & Peterson, 2017; Wacker et al., 2013).

More recent research examined some variables that might influence resurgence of previously eliminated behavior. A further understanding of these variables could help develop recommendations for applied interventions to prevent treatment relapse. Bruzek, Thompson, and Peters (2009) found that responses with longer histories of reinforcement showed a stronger resurgence effect relative to responses with a shorter and more recent history of reinforcement (see also da Silva, Maxwell, & Lattal, 2008; Doughty, Cash, Finch, Holloway, & Wallington, 2010). Similarly, Podlesnik and Shahan (2009) found resurgence was greater in the presence a stimulus associated with higher rates of reinforcement relative to the presence of a stimulus associated with lower rates of reinforcement. Researchers have also found that prolonged (Sweeney & Shahan, 2013) or multiple (Cleland, Foster, & Temple, 2000) exposures to extinction can decrease the magnitude of resurgence. In addition, Bachá-Méndez, Reid, and Mendoza-Soylovna (2007) found that the magnitude of resurgence was influenced by how recently the response was reinforced. These findings have clinical implications in which they portray that a multitude of historical effects can influence resurgence. In most cases, individuals' leaning histories are often complex. Therefore, an understanding of these factors contributing to resurgence can lead to developing more individualized and effective treatments.

Individuals also often have numerous response-class hierarchies in their repertoire with different histories of reinforcement. Response-class hierarchies are made up of responses that occur typically in sequence to produce a specific consequence. Response-class hierarchies consisting of problem behavior occur in sequence from low to high severity (see Lalli, Mace, Wohn, & Livezey, 1995).

Resurgence effects can differ when reinforcement differs among responses within a class hierarchy. When reinforcement is readily available for all responses, low severity responses are more likely to occur. However, as the low or mild severity responses are placed on extinction, more severe responses can emerge to produce reinforcement (Harding, Wacker, Berg, Barretto, Winborn, & Gardner, 2001, Lieving et al., 2004). Lieving et al. demonstrated resurgence within response-class hierarchies. The two participants exhibited response-class hierarchies consisting of various topographies of severe problem behavior. During the initial phase, reinforcement (access to tangible) was available for all topographies of problem behavior that occurred. During the second phase, reinforcers were withheld for disruptive responses, while being delivered for two or more alternative topographies of severe problem behavior (aggression or aggression and cursing). Finally, reinforcers were withheld for the two or more severe responses. During this final phase, both participants engaged in higher rates of the problem behavior previously reinforced in Phase 1, indicating a resurgence effect. They also found that resurgence was specific to behavior that more recently produced reinforcement during Phase 1, a recency effect (see also Bachá-Méndez et al., 2007).

Needless to say, resurgence of problem behavior is a threat to clinical-treatment gains. As more research on resurgence is conducted, researchers examine methods detailing ways to mitigate resurgence. There have been a number of strategies explored by researchers to prepare for fidelity errors (i.e. treatment integrity errors) and decrease the probability of the return of problem behavior. One common strategy is thinning the schedule of reinforcement for the alternative response. This involves systematically leaning the reinforcement schedule of the alternative behavior to ensure this behavior occurs at an appropriate rate and problem behavior continues to not occur. There have been many articles exploring approaches to thinning reinforcement schedules during DRA treatment. These include demand fading (Hagopian, Fisher, Sullivan, Acquisto, LeBlanc, 1998; Lalli, Casey, & Kates, 1995), delays to reinforcement (Fisher, Piazza, Cataldo, Harrell, Jefferson, & Conner, 1993; Fisher, Thompson, Hagopian, Bowman, & Krug, 2000), and multiple schedule arrangements (Fisher, Kuhn, & Thompson, 1998). However, there have been reports in several studies of increases in problem behavior (i.e. resurgence) and disruptions of communication during schedule thinning (Fisher et al. 1993; Hagopian et. al., 1998; Hanley et al., 2001).

In a basic study on resurgence with laboratory rats as subjects, Sweeney and Shahan (2013) sought to examine how reinforcement-schedule thinning influenced resurgence. They examined whether faster target response elimination and less resurgence could be achieved by beginning with a high rate of alternative reinforcement gradually thinning it to eventually remove the low rate during a stimulated treatment relapse. In Phase 1, lever pressing was reinforced on a variable-interval (VI) 45-s schedule. In other words, a reinforcer was delivered on average every 45 s. Subjects were then separated into four groups, rich, lean, thinning, and no reinforcement. In Phase 2, lever pressing was placed on extinction and nose poking was reinforced. For the rich group, poking was reinforced on a VI 10-s schedule throughout Phase 2. For the lean group, poking was reinforced on a VI 100-s schedule. For the thinning group, poking was reinforced on a VI 10-s schedule for the first day of Phase 2 the increased by 10 s each subsequent day. For the control group, the alternative response was never reinforced. In Phase 3, both responses were placed on extinction. They found that low and thinning rates of reinforcement did not result in resurgence compared to high rates of reinforcement of alternative behavior. Low and thinning rates of reinforcement of alternative behavior were seemingly beneficial to mitigating resurgence when eliminating DRA. However, these same rates of reinforcement were less effective at suppressing the target response while DRA remained in place (see also Winterbauer & Bouton, 2012).

