HHS Public Access
Author manuscript
J Appl Behav Anal. Author manuscript; available in PMC 2023 April 22.

Published in final edited form as:
J Appl Behav Anal. 2023 April ; 56(2): 282–301. doi:10.1002/jaba.971.

Relapse and its Mitigation: Toward Behavioral Inoculation

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Abstract

Relapse following the successful treatment of problem behavior can increase the likelihood of injury and the need for more intensive care. Current research offers some predictions of how treatment procedures may contribute to relapse, and conversely, how the risk of relapse can be mitigated. This review describes relapse-mitigation procedures with varying levels of support, the quantitative models that have influenced the research on relapse mitigation, different experimental methods for measuring relapse mitigation, and directions for future research. We propose that by viewing the implementation of relapse-mitigation procedures as a means of producing *behavioral inoculation*, clinicians are placed in a proactive and intentional role of exposing their client's behavior to an array of reinforcement and stimulus conditions during treatment with the goal of decreasing the detrimental impact of future treatment challenges.

Keywords

behavioral inoculation; problem behavior; relapse mitigation; renewal; resurgence

Treatment relapse refers to the reemergence of undesirable behavior following successful intervention. Relapse is an unfortunately common behavioral phenomenon that threatens the long-term maintenance of treatment effects for problem behavior (Briggs et al., 2018; Haney et al., 2022; Mitteer et al., 2022; Muething et al., 2020; Muething et al., 2021). As such, there has been a recent increase in the amount of basic, applied, and translational work surrounding the various types of treatment relapse. Wathen and Podlesnik (2018) provided a review of six laboratory models of treatment relapse and described research on several promising mitigation procedures. Since the publication of Wathen and Podlesnik, there have been many more studies investigating relapse. In fact, the *Journal of the Experimental Analysis of Behavior* dedicated an entire Special Issue to relapse in 2020. Thus, the purpose

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Conflict of Interest: The authors have no conflicts of interest to declare.

of this paper is to provide an overview of the common relapse types, discuss recent research on promising relapse-mitigation procedures, and describe the relevance of such procedures for clinicians. Effective mitigation procedures (i.e., procedures that lessen the damaging impact of treatment challenges) may provide a form of behavioral inoculation against relapse. Although relapse might not be consistently preventable, clinicians may expose their client's behavior to a series of environmental conditions that reduce the detrimental impact of future treatment challenges. An additional purpose is to provide suggestions for critical next steps for research within the context of treating severe behavioral challenges (e.g., self-injury, aggression, property destruction) exhibited by individuals with and without intellectual and developmental disabilities.

Common Types of Relapse

The relapse of problem behavior can occur for various reasons. In some cases, one type of relapse may occur in isolation. Alternatively, multiple relapse types might co-occur due to various stimulus changes in the environment that take place simultaneously (Kincaid et al., 2015; Mitteer et al., 2021; Wathen & Podlesnik, 2018). For researchers and clinicians alike, an awareness of the common forms of relapse and the variables that contribute to their occurrence is critical for recognizing how mitigation procedures may inoculate against relapse.

To understand the different types of relapse and when they occur, it is important to first consider the typical approach that researchers use to test for relapse. Researchers usually test for the different types of relapse using a three-phase arrangement (Wathen & Podlesnik, 2018). In Phase 1, target responding (e.g., problem behavior) produces reinforcement, analogous to baseline conditions. In Phase 2, researchers introduce an intervention to eliminate the target response (e.g., extinction of problem behavior, differential reinforcement). Finally, in Phase 3, researchers modify the stimulus or reinforcement conditions. The recurrence of the previously eliminated or suppressed target response during Phase 3 defines relapse, whereas continued low levels of the target response define treatment maintenance (i.e., successful relapse mitigation). Phase 3 relapse tests are characterized as treatment challenges (Mitteer et al., 2021; Vollmer et al., 1999; Wacker et al., 2011), and the manner in which stimulus or reinforcement conditions are changed in Phase 3 defines the type of relapse. Researchers can demonstrate effective relapse mitigation by showing lower levels of Phase 3 target responding in a test condition or group compared to relatively higher levels of target responding in a control condition or group.

Resurgence

Resurgence is a form of relapse that occurs when reinforcement for the alternative response in Phase 2 is discontinued or worsened in Phase 3 (Cleland et al., 2001; Epstein, 1985; Lattal et al., 2017). As a clinical example, problem behavior may result in reinforcement in Phase 1 (i.e., baseline), be extinguished in Phase 2 while an alternative response results in reinforcement (i.e., treatment), and continue to result in the absence of reinforcement in Phase 3 while the alternative response is also placed on extinction (Perrin et al., 2022). Recurrence of previously eliminated problem behavior in Phase 3 would constitute resurgence.

Clinicians should be particularly interested in resurgence-mitigation procedures because commonly prescribed interventions for problem behavior (e.g., differential reinforcement of alternative behavior [DRA]) are susceptible to resurgence. For example, resurgence may occur during reinforcement schedule thinning (Volkert et al., 2009) or during extinction of the alternative response (Leitenberg et al., 1970). Consider that in the natural environment, caregivers may intermittently withhold reinforcement for an alternative communication response, particularly if individuals emit the alternative response at high rates or at times when the caregiver is unable to deliver the reinforcer. Recent studies have suggested that resurgence occurs during 76%–91% of cases during reinforcement schedule thinning following functional communication training (FCT; Briggs et al., 2018; Kranak & Falligant, 2021; Mitteer et al., 2022; Muething et al., 2021).

Reinstatement

Reinstatement is a form of relapse that occurs when the reinforcer delivered in Phase 1 and withheld in Phase 2 is delivered in a response-independent or response-dependent manner in Phase 3 (Franks & Lattal, 1976; Miranda-Dukoski et al., 2016; Podlesnik & Shahan, 2009; Reid, 1958). Reinstatement is the return of the target response in Phase 3, such as an increase in the response rate relative to the rates observed during Phase 2. As a clinical example of response-independent reinstatement, following a baseline in which problem behavior is reinforced and a subsequent treatment in which problem behavior is extinguished, the reinforcer from baseline may be provided independently of responding (e.g., a passerby saying “Hi” to someone with attention-maintained problem behavior) or following non-targeted behavior (DeLeon et al., 2005; Falcomata et al., 2013). Response-dependent reinstatement may be especially relevant to clinicians because it can occur during lapses in treatment integrity following successful extinction of problem behavior. Response-dependent reinstatement occurs when the reinforcer is delivered contingent on the target response in Phase 3. For example, following treatments that include DRA, a caregiver may engage in a commission error in the form of delivering the functional reinforcer contingent on problem behavior (e.g., Kranak et al., 2022; Mitteer et al., 2021; Pritchard et al., 2014).

Renewal

Renewal is evaluated under conditions where the stimulus context of Phase 2 (treatment) is changed in Phase 3 (Kimball & Kranak, 2022; Podlesnik et al., 2017; Saini & Mitteer, 2020). Renewal is the reemergence of a previously suppressed target response during Phase 3 when the context changes, but the contingencies remain unchanged from Phase 2. The typical testing arrangement for renewal includes the following progression. In Phase 1, reinforcement is contingent on target responding in Context A. Phase 2 typically occurs in Context B where target responding results in extinction. Finally, Phase 3 occurs in the original Context A or in a third Context C where target responding remains on extinction. As a clinical example, following baseline (i.e., Phase 1) and treatment of problem behavior (i.e., Phase 2), one may introduce a new therapist or transition treatment from a clinic to a home or school (i.e., Phase 3).

Clinicians should consider that the contexts associated with the historical reinforcement of problem behavior establish the opportunity for renewal. That is, problem behavior that first results in reinforcement in one context (e.g., home), may result in extinction during intervention in a different context (e.g., clinic), and may then increase when returning to the original context (home) or when transitioning to a novel context (e.g., school). Thus, an understanding of the procedures that researchers have shown to mitigate renewal can help clinicians ensure that treatment effects generalize across context changes. Renewal has also been found to be prevalent in the outpatient and inpatient treatment of problem behavior. Muething et al. (2020) found renewal with 67.2% of participants in their outpatient clinic and that it occurred during 42.3% of context changes (i.e., new therapists or new therapy rooms). Falligant et al. (2021) found renewal with 59% of participants in their inpatient program and that it occurred during 24% of context changes (see also Haney et al., 2022; Mitteer et al., 2022).

Sequential and Nonsequential Renewal—In standard (i.e., sequential) ABA and ABC renewal progressions, a return to Context A or progression to Context C, respectively, occurs only after target-response elimination occurs in Context B. However, recipients of behavioral services do not often maintain uninterrupted access to therapeutic contexts (Context B). More often (e.g., during outpatient clinical therapy), clients are exposed to a few hours of therapy at a time, during appointments of a fixed duration that occur nonconsecutively. As a result, therapeutic progress in Context B is established gradually and is frequently interspersed with re-exposures to Context A before optimal outcomes are achieved (e.g., clients go home between clinic-based therapy sessions).

For this reason, sequential-renewal preparations may not be a realistic (or appropriate) model for assessing the impact of mitigation efforts in outpatient applied settings. For example, Craig et al. (2019) demonstrated that renewal of lever pressing by rats was differentially impacted by intermittent re-exposures to Context A during conditions in which target responding was eliminated in Context B. That is, frequent and repeated (i.e., “nonsequential”) alternations between Contexts A and B exacerbated renewal relative to a more traditional, “sequential” progression (Sullivan et al., 2018). To the extent these findings are generalizable to humans in applied settings, their implications should be considered in clinical practice and during future research on renewal mitigation.

Spontaneous Recovery

Spontaneous recovery occurs when a previously extinguished response recurs following the later reintroduction of extinction (Lerman et al., 1999; Thrailkill et al., 2018). As a clinical example, following a baseline of reinforcement (Phase 1) and extinction of problem behavior (Phase 2), there may be a break in sessions (e.g., a long weekend or holiday; referred to as the retention interval) before resuming extinction (Phase 3) of problem behavior. Research on spontaneous recovery implies that previously treated problem behavior may return following the passage of time away from the therapeutic context and associated contingencies. However, the extent to which treatment relapse in applied contexts is affected by spontaneous recovery has yet to be explored.

Quantitative Theories and a Narrative Account of Relapse

Context Theory, Behavioral Momentum Theory (BMT), and Resurgence as Choice (RaC) are narrative accounts or formal quantitative theories aimed at describing the behavioral processes presumed to underlie different forms of relapse (Bouton, 1993; Shahan & Craig, 2017; Shahan & Sweeney, 2011). Understanding these frameworks and models can allow predictions of how subtle changes to stimulus and reinforcement conditions may increase or decrease the likelihood and magnitude of relapse (Fisher et al., 2022). Accordingly, these frameworks and models have sparked systematic lines of research examining the clinical utility of procedures designed specifically to mitigate relapse (e.g., Fisher et al., 2019; Fisher, Greer, Fuhrman et al., 2018; Fuhrman et al., 2016; Greer et al., 2020; Greer, Shahan, et al., 2022). These lines of research are imperative, given recent calls from applied researchers and clinicians for answers concerning relapse mitigation (Kestner & Peterson, 2017; Ringdahl & St. Peter, 2017). Indeed, even the Board Certified Behavior Analyst Test Content Outline (6th ed.) from the Behavior Analyst Certification Board (BACB) includes an item pertinent to relapse mitigation: *H.5 Plan for and attempt to mitigate possible relapse of the target behavior* (BACB, 2022), suggesting that clinicians will soon be responsible for understanding the content reviewed herein. Although providing complete descriptions of each content area is beyond the scope of the present paper, we will provide brief reviews of the theories that have informed both validated and promising approaches to successful relapse mitigation.

Context Theory

The foundation of Context Theory suggests that the learning that occurs during extinction is specific to the context in which extinction occurs (see Greer & Shahan, 2019; Shahan & Craig, 2017; Wathen & Podlesnik, 2018, for further discussion). According to Context Theory, *context* can refer to any aspect of the environment capable of controlling behavior, such as visual and auditory stimuli, internal stimulus states and discriminated changes relevant to motivation, reinforcement contingencies, and the passage of time (Bouton, 1993, 2019). For example, according to Context Theory, decreases in problem behavior resulting from FCT with extinction implemented in the clinic may not generalize to other contexts (e.g., to home or school) because the learning that occurred in the clinic is specific to the unique stimulus context associated with treatment (e.g., specific therapists who worked with the individual, the room in which treatment sessions occurred). Accordingly, researchers have focused on increasing the similarity between treatment and non-treatment contexts to mitigate relapse (Haney et al., 2021; Todd et al., 2012). As a narrative (i.e., non-quantitative) account, the predictions offered by Context Theory are difficult to quantify, and thus, have been viewed as challenging to falsify (Craig & Shahan, 2016; Greer & Shahan, 2019).

Behavioral Momentum Theory

BMT is a collection of quantitative models describing the variables that contribute to behavioral persistence in the face of disruption (e.g., resistance to extinction; Nevin et al., 2017; Podlesnik & Shahan, 2009, 2010; Shahan & Sweeney, 2011; Thrailkill et al., 2018). The theory is a metaphorical extension of Newton's second law of physics (Craig et al., 2014; Nevin et al., 1983; Nevin & Grace, 2000). In terms of relapse, BMT treats environmental changes that produce relapse, such as periods of extinction for the alternative response (i.e., resurgence tests) and changes in context (i.e., renewal tests), as disruptors that affect the persistence of behavior. In its most basic form, BMT asserts that higher rates or magnitudes of reinforcement in a given stimulus context produces behavior that is more resistant to change (i.e., more persistent) in that same context relative to lower rates or magnitudes of reinforcement. As an illustration, Fisher et al. (2019) found that dense baseline schedules of reinforcement were associated with higher magnitudes of resurgence of severe problem behavior than were lean baseline schedules of reinforcement when therapists placed functional communicative responses (FCRs) on extinction. Although studies have shown that BMT predictions fall short of describing relapse phenomena, the model has spurred several lines of research (described below) on clinically viable approaches to relapse mitigation, and conceptual aspects of the model remain useful for directing some aspects of clinical practice (Craig & Shahan, 2016; Fisher, Greer, Craig, et al., 2018; Fisher, Greer, Fuhrman, et al., 2018; Lambert et al., 2016; Mace et al., 2010; Trump et al., 2021).