Given the limitations of schedule thinning, Lambert, Bloom, Samaha, Dayton, and Rodewald (2015) explored a different strategy to mitigate resurgence of problem behavior. Problem behavior and alternative responses are often in the same responses class (i.e. they occur to produce the same outcome; Harding, Wacker, Berg, Winborn-Kemmrer, Lee, & Ibrhimovic, 2009; Lalli et al., 1995; Winborn, Wacker, Richman, Asmus, & Geier, 2002). Because of this common function, they proposed using serial DRA training (i.e. teaching multiple alternative responses) to mitigate resurgence of problem behavior. Relating to research on response-class hierarchies, they proposed that training multiple alternative responses would expand that individual's response class. Therefore, when faced with challenges (i.e. extinction) a recency effect might occur in which more recently reinforced responses (i.e. alternative responses) would resurge before or in greater magnitude than problem behavior.

In a laboratory study with adult diagnosed with developmental disabilities, Lambert et al. (2015) examined whether programing an intervention involving serial DRA would ensure a variety of appropriate responses in the participants' repertoire, thereby mitigating resurgence of the originally trained response. They used a 2-component multiple schedule (i.e. rapidly switched between the test and control condition) to compare the effects of typical-DRA and serial-DRA training on the magnitude of target-response resurgence. In a control condition, Lambert et al. demonstrated typical resurgence effects in a three phase procedure. In the test condition arranging serial-DRA training, three alternative responses were sequentially trained with only one response being reinforced at a time. When reinforcement was no longer available for all responses the rate of responding for the alternative response was greater than the rate of target responding. Also, during serial-DRA training when reinforcement was withheld, at least one of the alternative responses resurged before the target response. The implications for clinical settings is that serial-DRA training could be a proactive strategy to mitigate resurgence effects by creating a more robust treatment when faced with challenges to DRA treatment, such as breakdowns in treatment integrity.

Lambert, Bloom, Samaha, & Dayton (2017) then replicated Lambert et al. (2015) in a clinical study with two children who exhibited problem behavior. They trained mands (e.g., requests) using FCT. They compared the effect of traditional-FCT to serial-FCT on resurgence of problem behavior using the same methods as Lambert et al. In contrast with previous research with serial-DRA, a primacy effect was observed for both participants. Specifically, the magnitude of resurgence of problem behavior was greater than any mand that was trained after. However, the total amount of responding allocated to the problem behavior was less in the serial-FCT component than the traditional-FCT component. These two studies both have significant implications and reveal greater insight into creating effective methods for reducing response resurgence. However, the potential clinical efficacy of serial-DRA training on resurgence suggests there is a need for more research on this approach (see Shahan & Craig, 2017, for a discussion).

Although Lambert et al. (2015) proposed and demonstrated a promising strategy to reduce resurgence, there are some limitations of the study that must be addressed. First, participants in their study were adults with developmental disabilities, possibly limiting the generality of the results to other populations (see Lambert et al., 2017). Second, all responses in their study were topographically similar, being various kinds of switches. Finally, comparison of resurgence following typical- and serial-DRA conditions was analyzed using a multiple schedule providing the chance for carry-over effects, in which effects transfer across conditions. Due to these limitations, the purpose of the present study was to replicate and extend the findings of Lambert et al.

The present study was conducted in a laboratory with the general purpose of further evaluating resurgence following serial-DRA and typical-DRA training. As in Lambert et al. (2015), the present study employed a translational approach arranging reinforcement and extinction of arbitrary responses. Both the typical-DRA condition and the serial-DRA condition consisted of three phases. In Phase 1 of the control (typical-DRA) condition, the target response was reinforced. In Phase 2, an alternative response was introduced and reinforced while the target response was placed on extinction. In Phase 3, both the alternative response and the target response were placed on extinction. Phase 1 of the serial (serial-DRA) condition looked the same as Phase 1 of the control condition. However, in Phase 2, three separate alternative responses were introduced in sequential order. In Phase 3, all alternative responses and the target response were placed on extinction. Translational models allow for experimental control over external variables that may be present when assessing and treating problem behavior in a clinical application. By utilizing a translational model, the present study provided additional information on how contingencies may affect the persistence of problem and alternative behavior. The results of this study contribute to a further understanding of DRA and lead to more effective behavioral treatments.

Method

Participants

Three children Ernie, 6, Reid 8, and Scott, 9, recruited through The Scott Center for Autism Treatment, participated in the study. All three children had no prior diagnoses. All participants were able to sit for 5-min sessions without engaged in problem behavior (e.g., self-injurious behavior, aggression). All participated followed instructions and were able to engage in the motor response specific to the different responses that were included in the study. All participants had advanced verbal repertoires and attended local schools.