Resurgence as Choice

Another quantitative model of relapse, RaC, suggests that resurgence can be explained by the same variables that influence choice via the matching law (Greer & Shahan, 2019; Herrnstein, 1961; Shahan et al., 2020; Shahan & Craig, 2017). For example, consider that Borrero et al. (2010) found that participants allocated responding toward either problem behavior or socially appropriate behavior based on the relative rates of reinforcement available for those two response options, and their data were well described by the predictions of the generalized matching law (Baum, 1974). RaC makes similar predictions about the allocation of behavior in choice arrangements between a target response (e.g., property destruction) and an alternative response (e.g., the FCR). As the relative value of the alternative response decreases (e.g., due to a lower rate, quality, or magnitude of reinforcement), the probability of observing target responding increases. The theory states that when reinforcement is unavailable for a response, such as when clinicians program extinction for problem behavior during FCT, the current value of that response is partly determined by the history of reinforcement for that response. Another layer of the model suggests that recent histories of reinforcement are weighted more heavily than more distant reinforcement histories (i.e., the Temporal Weighting Rule; Devenport & Devenport, 1994). In other words, reinforcement provided months or even years in the past for a response can still impact current behavior, but recent histories of reinforcement for a response matter more. Accordingly, RaC suggests that when extinction is in place for both the target and alternative response, the allocation of behavior is governed by the current value of both response options, which depends in part on the recency of reinforcement for each response. Unfortunately, the model suggests that even though a clinician might arrange extinction for problem behavior, the relative value of problem behavior will increase when the current reinforcement conditions worsen for an alternative response (e.g., during reinforcement schedule thinning for the FCR). In these situations, RaC predicts that resurgence of problem behavior may occur. Although research on the RaC model is just beginning, Greer and Shahan (2019) recently outlined a few intervention strategies based on the model that may decrease the likelihood of resurgence (see also Shahan & Greer, 2021 and Falligant et al., 2022).

Behavioral Inoculation Against Relapse

Context Theory, BMT, and RaC suggest unique approaches to relapse mitigation. However, researchers interested in relapse phenomena acknowledge that general strategies designed to promote the generalization and maintenance of behavior change may also show promise as routine relapse-mitigation procedures. In other words, many of the relapse-mitigation procedures we discuss in this paper comport with long-established strategies that fit well in the behavior-analytic conceptual system. For example, Podlesnik et al. (2017) outlined several strategies provided by Stokes and Baer (1977), such as programming common stimuli and training sufficient exemplars that can be adapted and leveraged to promote the mitigation of relapse in the form of renewal.

Exploring the mitigation of relapse is a relatively new frontier for behavior-analytic researchers (e.g., Lambert et al., 2015; Winterbauer et al., 2013). Evaluating the effects of relapse mitigation through basic and translational research with arbitrary responses provide researchers with low-cost opportunities to test for the boundary conditions of relapse mitigation procedures, or the conditions under which relapse mitigation procedures fail. Furthermore, studying relapse mitigation through basic and translational research also allows experimenters to remove many of the potential risks associated with examining relapse mitigation in applied settings with socially significant behavior while also allowing for the isolation (or controlled combination) of different relapse types (see Greer, Fisher, et al., 2022, for discussion). Accordingly, researchers have engineered many relapse-mitigation procedures to address distinct forms of relapse. For example, multiple-context training (discussed below) is an approach to mitigating renewal. However, this procedure is unlikely to be successful at mitigating other forms of relapse, such as reinstatement or resurgence (Bernal-Gamboa et al., 2020). Therefore, it may be advantageous for clinicians to employ multiple mitigation strategies to help prepare their client's behavior for a dynamically changing environment, which may present treatment challenges consistent with multiple forms of relapse triggered by interrelated events or by distinct events occurring simultaneously (Mitteer et al., 2021; Wathen & Podlesnik, 2018).

Although we acknowledge that relapse mitigation (i.e., decreasing the detrimental impact of treatment challenges) is an appropriate priority for current research, we also understand that relapse prevention might be the ideal goal for many clinicians. Unfortunately, we do not yet have the technology or evidence to provide recommendations for how to eliminate the likelihood of relapse. Furthermore, the ambitious goal of relapse prevention, if attainable, will likely require the implementation of relapse-mitigation procedures for both client and caregiver behavior (e.g., Mitteer et al., 2018, 2021). Considerably more relapse-mitigation procedures have been evaluated for client behavior than for caregiver behavior, highlighting a vitally important gap in our knowledge of how best to improve the durability of common treatments for problem behavior.

However, our current understanding of relapse and its mitigation affords us better prediction and management of relapse than in the past. Additionally, recent research has identified promising relapse-mitigation procedures that lessen the detrimental impact of future treatment challenges. In the case of severe problem behavior, even moderate reductions in recurred problem behavior could have a robust impact on the health and wellbeing of clients and stakeholders (Thrailkill et al., 2018). For example, caregivers may be less apt to reinforce recurred problem behavior if its rate remains low. The same may be true when it comes to other response parameters (e.g., lower intensity) and for different topographies of the same response class (e.g., a less destructive response). We believe that these represent important targets for relapse mitigation, as do a variety of variables that likely affect caregiver behavior, especially ones that encourage caregiver persistence of correct treatment implementation in the face of challenging situations.

Although we cannot prevent relapse, clinicians can use proven relapse-mitigation procedures to prepare their client's behavior for the many challenging conditions shown to produce relapse. To that end, we suggest that behavior analysts consider using a range of procedures to promote *behavioral inoculation*[1] against treatment relapse. To paraphrase Merriam-Webster's Dictionary (n.d.), in medicine, to inoculate is to introduce a material, such as an antibody or antigen, to prevent disease. Similarly, The Centers for Disease Control and Prevention and other medical dictionary definitions state that an inoculation, which is a term that is often synonymous with vaccination or immunization, produces protections against a disease, produces disease resistance, or boosts immunity to a specific disease (CDC, 2021; Severynse, 2002). Researchers in related disciplines, such as clinical psychology, have adopted the term inoculation to describe the effects of preventive interventions, such as the mitigation of future stress (Bouchard et al., 2012; Jay & Elliott, 1990).

We adopt the term *behavioral inoculation* to distinguish relapse mitigation that occurs during a treatment challenge from the act of arranging aspects of the assessment and treatment process to produce that result. In this view, behavioral inoculation is what is achieved by the programming of successful relapse-mitigation procedures to produce later relapse mitigation. By viewing the implementation of relapse-mitigation procedures as a means of producing behavioral inoculation, clinicians are placed in the proactive role of arranging environmental conditions intentionally for their clients, modifications that may lead to successful outcomes during later planned and unplanned treatment challenges.