Setting and Materials

Sessions were conducted in treatment rooms at The Scott Center for Autism Treatment. Each room contained a table, two chairs, task materials, data collection materials, preference assessment materials, and a video camera.

Task materials included five different analogue devices: a Montessori Object Permanence Box, a tally counter, a black 4”x6” card, a Learning Resources recording button, and a Leviton 3-way switch (see figure 1). Data collection materials included a clipboard, paper, pen, a timer, and a laptop. Preference assessment materials included edibles specific to each child.

Response Definition and Measurement

The primary dependent variables were the response rates of the five topographically different analogue responses in each session in response per min. The target response for all participants was defined as dropping a ball into the natural wood object permanence box. The alternative responses during the control (C) or serial (S) training were varied across participants (C1 or S1, S2, S3). In other words, the C1 response for one participant, may have been designated as the S2 response for another participant, see Table 1 for these assignments. The alternative responses definitions differed for each analogue device. A response for the tally counter was defined as pushing the button on the clicker with enough pressure for a number to be recorded on the device. A response for the black 4”x 6” card was defined as touching the black card with any part of the hand and lifting the hand off the card at least 3- inches away. A response for the Learning Resources recording button was defined as pushing the green button with enough pressure for the device to emit the recorded sound, which was a clicking sound. A response for the Leviton 3-way switch was defined as pressing the lifted part of the switch with enough pressure to make a sound and for the other side of the switch to lift up.

Additional dependent variables were measured including frequency of emotional responses such as crying, whining, or any other vocalizations above conversational level, with an immediate onset and 3-s offset. The frequency of functionally equivalent responses (i.e. other responses) were also measured. These included asking for, reaching for, or attempting to steal edibles. Frequency of reinforcer deliveries was also measured, defined as each instance the experimenter placed an edible in front of the participant.

Procedure

The participants experienced two conditions, a control (typical DRA) and a serial (serial DRA) condition. Each condition included three phases – reinforcement, elimination, and resurgence phases as shown in Table 2. In the control condition, the target response was reinforced in the reinforcement phase, in the elimination phase, the target response was placed on extinction and an alternative response was reinforced (as typical to traditional DRA with extinction).

In the resurgence phase, both responses were placed on extinction. In the serial condition, the initial reinforcement phase was identical with the control. However, the following elimination phase consisted of reinforcement of three separate alternative responses in sequential order. The final resurgence phase arranged extinction of the target response and all three alternative responses. Conditions were counterbalanced across participants. Each session was five min.

Preference Assessment. At the beginning of every session, the experimenter conducted a multiple-stimulus-without-replacement (MSWO) preference assessment (DeLeon & Iwata, 1996). The two most highly preferred edibles determined by the MSWO were delivered randomly according to the reinforcement schedule for the specific phase.

Training: Before the initial session, the participant was prompted to perform each response using a verbal prompt ("Do this") and model or physical prompt if needed. Edibles were delivered for every target response until the participant performed the target responses ten consecutive times independently (see Liggett, Nastri, & Podlesnik, 2018). Training was also conducted prior to the initial session in which a new alternative response was introduced. This was conducted to ensure the participant was able to emit the response and contact the new contingency (see also Lambert et al., 2015). The participant was physically prompted to perform the currently trained response. Edibles were delivered randomly for every alternative response emitted until the participant performed the given response ten consecutive times independently.

Phase 1: Reinforcement Phase. Prior to the start of a session for both conditions, the target box was placed at the center of the table and an instruction was delivered "You can do as much or as little as you want. Start." During both conditions, the participant was free to manipulate the device at any time. All responses were reinforced on a variable-ratio (VR) 2 schedule. In other words, a reinforcer was delivered on average of every two responses. A VR 2 schedule was used to mimic delivery of reinforcement in the natural environment, in which intermittent reinforcement is more likely than continuous reinforcement. Intermittent reinforcement schedules also increase the likelihood of resurgence in Phase 3 (see also Liggett et al., 2018).

Phase 2: Elimination Phase. During the elimination phase, target responding was placed on extinction in both control and serial conditions and alternative responses were reinforced on a fixed-ratio (FR) 1 schedule. In other words, every response emitted was reinforced, as is typical with DRA (Tiger et al., 2008). Participants were taught to emit the alternative responses the same way as target responding as described above.

In the control condition, participants were trained to emit a single alternative response (C1). In the serial condition participants were trained to emit three separate alternative responses (S1, S2, and S3) in sequential order. That is, participants were trained to emit S1 while the target response is placed on extinction. Once high, stable responding was observed for S1, S1 was placed on extinction (while keeping the target response on extinction) and participants were trained to emit S2. Once occurring at a high, stable rate, S2 was placed on extinction (while keeping the target response and S1 on extinction) and participants were trained to emit S3. Once S3 occurred at a high, stable rate, we then moved to the resurgence phase.

Devices associated with untrained responses were unavailable until trained. Once responding to a given device was trained, that device remained available throughout the rest of phases. For example, only the target box was available in the reinforcement phase for both conditions. However, by the end of the resurgence phase within the control condition, the devices associated with the target response and C1 were available. In the serial condition, the four devices associated with the target response, S1, S2, and S3 were available during the resurgence phase.