Relapse-Mitigation Procedures

What follows are descriptions and analyses of specific relapse-mitigation procedures. For each mitigation procedure, we have included (a) summaries of relevant basic and applied research, (b) implications for clinical work in applied settings, and (c) critical next steps for future research. Our classification of relapse-mitigation procedures is organized not by relapse type, but rather by the different features of the treatment process that clinicians

[1]Weinsztok and DeLeon (2022) recently used the term "behavioral 'inoculation'" to describe the benefits of manipulating reinforcer magnitude and quality to decrease the likelihood of relapse when treatment integrity errors occurred. These and other behavior-analytic researchers have used similar terminology to describe a general tendency for target responding to remain suppressed during periods of disruption when treatment procedures are enhanced via effective relapse-mitigation procedures.

might target with the mitigation procedures (e.g., enhancing stimulus control, manipulating response effort of the target and alternative responses, increasing the duration of treatment). We begin our discussion by introducing mitigation procedures relevant to baseline (i.e., Phase 1), followed by procedures that clinicians might introduce during treatment (i.e., Phase 2). Next, we examine mitigation procedures that clinicians may consider during treatment challenges (i.e., Phase 3). Finally, we discuss mitigation procedures relevant to specific treatment challenges. It is important to note that some mitigation procedures have more empirical support than others. For example, the applied literature on more prolonged exposure to treatment has not shown this approach to mitigate relapse in the clinic, at least with the durations of treatment evaluated to date. However, we include such literature in our review to better equip clinicians with insight on the varying degrees of empirical support for each approach.

Manipulations of Baseline Response Rate

To our knowledge, little research exists on manipulating baseline response rates as a strategy to mitigate relapse, but several researchers have examined the role of baseline response rate on the magnitude of resurgence (e.g., da Silva et al., 2008; Reed & Morgan, 2007; Sweeney & Shahan, 2013a; Winterbauer et al., 2013) and reinstatement (Doughty et al., 2004). Accordingly, we will provide a summary of such findings and then discuss the clinical implications of how clinicians and applied researchers might manipulate the rate of target responding in baseline to mitigate relapse.

Researchers investigating the impact of differential baseline rates of target responding have consistently found that higher rates of target responding in baseline tend to result in higher magnitudes of resurgence and reinstatement relative to lower rates of target responding in baseline. For example, in an experiment in which rats pressed levers for food, Reed and Morgan (2007) alternated differential reinforcement of low rate (DRL) schedules with differential reinforcement of high rate (DRH) schedules within a multiple schedule in Phase 1. In Phase 2, the experimenters then exposed target responding to identical fixed interval (FI) 60-s schedules in both components of the multiple schedule until response rates were identical across the two components. Target responding following the DRH component resurged more during Phase 3 extinction than did responding following the DRL component. However, the experimenters noted that reinforcement rates between the DRH and DRL schedules differed, which provides an alternative explanation for their findings. Additionally, Podlesnik et al. (2017) conducted retrospective analyses of data obtained by Bouton et al. (2011) and Podlesnik and Shahan (2009) on renewal with nonhuman animals. Neither of the reviewed studies examined baseline response rates on renewal specifically, but the two studies presented their findings in such a way that allowed Podlesnik et al. to reanalyze the prior findings with respect to baseline response rates. Podlesnik et al. found that higher target response rates in baseline often resulted in higher magnitudes of renewal.

Data from these nonhuman animal studies suggest that future applied research on the impact of baseline response rates on multiple forms of relapse is warranted. One important methodological control needed in such studies is to equate the rate of reinforcement delivery in baseline when response rates are manipulated (i.e., differential reinforcement rates need to be ruled out as a potential confound). When that level of control can be accomplished, future research on the use of DRL and DRH schedules, similar to those arranged in Reed and Morgan (2007), will allow for a greater understanding of how response rate impacts relapse, independently of reinforcement rate (see Bonner & Borrero, 2018, for discussion on the use of DRL schedules for the treatment of problem behavior).

Duration of Baseline (Phase 1) and Treatment (Phase 2)

BMT and RaC both predict that longer durations of treatment, or more specifically, longer exposures to extinction, reduce the magnitude of resurgence. Conceptually, it seems logical that a longer history of reinforcement for problem behavior before treatment would translate to increased magnitudes of relapse. Similarly, it also makes conceptual sense that a longer history of reinforcement for appropriate behavior, and in turn, greater durations of exposure to extinction for problem behavior in treatment, would provide behavioral inoculation against future relapse. Nonetheless, years of research examining baseline and treatment duration on relapse have produced mixed results.

Duration of Baseline—In a group design, Winterbauer et al. (2013) found that 12 sessions of baseline reinforcement for rats' target responding produced more resurgence than did 4 sessions. Todd et al. (2012) also found more responding for a group of rats that received 12 sessions of reinforcement for target responding in baseline relative to a group with 4 sessions of baseline reinforcement when they tested for ABC renewal.

To our knowledge, researchers have yet to compare different durations of baseline on the magnitude of relapse during treatment challenges with socially significant behavior. Even so, in a simulated caregiving context with undergraduate college students, Bruzek et al. (2009) found that three sessions of baseline reinforcement for target responding resulted in more resurgence in Phase 3 relative to a single session of baseline. In contrast, Lambert, Pericozzi, et al. (2020) and Smith and Greer (2022) both failed to detect differences in the magnitude of resurgence following differential exposure to baseline durations with humans and arbitrary responses. However, it should be noted that Smith and Greer did find lower levels of resurgence when they combined shorter Phase 1 durations with longer Phase 2 durations.

Although not yet evaluated with clinical populations, collectively, these data suggest that clinicians should consider avenues to treatment that limit the duration of baseline (inclusive of all conditions associated with the reinforcement of problem behavior such as a functional analysis; Henry et al., 2021; Jessel et al., 2020; Saini et al., 2020). Proactive or preventive approaches can also potentially shorten the exposure of problem behavior to reinforcement before treatment (Fahmie et al., 2018; Fahmie & Luczynski, 2018). Future research is needed to validate these approaches to relapse mitigation.

Duration of Treatment—Research with nonhuman animals provides mixed results concerning the impact of longer exposures to treatment on resurgence. Pioneering research from Leitenberg et al. (1975) found that 27 days of extinction for target responding following baseline generated less resurgence than 9 or 3 days of extinction with rats. In Shahan et al. (2020), five groups of subjects experienced 3, 7, 15, 23, or 31 days of

DRA before a resurgence test. Longer exposure to DRA during treatment produced small, but consistently less resurgence in the treatment challenge. Notably, the study by Shahan et al. is the most extensive evaluation of treatment duration on resurgence conducted to date, and less extensive evaluations with nonhuman animals have failed to detect similar results (Nall et al., 2018; Trask et al., 2018; Winterbauer et al., 2013), suggesting that the effects of increased treatment duration on resurgence are small and difficult to demonstrate experimentally.

Evaluations with humans have also demonstrated mixed effects of short vs. long exposure to DRA during treatment (Fisher, Greer, Fuhrman, et al., 2018; Greer et al., 2020; Greer, Shahan, et al., 2022; Smith & Greer, 2022; Wacker et al., 2011). In an investigation on the effects of both baseline and treatment durations, Smith and Greer (2022) found that 20 min of DRA in Phase 2 contributed to less resurgence in Phase 3 than 5 min of DRA in a computer task with human participants. Regarding socially significant behavior, Wacker et al. (2011) examined the resurgence of severe problem behavior exhibited by eight children diagnosed with developmental disabilities. After reinforcement for problem behavior during a functional analysis (i.e., baseline of the traditional three-phase resurgence arrangement), experimenters alternated periods of FCT with extinction (Phase 2) and extinction for all behavior (Phase 3). Resurgence decreased across successive extinction challenges, suggesting that additional exposures to FCT may reduce resurgence. However, other research (e.g., Kestner, Diaz-Salvat, et al., 2018) has shown that magnitudes of resurgence sometimes decrease during repeated within-subject resurgence tests (e.g., Redner et al., 2022), so it is unclear whether the longer exposures to FCT decreased resurgence in the Wacker et al. study or simply repeated exposure to resurgence testing decreased resurgence (see Shahan et al., 2020, for additional data relevant to repeated resurgence testing).