Phase 3: Resurgence Phase. In this phase, all responses were placed on extinction. Devices for the target response and C1 were available in the control condition. Devices for the target response, S1, S2, and S3 were available in the serial condition.

Inter-Observer Agreement and Treatment Integrity

A second trained observer collected Inter-observer agreement (IOA) data on all dependent variables; target, alternative, emotional, and other responses. The independent observer collected data simultaneously as the primary observer ran sessions (in a separate room sharing a two-sided mirror with the treatment room) or from a video recording. Agreement scores for each session consisted of dividing the total number of intervals in which the observers recorded the same count by the total number of 10-s intervals and obtaining a percentage. IOA was calculated for a minimum of 33% of sessions for all participants. For Reid, mean agreement for target responding, C1 responding, S2 responding, S3 responding, emotional responding, and other responding were 94.6%, 95.6%, 89.2%, 94.8%, 100% and !00% respectively. For Reid, the tally counter was the S1 response, IOA was not taken on this response due to the measurement of the response only included what the device recorded. For Ernie, mean agreement for target responding, S1 responding, S2 responding, S3 responding, emotional responding, and other responding were 92.2%, 90.9%, 96.7%, 95.2%, 100%, and 99.5%. For Ernie, the tally counter was the C1 response. For Scott, mean agreement for target responding, C1 responding, S1 responding, S2 responding, emotional responding, and other responding were 91.9%, 97.6%, 98.5%, 94.2%, 100%, and 98.9% respectively. For Scott, the tally counter was the S3 response.

Treatment integrity data was also collected for a minimum of 33% of sessions. An independent observer collected data simultaneously with the primary observer or from a video recording. The observer recorded whether (a) the correct condition and phase was assembled correctly, (b) and an MSWO was conducted, (c) the correct instruction was delivered, and (d) the reinforcement schedule was followed as specified in the protocol for each specific condition and phase. Treatment integrity was calculated by the total number of steps implemented correctly divided by the total number of steps and multiplying by 100 to obtain a percentage. Mean percentage of treatment integrity for all participants was 100%.

Results

Table 3 shows the mean reinforcer rates for all conditions. For all participants, the mean rate of reinforcer deliveries was lower in the reinforcement phase with the VR2 schedule than in the elimination phase with the FR1 schedule during both conditions. Figure 3 shows the rates of target and alternative responses across phases for both conditions. A similar pattern for all three participants was observed in the reinforcement and elimination phase. In the reinforcement phase, target responding increased gradually and then stabilized under the VR2 schedule of reinforcement. For Scott, however, reinforcement phase responding was more variable than Ernie and Reid. Therefore, stabilization criteria was met when session data was close to the average of the previous few sessions. The level of target responding was relatively similar for the first and second reinforcement phase for all three participants. Scott's target responding was less variable in the second reinforcement phase compared to the previous.

In the elimination phase, alternative responding exceeded target responding when alternative responding was reinforced on an FR1 schedule for all participants. For all participants, target responding immediately fell to zero or near zero levels when introducing and reinforcing the alternative response(s). Within the serial condition, for all participants, as a new alternative response was introduced and reinforced the previous alternative response immediately fell to zero or near zero levels. Additionally, extinguished responses remained at zero levels

There were idiosyncratic results for all three participants for both conditions within the resurgence phase, suggesting other variables, such as the sequence of conditions were what controlled responding. For Ernie and Reid, who both experienced the serial condition first, greater resurgence was observed in the serial condition than in the control condition. For Scott, who experience the control condition first, greater resurgence was observed in the control condition than the test condition.

Figure 4 shows the means for each participant across all sessions of the resurgence phase. White segments represent alternative responding, and black segments represent target responding. For Reid and Scott, there was greater overall responding in the serial condition. Additionally, for both participants target responding occupied a smaller percentage of total responding in the serial condition than control condition. For Ernie, there was slightly greater overall responding in the control condition, and greater percentage of target responding in the serial condition.

Figure 5 shows the target response rate as a proportion of the reinforcement phase for all three participants. Greater resurgence was observed in serial condition for Ernie and Reid, whereas greater resurgence was observed in the control condition for Scott. For Reid, there was minimal resurgence across both conditions. Ernie displayed the highest levels of resurgence across the participants within the serial condition. Scott displayed the highest levels of resurgence across the participants within the control condition.

Discussion

The purpose of the present study was to replicate and extend Lambert et al. (2015) by comparing the effects of typical-DRA and serial-DRA on resurgence using topographically different responses and children participants. Consistent with the results of Lambert et al., for 2 out of 3 participants serial-DRA increased the total amount of responding observed during the resurgence phase while decreasing the percentage of this responding allocated to target responding. Also, for 2 out of 3 participants, at least one of the previously trained alternative responses resurged before the target response during the serial condition. In contrast with Lambert et al., less resurgence observed in the serial condition for only one participant. Overall, the results of the present study failed to consistently replicate the results of Lambert et al. and suggest that more research should be demonstrated before further application to therapeutic contexts. Although serial-DRA did not mitigate overall resurgence of the target behavior, it did delay resurgence for two participants, in which during this time the participants were engaging in alternative responses. In the natural environment it is likely that one of the trained alternative responses would be reinforced before the individual reverted back to the problem behavior (Lambert et al, 2017). Therefore, this could be a potential method for preventing resurgence of problem behavior when treatment errors do occur.

The results of the present study are more in line with the results of Lambrt et al. (2017). They arranged related procedures applied to socially significant behaviors using FCT. For one of two of their participants, resurgence was less in the serial-FCT condition. Also, serial-FCT increased the total amount of responding observed during extinction for both subjects, while decreasing the percentage of this responding allocated to challenging behavior. However, all other effects demonstrated by Lambert et al. (2015) were either inconsistent or not observed at all (see also Lambert et al., 2017).

For all three participants within the serial condition, the most recently reinforced alternative response had the highest level of resurgence during the first session of the resurgence phase. Also, for all participants within the resurgence phase, allocation of responding was higher on the alternative response(s). These results are in line with previous research that found that the magnitude of resurgence was influenced by how recently the response was reinforced (Bachá-Méndez, Reid, and Mendoza-Soylovna, 2007; Leiving et al. 2014).

Considering other variables that influence resurgence, the different levels of resurgence might have been observed due to the short histories of reinforcement with each response. Research has shown that responses with a longer history of reinforcement show a stronger resurgence effect than responses with shorter and more recent histories of reinforcement (Bruzek, Thompson, & Peter, 2009: da Silva, Maxwell, & Lattal, 2008; Doughty, Cash, Finch, Holloway, & Wallington, 2010). During the serial condition the exposure to reinforcement for each alternative response was very short (i.e. three sessions). Whereas, in the control condition the exposure to the alternative response was longer and more equitable to the target response. Therefore, during the serial condition, the longer history of the target response potentially made it more persistent creating a greater resurgence effect of target responding compared to that of the alternative responses. This effect was also observed in Lambert et al.'s (2017) clinical study, in which in the resurgence phase within both typical- and serial- DRA they observed a primacy effect. Specifically, the problem behavior resurged before any of the alternative responses. The socially significant behavior that was targeted for decrease had a much longer history of reinforcement than the mands that were trained. This long history of reinforcement of socially significant behavior also conflicts with the short histories of reinforcement of arbitrary responses used in translational research. This is something to consider for future research when assessing treatments involving problem behavior.

The reason for disparity in results between Lambert et al. (2015) and the present study is likely due to a number of contributing variables. One explanation for the difference may be due to the population targeted. Lambert et al. included adult participants with developmental disabilities. Their responding was likely slower and more likely to be contingency shaped. In contrast, the participants of the present study were three typical functioning adolescents, who responded quickly. It is also likely that a past history of being in a room with an adult and a task could promote responding to the task due to a past history of following rules and engaging in tasks in the presence of adults.

Another explanation for differences in results may be due to the different types of responses used across the studies. Lambert et al. (2015) used multiple types of switches and an alarm button as response alternatives. These responses were most likely equitable in response effort and took the same amount of time to perform. In contrast, the target response used in the present study might have required more response effort and taken a longer time to perform than the other responses. The target response used had a natural delay in which the participant had to wait for the ball to roll out of the box in order to emit another response. Additionally, the alternative responses were all different from the target response. Doughty, da Silva, and Lattal (2007) showed that extinction of alternative responses that are topographically dissimilar to the target response can produce greater resurgence of the target response than the extinction of alternative responses that are topographically similar to the target response (see also Lambert et al., 2017). Therefore, the topographically dissimilar alternative responses compared to the target response used in the current study may have contributed to the amount of resurgence of the target response.

For all participants in the present study, the magnitude of resurgence was lower in the second condition. This suggests that exposure to extinction in the first condition might have decreased resurgence in the second condition. This aligns with previous research that multiple exposures to extinction can decrease the magnitude of resurgence (Cleland, Foster, & Temple, 2000). Additionally, for both the participants who experienced the serial condition and then the control condition, there were very low levels of resurgence of the target response. The control condition was a replication of a typical resurgence model that has been demonstrated repeatedly (Leitenberg, Rawson, & Bath, 1970; Lattal & St. Peter Pipkin, 2009; Leitenberg, Rawson, & Mulick, 1975; Lieving & Lattal, 2003). This suggests the present findings demonstrated sequence effects, in which the first condition influenced effects of the second condition, regardless of the contingencies tested.