Fisher, Greer, Fuhrman, et al. (2018) examined resurgence of severe problem behavior exhibited by four individuals diagnosed with autism spectrum disorder. Each participant experienced two FCT conditions with 15 and 5 sessions of exposure to each. The experimenters also provided a lean schedule of reinforcement for problem behavior during baseline and a lean schedule of reinforcement for the FCR during FCT. Longer exposure to FCT produced less resurgence than the relatively short exposure to FCT, but Fisher et al. noted that they could not necessarily attribute the reduced levels of resurgence to only the increased duration of FCT because they also manipulated the schedules of reinforcement for problem and communicative behavior.

In Greer et al. (2020), participants experienced three sessions of FCT in a long-exposure condition for every one session of FCT in a short-exposure condition. Their results showed no differences in resurgence of problem behavior between the conditions across six participants. A follow-up study by Greer, Shahan, et al. (2022) corrected some of the methodological limitations of Greer et al. (2020) but was similarly unable to detect a mitigation effect.

Beyond resurgence, researchers have rarely investigated the impact of differential exposure to treatment (i.e., amount of extinction or DRA) on other forms of relapse, such as renewal, reinstatement, and spontaneous recovery with humans or nonhuman animals. As an exception, Bouton et al. (2011) compared 4 and 12 sessions of extinction training on the renewal of lever pressing with rats. Tripling the number of extinction sessions did not significantly weaken AAB renewal effects. Given the relative scarcity of research concerning the effects of exposure to treatment for renewal, reinstatement, and spontaneous recovery, we identify this as a critical area for future research. Clinically, it would be helpful to know if longer exposures to treatment in one context decrease the likelihood or magnitude of renewal when treatment outcomes are tested in a new context or in a context previously associated with reinforcement for problem behavior. If longer exposure to treatment does not weaken renewal, researchers and clinicians could focus their efforts on procedures that have shown promise with mitigating renewal (e.g., multiple-context training; Bernal-Gamboa et al., 2020).

Clear recommendations regarding the appropriate duration of treatment cannot be provided at this time. The clinical implications for increased treatment duration are similarly uncertain. Additional investigation on this topic appears less promising than other relapse-mitigation procedures. Still, prolonged exposure to treatment is unlikely to be harmful, and clinicians should ideally tailor the duration of treatment to clients' relative responsiveness to treatment. Researchers looking to answer related questions on the effects of increased treatment duration on relapse would do well to adopt a laboratory approach with arbitrary responses and to examine highly disparate treatment durations (see Lambert, Pericozzi, et al., 2020, for a model). Moreover, researchers may consider asking questions about treatment duration from a slightly different lens. For instance, perhaps researchers could vary the duration of treatment after problem behavior reaches a desired reduction criteria (e.g., 80% decrease from baseline).

Reinforcement-Schedule Manipulations

In general, higher rates of reinforcement for the target response in baseline and higher rates of reinforcement for the alternative response during treatment lead to greater relapse during treatment challenges than lower rates of reinforcement (Nevin & Shahan, 2011). Given that most standard-of-care assessment and treatment procedures include dense (e.g., fixed-ratio [FR] 1) schedules of reinforcement, clinicians may be inadvertently promoting relapse. As such, manipulating the rate of reinforcement during baseline and in treatment is another mitigation procedure to consider in the discussion of behavioral inoculation against relapse.

Baseline—Low-rate reinforcement schedules for target responding in baseline result in less relapse than following high-rate reinforcement schedules (e.g., Kuroda et al., 2016; Podlesnik & Shahan, 2009; 2010). For example, for pigeons that pecked keys for food, Podlesnik and Shahan (2009) programmed two conditions with two alternating but equal reinforcement schedules with one condition including an overlaid fixed-time (FT) reinforcement schedule that increased the reinforcement rate. Baseline response rates were lower; resistance to extinction was greater; and resurgence, renewal, and reinstatement were more likely in the condition with added response-independent reinforcement.

Fewer studies have isolated the effects of baseline reinforcement rates on relapse with humans, and those that exist have been limited to investigations of resurgence. Fisher, Greer, Fuhrman, et al. (2018) observed lower levels of resurgence in a condition that included low-rate, relative to high-rate, baseline variable-interval (VI) reinforcement schedules. However, the study included other experimental manipulations (i.e., phase duration and reinforcement rate differences during treatment) that confounded the isolation of baseline reinforcement rate. In a follow-up study, Fisher et al. (2019) isolated the effects of baseline reinforcement rate with VI schedules on the resurgence of problem behavior with seven participants. The researchers observed resurgence with only four of seven participants, but when resurgence occurred, it was lower in the condition associated with low-rate reinforcement in baseline.

Future investigators should similarly isolate the effects of baseline reinforcement rate from other experimental manipulations (e.g., phase duration, reinforcement rate for the alternative response during treatment) and on other forms of treatment relapse (i.e., renewal, reinstatement, spontaneous recovery) with clinically relevant populations. Although leaner schedules of baseline reinforcement may mitigate relapse, they often produce higher and more variable rates of problem behavior (e.g., Fisher et al., 2019; Vollmer et al., 1998). The risks associated with higher and more variable rates of problem behavior during baseline may offset the later benefits of relapse mitigation. More complex reinforcement schedules that decrease both reinforcement and response rate (e.g., DRL schedules) in baseline may mitigate relapse more than either individual procedure without producing high rates of problem behavior. Taken together, the findings to date are promising but suggest that additional research is needed before recommending leaner reinforcement schedules in baseline during clinical application.

Treatment—Many studies with nonhuman animals indicate that low-rate reinforcement schedules for alternative responding during treatment result in less resurgence than high-rate reinforcement schedules (e.g., Cançado et al., 2015; Craig et al., 2016b; Leitenberg et al., 1975; Sweeney & Shahan, 2013a). For example, in a study by Craig et al. (2016), rats' lever presses resulted in cocaine reinforcement during baseline (i.e., Phase 1). During treatment (i.e., Phase 2), cocaine was discontinued, and the experimenters programmed high-rate, low-rate, or no food reinforcement for an alternative response across three groups of rats. High-rate food reinforcement resulted in the fastest elimination of target responding, but it also resulted in the most resurgence during the treatment challenge. In fact, no resurgence was observed among the groups that received low-rate or no food reinforcement during treatment.

Studies investigating low-rate reinforcement schedules for the alternative response during treatment have demonstrated the mitigation of renewal (Pritchard et al., 2016), resurgence (Nevin et al., 2016; Pritchard et al., 2014), and reinstatement (Nevin et al., 2016; Pritchard et al., 2014) with children receiving treatment for problem behavior. For example, Nevin et al. (2016; Experiment 2) programmed rich and lean reinforcement schedules across conditions during treatment, and the experimenters observed lower levels of resurgence and reinstatement following lean reinforcement schedules during treatment. Although several studies have demonstrated the mitigating effects of lean reinforcement schedules for alternative behavior during treatment, some studies have not replicated this finding (Craig

& Shahan, 2016; Cançado & Lattal, 2013; Fujimaki et al., 2015; Winterbauer & Bouton, 2010). For example, Fujimaki et al. (2015) conducted a series of experiments to examine the effects of treatment reinforcement rate for an alternative response on resurgence in pigeons. Across all experiments, the researchers programmed equal reinforcement rates in baseline, rich or lean rates of reinforcement during treatment, and extinction for both responses during the resurgence test. All experiments produced inconsistent levels of resurgence across groups.