Along with these previous studies, the present study contributes to the body of research investigating the components of DRA that make it an effective behavioral intervention. The present study investigated the effects of training multiple alternative responses on resurgence of problem behavior when treatment is challenged. Findings from all participants suggest that repeated assessment from each condition produced the greatest changes in resurgence between successive conditions. Although the results were not fully consistent with Lambert et al. (2015), they continue to pave the way for further understanding the factors that contribute to resurgence of problem behavior within behavioral treatment. Researchers should consider continuing to use translational methods to model specific human problems in order to facilitate resolution (Mace and Critchfield, 2010). Due to the different results examining serial-DRA as a technique to mitigate resurgence between studies using translational models (e.g. the current study, Lambert et al., 2015) and applied models (Lambert et al., 2017), there is an emphasis on the importance systematic replication of translational findings. With this combination we can further determine to what degree highly controlled experimental settings can be replicated across more natural, less controlled settings. More controlled laboratory studies offer the capacity to examine experimental variables without testing on potentially dangerous clinically relevant behavior (see also Mace et al., 2010).

Nevertheless, all findings provide a better understanding of the processes that contribute to treatment relapse and help aid practitioners in programming for maintenance of behavior change (see Mace & Critchfield, 2010; Pritchard et al., 2014). The techniques to mitigate changes after treatment integrity errors requires further research. The methods used in the current study provide a platform for further understanding relapse processes that can aid in creating more robust and effective behavioral treatments. The outcomes of more robust treatments could potentially lead to more socially significant outcomes and increased independence for clients.

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Table 1

Assignment of Responses

	C1	**S1**	**S2**	**S3**
Reid	Learning Resources recording button	Tally counter	4x6 black card	Leviton 3-way switch
Ernie	Tally counter	Learning Resources recording button	Leviton 3-way switch	4x6 black card
Scott	4x6 black card	Leviton 3-way switch	Tally counter	Learning Resources recording button

Table 2

Three Phases of Two Conditions

	Control Condition	Serial Condition
Phase 1: Reinforcement Phase	Target-response Reinforcement • Target response reinforced • Alternative response absent	
Phase 2: Elimination Phase	Alternative Reinforcement of C1 response • Target response extinguished • C1 response reinforced	Alternative Reinforcement of S1, S2, and S3 responses • Target response extinguished • S1 reinforced • S1 extinguished, S2 reinforced • S2 extinguished, S3 reinforced
Phase 3: Resurgence Phase	Extinction of All Responses • Target response extinguished • C1 extinguished	Extinction of All Responses • Target response extinguished • S1, S2, and S3 extinguished

Table 3

Mean Rate Reinforcer Deliveries in the two Conditions

Participant	**Control Condition** Mean Rate Reinforcer Deliveries			**Serial Condition** Mean Rate Reinforcer Deliveries		
	Phase 1	Phase 2	Phase 3	Phase 1	Phase 2	Phase 3
Reid	14.2	21.3	0	12.5	22.6	0
Ernie	12.7	26.9	0	13.4	27.4	0
Scott	12.4	20.1	0	11.7	28.0	0

Note. Mean reinforcer deliveries per minute for each of three phases in the Control and Test condition for three participants.

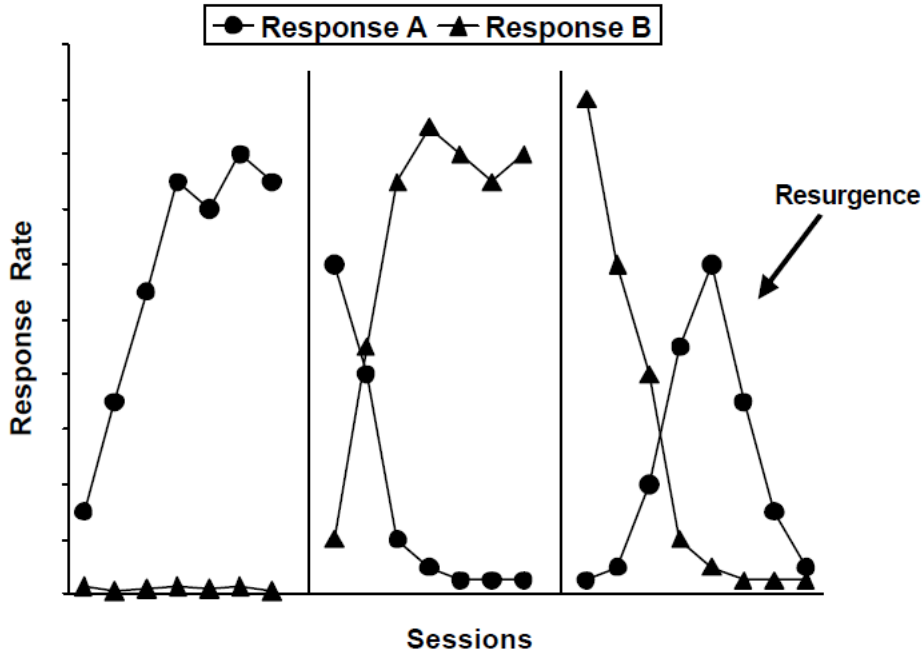

Figure 1. Hypothetical data illustrating resurgence.

Figure 2. From left to right: on top: Montessori object permanence box, tally counter, black 4x6 card; on bottom: Learning Resources recording button, and Leviton 3-way switch.