Therefore, additional research is needed, preferably in the form of well-controlled group studies, before clinicians consider manipulating reinforcement rates for the alternative response during treatment as a mitigation procedure. For example, researchers should investigate the differential impact of manipulating reinforcement rates on each type of relapse (i.e., renewal, reinstatement, spontaneous recovery). Researchers could also identify interaction effects with other experimental variables (e.g., phase duration, design type, response rate) that have differed across studies that have reported discrepant findings (see Fujimaki et al., 2015, for a discussion).

Reinforcement of the target response during treatment also affects relapse. For example, Kranak et al. (2022) found that establishing a history of reinforcement for target responding during treatment potentially inoculated target responding against reinstatement. In a proof-of-concept translational study with adult human participants pressing buttons on a computer task for points, the experimenters first reinforced target responding in baseline and then introduced DRA during treatment. After responding adapted to the DRA contingency, the experimenters introduced a brief concurrent FR 1 FR 1 schedule of reinforcement for target and alternative responding. When target responding reemerged, the experimenters then exposed target responding to a progressive-ratio schedule in the presence of a distinct stimulus (i.e., purple colored background) while alternative responding continued to produce reinforcement on an FR 1 schedule. The progressive-ratio training provided a reinforcement history for target responding in which the likelihood of reinforcement for that response diminished in the presence of the distinct stimulus, encouraging a bias toward alternative responding. In Phase 3, the experimenters introduced a response-dependent reinstatement test analogous to DRA implemented with occasional treatment integrity errors of commission by arranging probabilistic schedules of reinforcement for the target response (i.e., intermittent reinforcement of the target response; St. Peter Pipkin et al., 2010). Reinstatement was weakened when the discriminative stimulus associated with the progressive ratio training from treatment was present relative to when it was absent. Although it might seem counterintuitive to reinforce target responding after it has been suppressed, the results from Kranak et al. suggest the need for future research on exposing target responding to unique histories of reinforcement during treatment as behavioral inoculation against relapse (see also Shahan et al., 2020).

Discrimination Training

Discrimination-training procedures enhance an organism's ability to distinguish the conditions under which reinforcement is and is not available for target and alternative responding. In general, relapse-mitigation procedures involving discrimination training have produced promising results. Furthermore, these procedures are relevant to clinicians as many of them can be easily incorporated into current standards of care for treating problem behavior.

Discriminative Stimuli—Using discriminative stimuli during DRA can mitigate resurgence of problem behavior. Betz et al. (2013) presented a discriminative stimulus (S^D) during the reinforcement component of a multiple schedule to signal the availability of reinforcement for the FCR and presented an alternative discriminative stimulus during extinction components. When increasing the extinction component duration from 1 to 4 min, problem behavior did not resurge for any participant. Fuhrman et al. (2016) further compared levels of resurgence during extended periods of extinction following both multiple schedule (mult) FCT and traditional FCT. During mult FCT, experimenters signaled the availability of reinforcement with one stimulus (S^D) and the unavailability of reinforcement with a separate stimulus (S^Δ). No such discriminative stimuli were used during traditional FCT. Following treatment, the experimenters programmed a series of 10-min extinction sessions that either included the S^Δ from mult FCT or no such stimuli. Less resurgence occurred when the S^Δ was present than when it was absent. In a similar evaluation, Fisher et al. (2020) found that including the S^Δ during an extinction challenge reduced resurgence by a mean of 81% across participants. Despite these promising findings in the clinic, Browning and Shahan (2021) found contrary results with rats. Procedural differences across the studies may be responsible for their discrepant findings, and a closer examination of possible contributing variables appears to be an important next step in this line of research.

Given that renewal is a stimulus-control phenomenon, it seems logical to investigate whether programming the discriminative stimuli from treatment (e.g., the S^Δ) mitigates renewal. Greer et al. (2019) transferred programmed stimuli from multiple and chained schedules of reinforcement during FCT from therapists (Context B) to a caregiver (Context A) and saw immediate low levels of problem behavior despite the caregiver's history of delivering reinforcement for problem behavior. The findings of Greer et al. replicated those of an earlier study by Fisher et al. (2015) who examined the rapid transfer of treatment effects across settings and therapists afforded by the programming of similar discriminative stimuli. Future lines of targeted research are needed to examine the mitigating effects of treatment-related discriminative stimuli on renewal, and researchers should consider experimental designs that allow for renewal testing with and without discriminative stimuli present.

Extinction Cues.: Cues (i.e., stimuli) associated with extinction of the target response during treatment can mitigate reinstatement, renewal, and spontaneous recovery (Bernal-Gamboa Nieto, et al., 2017, Bernal-Gamboa et al., 2021; Gámez & Bernal-Gamboa, 2019; Nieto et al., 2017, 2020; Trask & Bouton, 2016; Willcocks & McNally, 2014). For example, Nieto et al. (2020) examined the impact of extinction cues on ABC renewal with rats in a within-subject design. After reinforcing lever pressing in Context A, the experimenters introduced an intermittent, brief audible tone while lever pressing was placed on extinction in Context B. Next, experimenters tested for renewal in Context C where extinction remained in effect for lever pressing while the extinction cue (i.e., the intermittent tone) either did or did not continue. Renewal was mitigated by the presentation of the extinction cue in Context C. According to Context Theory, the similarity of the stimulus conditions between Contexts B and C afforded by the continuation of the extinction cue mitigated renewal. Other researchers have found similar results with spontaneous recovery and reinstatement (e.g., Bernal-Gamboa et al., 2021).

Including an extinction cue (e.g., an audible tone) and presenting S^{Δ} materials (e.g., a colored card on a lanyard) share common features as relapse-mitigation procedures. Experimenters pair both stimuli with extinction for target responding during treatment, and both stimuli are only intermittently present during treatment before being presented during the relapse test. However, one potentially important difference is that experimenters alternate the S^{Δ} with the S^{D} (e.g., during mult or chained FCT) to establish discriminated alternative responding before presenting the S^{Δ} in the relapse test. Extinction cues may function similarly, but researchers do not typically arrange explicit discrimination training when using extinction cues like they do when using S^{Δ} materials. Both approaches to relapse mitigation align well with the strategy of programming common stimuli described by Stokes and Baer (1977).

Alternation of DRA and Extinction During Treatment—Findings from several studies with nonhuman animals (e.g., Sweeney & Shahan, 2013) suggest that alternating between unsignaled periods of (a) differential reinforcement of the alternative response and (b) extinction for the target response and alternative response during treatment mitigates resurgence during treatment challenges (Schepers & Bouton, 2015; Shahan et al. 2020; Trask et al., 2018). Said another way, cycling alternative reinforcement "on" and then "off" across days during treatment mitigates resurgence. For example, Shahan et al. (2020) compared resurgence across groups of rats following either constant DRA or cycled on/off DRA during treatment. Subjects from the On/Off group experienced DRA on odd-numbered days and extinction for both responses on even-numbered days. The experimenters found that subjects from the On/Off group continued to exhibit some resurgence throughout treatment on days in which extinction was programmed for both responses (i.e., "off" days). Nevertheless, the experimenters observed less resurgence in the On/Off group relative to the Constant DRA group across comparable exposures to treatment.