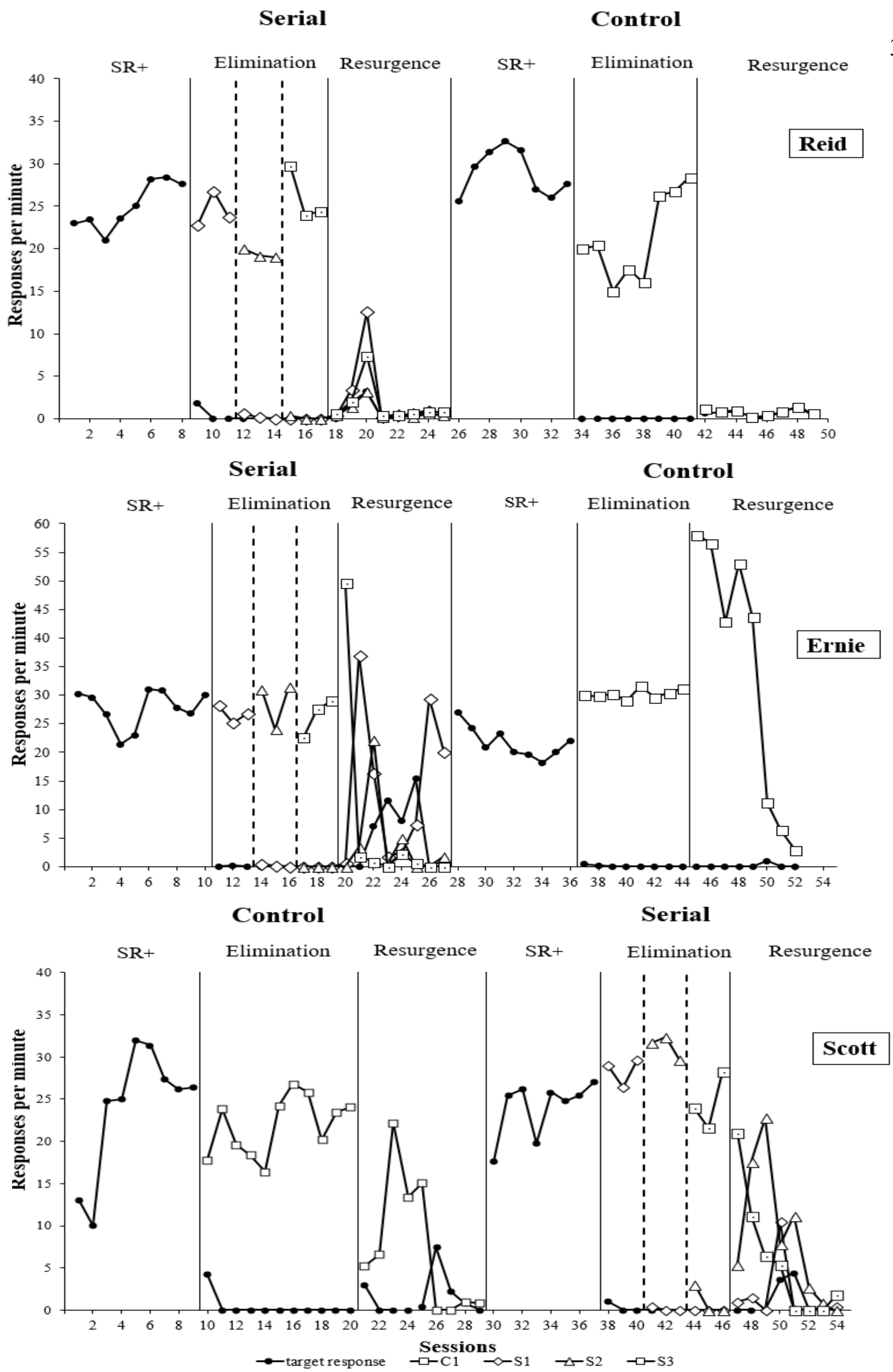

Figure 3. Rates of target and C1, S1, S2, and S3 alternative responding for all participants. Note the x- and y- axes differ across participants.