To account for the findings from their experiment, Shahan et al. (2020) proposed an extension of RaC called Resurgence as Choice in Context (RaC^2), which suggests that the reduced resurgence exhibited by the On/Off group resulted from learning that reinforcement was unavailable for the target response, regardless of reinforcer availability for the alternative response. This learning across "on" and "off" sessions produced a growing bias away from the target response in treatment that continued during resurgence testing. Therefore, RaC^2 predicts that the on/off cycling of DRA during treatment facilitates a learned discrimination regarding the source and availability of reinforcer deliveries (i.e., the alternative response alone produces reinforcement but not always) that biases responding toward the alternative response, which then carries into the resurgence test (see Shahan et al., 2020, for further details).

Researchers have yet to investigate on/off cycling of DRA during clinical treatment as a relapse-mitigation procedure. However, the results from Wacker et al. (2011) can be interpreted as an applied evaluation of on/off cycling of DRA for mitigating resurgence. During long-term treatment with FCT throughout an average of nine months, the experimenters exposed problem behavior and FCRs to intermittent extinction approximately every two months, similar to the on/off cycling of DRA procedures from Shahan et al. (2020). Resurgence tended to decrease in magnitude across successive tests; however, as noted previously, it is difficult to determine whether reductions in resurgence resulted from the alternation of FCT and extinction tests or simply from prolonged exposure to FCT.

Further research in this area is clearly warranted. Research suggests that extinction is often a necessary component of DRA-based interventions, and alternative responding is often subjected to increased extinction exposure when treating problem behavior (e.g., Greer et al., 2016; Hagopian et al., 1998). Although cycling between DRA and extinction upon the introduction of treatment may not be a practical approach to relapse mitigation in some cases (e.g., those in which extinction bursts of severe problem behavior may occur during "off" sessions; Lerman & Iwata, 1995), it is currently unclear whether the timing of such cycles must occur early in treatment. This approach may be more feasible later in treatment, but the practicality of such an approach will need to be determined by future research before being adopted therapeutically.

Expanding the Operant Class

Certain mands may be more effective at capturing the attention of listeners, but the response most likely to be effective during any given occasion varies and may be difficult to predict. Individuals who have been taught (a) multiple potentially effective mands and (b) to cycle through those mands without problem behavior when initial responses contact extinction are more likely to recruit reinforcement than those who have not. By having a repertoire of multiple appropriate mands, individuals may be more likely to obtain reinforcement, avoid contacting extinction, and thereby preclude resurgence (Bloom & Lambert, 2015; Lambert et al., 2015).

Neely et al. (2020) and Banerjee et al. (2022) demonstrated how topographically distinct mands (i.e., English, Spanish) can differentially impact the probability of reinforcement from a local verbal community proficient in only one of the two languages. When the receptive repertoire of therapists "shifted" from the language trained during FCT to the alternative language, resurgence of problem behavior occurred. When the researchers adapted FCT to include mands in both languages (Neely et al., 2020) and provided training on alternative-response variation (Banerjee et al., 2021), resurgence no longer occurred because the alternative response continued to produce reinforcement.

Other studies have investigated whether training multiple alternative responses mitigates resurgence under conditions in which reinforcement is unavailable for all responding. The findings from such studies have been mixed (e.g., Lambert et al., 2017), and the mechanisms responsible for resurgence mitigation when it does occur are not well understood (Diaz-Salvat et al., 2020; Lambert, Pericozzi, et al., 2020; Lattal et al., 2019). Therefore, whether such approaches mitigate resurgence is currently unclear (Fuhrman et al., 2021).

Common Methods of Expansion—Another minimally tested assumption is that training multiple mands during FCT should ensure varied responding during lapses in treatment fidelity. Unfortunately, hierarchies often emerge amongst functionally equivalent responses (e.g., Borrero & Borrero, 2008; Dracobly & Smith, 2012; Fritz et al., 2013; Herscovitch et al., 2009; Langdon et al., 2008; Smith & Churchill, 2002), and participants often engage in near-exclusive responding toward a single preferred topography when multiple alternatives exist (e.g., Harding et al., 2009). As such, there exist different approaches for establishing multiple mands in treatment.

Lag Schedules.: Falcomata et al. (2018) taught two participants to engage in five topographically distinct mands. Then, they used lag-5 reinforcement schedules to establish and maintain variability across these topographies. As specific mands contacted extinction, different mands consistently emerged to the near exclusion of problem behavior. Although this effect was uncontrolled (experimentally), it lends credibility to the premise of operant expansion as a resurgence-mitigation procedure (see also Adami et al., 2017).

Serial Training.: Serial training is a process by which researchers teach and then subsequently extinguish newly acquired alternative responses in sequential fashion, until all desired topographies have been established, reinforced, and eliminated (except for the final topography). Like lag schedules, serial training appears to promote variability during periods of extinction (Gratz et al., 2018; Lambert et al. 2015; Lambert et al., 2017; Lambert, Pericozzi, et al., 2020; Lattal et al., 2019; Mechner & Jones, 2011; Reed & Morgan, 2006; Schmitz et al., 2019).

Value-Altering and Response-Effort Manipulations

By this point, we have considered relapse-mitigation procedures with early empirical support, but there are additional strategies that have yet to be formally tested. For example, RaC predicts that interventions aimed at increasing the value of the alternative response (e.g., manipulating the quality of reinforcement for that response) should mitigate resurgence. Similarly, RaC suggests that interventions focused on increasing an individual's bias toward the alternative response, such as decreasing response effort for the alternative response, should also mitigate resurgence (Greer & Shahan, 2019).

RaC suggests that resurgence may occur during any condition in which the relative value of the target response increases in relation to that of the alternative response. Thus, any intervention aimed at increasing and maintaining the value of the alternative response while simultaneously suppressing the value of the target response should mitigate resurgence during treatment challenges. Recall, RaC posits that value is determined by current and historical reinforcement histories for each response. Fortunately, researchers have developed successful strategies for increasing response allocation toward appropriate behavior, even when target behavior continues to produce reinforcement (e.g., Athens & Vollmer, 2010; Briggs et al., 2019; Davis et al., 2018; Kunnavatana et al., 2018).

In a now seminal study, Athens and Vollmer (2010) found that arranging reinforcement to be more immediate, of a higher quality, or of a longer duration following appropriate behavior than following problem behavior increased the likelihood of appropriate behavior relative to problem behavior. Based upon RaC, similar manipulations should decrease resurgence. For example, if the rate of reinforcement for the alternative response decreases (e.g., during programmed reinforcement schedule thinning), but the magnitude or quality of that reinforcer favors the alternative response, resurgence could be weakened (Weinsztok & DeLeon, 2022). Future research should investigate the effects of such arrangements on renewal, reinstatement, and spontaneous recovery.