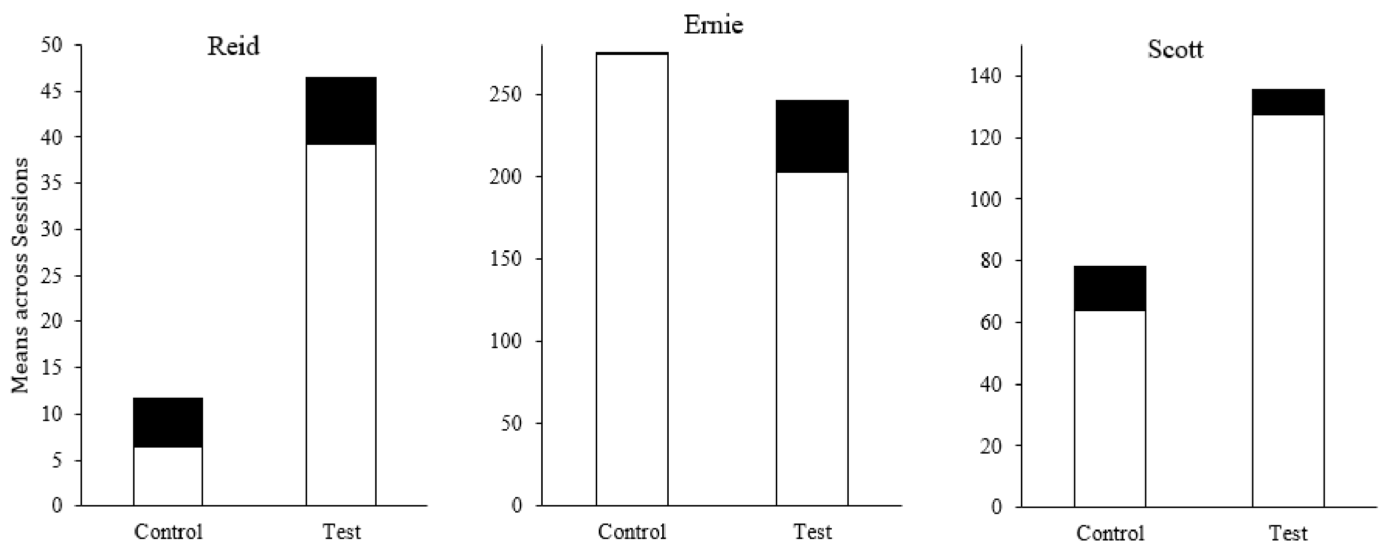

Figure 4. Means across sessions during the resurgence phase for both conditions. White segments represent all alternative responding and black segments represent target responding. Data from the control condition are on the left and data from the test condition are on the right for each participant. Note the y- axes differ across participants.

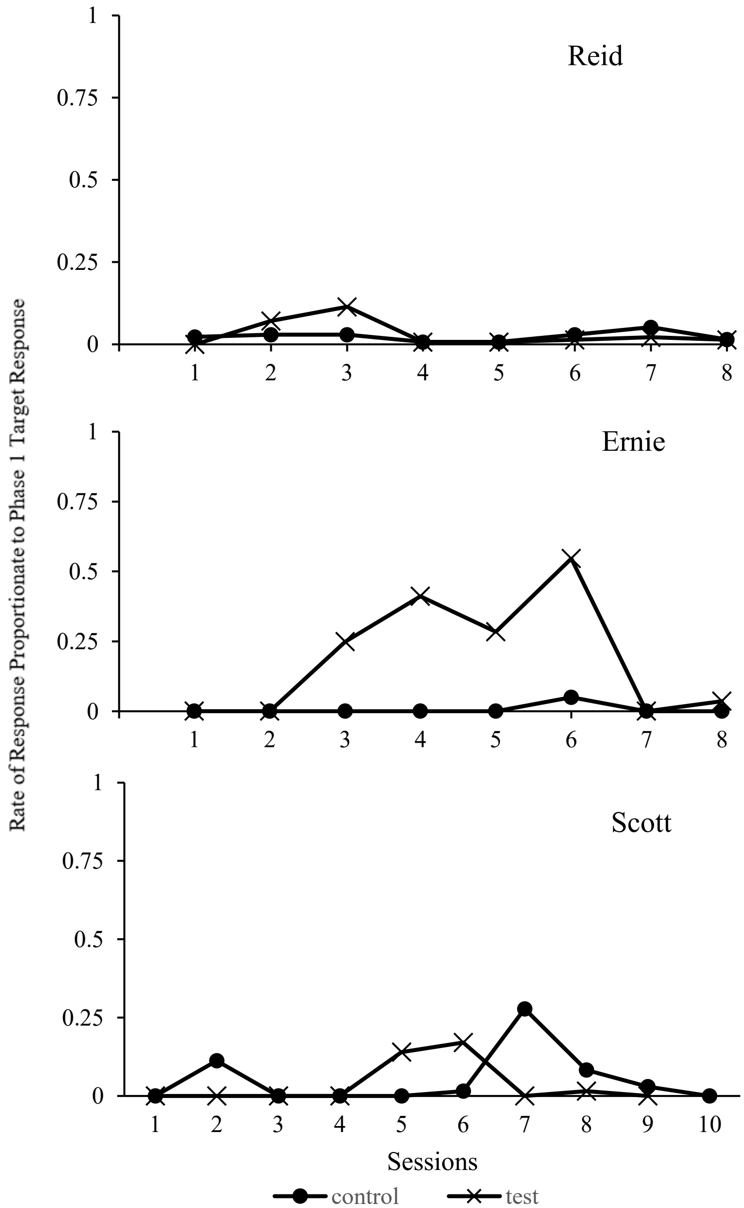

Figure 5. Target-response rate as a proportion of Phase 1 response rates in both conditions. The y-axis is the rate of response that is proportionate to Phase 1 level of target response. The x-axis depicts sessions. The closed circles represent the target response in the control condition and the x symbols represent the target response in the test condition.