Manipulating response effort may also help mitigate relapse. Clinicians should consider selecting relatively low-effort communicative responses, such as a card touch or card exchange during FCT to increase the likelihood that the client will allocate responding toward low-effort communication and away from relatively high-effort problem behavior (DeRosa et al., 2015; Horner & Day, 1991; Tiger et al., 2008; see also Randall et al., 2021). If clinicians wish to instead teach a vocal communication response, the response should be simple (e.g., one or two-word request) and not complex. Alternatively, increasing the response effort for problem behavior may have similar effects (Zhou et al., 2000). Still, little is currently known about using response-effort manipulations as a relapse-mitigation procedure.

To our knowledge, Wilson et al. (2016) is the only published study that has examined the role of response effort on relapse. Experimenters examined the resurgence of arbitrary responses exhibited by six children. In baseline, the experimenters reinforced removing a ball from a cardboard box and placing it in a bin across the room (the target response) with tokens on a VI 10-s schedule. During treatment, the experimenters reinforced a lower-effort response of placing the ball in a bin located immediately next to the participant. Finally, experimenters placed all responding on extinction in the resurgence test. Wilson et al. observed minimal resurgence of the more-effortful response for all six participants when the alternative response required less response effort. However, the researchers did not compare resurgence in this condition to one in which response effort was equated across the options, limiting their findings. We encourage researchers to examine the role of response effort, particularly for the alternative response, on relapse prevalence and magnitude.

Alternative Methods for Eliminating the Target Response

Most of the mitigation procedures we have considered thus far have relied on DRA. However, clinicians may incorporate supplemental procedures such as punishment or differential reinforcement of other behavior (DRO) to bolster the effects of DRA-based interventions (Greer et al., 2016). Such manipulations may also contribute to behavioral inoculation against relapse.

Punishment—In nonhuman animal evaluations, pairing punishment of the target-response with extinction during DRA serves to reduce (or eliminate) subsequent resurgence (e.g., Kestner et al., 2015; see Kuroda et al., 2020, for differential effects of punishment on resurgence and renewal). However, the resurgence-mitigating effects of punishment have been unreliable with humans (e.g., Bolivar & Dallery, 2020; Houchins et al., 2020; Kestner, Romano, et al., 2018; Okouchi, 2015). There may be clinically relevant circumstances in which arranging punishment for target responding mitigates resurgence, but those circumstances are not well understood. Additional work on this topic is needed. Clinicians should carefully consider the ethics of including or not including a punishment component in their intervention plan, as well as follow existing guidelines on the use of punishment-based procedures (e.g., Ethics Code for Behavior Analysts; BACB, 2020)

Differential Reinforcement of Other Behavior—Substituting DRA contingencies with DRO contingencies during response elimination (treatment or Phase 2 procedures) often increases the magnitude and the immediacy of resurgence (e.g., Doughty et al., 2007; Romano & St. Peter, 2017). Accordingly, DRA appears to be the favorable option when it comes to relapse mitigation. However, Craig et al. (2018) suggested that the effects of DRO and DRA on resurgence may not always be so straightforward. Pigeons pecked keys in a chained DRO DRA schedule. The magnitude of resurgence following this signaled DRO DRA progression suppressed resurgence to a greater degree than the DRA-only arrangement. Such progressions are commonly employed by clinicians during discrimination training when treating problem behavior (e.g., Greer et al., 2016), and following function-based punishment in individualized level systems (e.g., Hagopian et al., 2002). For example, in some cases, clinicians employ DRO contingencies (i.e., as opposed to extinction only) during S^{Δ} components of mult FCT. Once the omission criterion is met, the clinician initiates the reinforcement component, displays the S^{D}, and the alternative response produces the functional reinforcer. Such clinical arrangements might not only reduce problem behavior during treatment, but they might also mitigate resurgence.

Multiple-Context Training

Investigations with nonhuman animals have shown that applying extinction for the target response in multiple treatment contexts can mitigate renewal (Bernal-Gamboa et al., 2017, 2020). For example, Bernal-Gamboa et al. (2020) investigated the effects of multiple-context training on ABA renewal with college students playing a computer game. Experimenters first reinforced the target response (i.e., mouse clicks) in Context A. Next, half the participants experienced extinction for target responding in Context B, whereas the other half experienced extinction in three separate contexts (Contexts B, C, and D). Finally, all participants experienced the renewal test in Context A. Participants who experienced extinction in multiple contexts exhibited less renewal in the return to Context A relative to participants who experienced extinction only in Context B. Other findings suggest that multiple-context training may better mitigate ABC renewal than ABA renewal (Bernal-Gamboa, Nieto, et al., 2017), but it is worth noting that ABA renewal is often more robust than ABC renewal, which may account for any diminished mitigation effect produced by this approach across the two progressions.

Generalization training across multiple stimulus contexts is often recommended as standard of care (Falcomata & Wacker, 2013; Neely et al., 2018; Stokes & Baer, 1977), but there is a shortage of research on the relapse-mitigating effects of multiple-context training in clinical application. Strategies for promoting generalization, such as training sufficient stimulus exemplars, sequential modification, and multiple-exemplar training (Stokes & Baer, 1977; Stokes & Osnes, 1989), share considerable overlap with the notion of multiple-context training. Incorporating multiple clinicians across different controlled settings before deploying treatment to novel stakeholders (e.g., new teachers) and settings (e.g., a new classroom) is a promising strategy for mitigating renewal.

Beyond confirming that multiple-context training indeed mitigates renewal of problem behavior, future research should determine the ideal number of training contexts to mitigate renewal, the necessary disparity in contextual stimuli, and the impact of programming similar discriminative stimuli across contexts (e.g., Fisher et al., 2015). Finally, applied researchers might also consider testing the effects of multiple-context training within a nonsequential renewal arrangement (Craig et al., 2019).

Increasing the Similarity Between Treatment and Non-Treatment Settings

The magnitude of ABA and ABC renewal depends on the disparity between the treatment context (i.e., the extinction context; Phase 2) and the renewal test context (i.e., Phase 3) (Podlesnik & Miranda-Dukoski, 2015; Todd et al., 2012). Increasing the similarity between treatment and non-treatment settings has potential to mitigate the renewal of socially significant behavior (Haney et al., 2021; Kelley et al., 2018; Kimball & Kranak, 2022). Kelley et al. (2018) observed less renewal of inappropriate mealtime behavior when a caregiver (Context A) sat next to a trained therapist implementing escape extinction (Context B) relative to conditions in which caregivers were absent during treatment. Haney et al. (2021) gradually introduced caregivers into therapy sessions in the treatment context, introduced stimuli from home into these sessions, and/or projected an image from the home in the therapy room. These stimulus changes were found to mitigate renewal.

Increasing the similarity between treatment and generalization settings was suggested by Stokes and Baer (1977) as programming common stimuli. However, Neely et al. (2018) found that only 29% of FCT studies reported using this tactic. Given the potential benefit of relapse mitigation, clinicians should consider adopting, and reporting on, this strategy more widely. Future research should replicate the procedures reported by Kelley et al. (2018) and Haney et al. (2021) across various settings (e.g., schools), topographies of problem behavior, and perhaps in nonsequential renewal designs.

Considerations for Treatment Challenges (Phase 3)

Researchers have primarily introduced the mitigation strategies reviewed thus far before initiating Phase 3. But a small collection of studies suggest that some mitigation strategies are effective when implemented during treatment challenges. For instance, Bouton and Trask (2016) and Marsteller and St. Peter (2014) showed that pairing alternative-response extinction with NCR was an effective strategy for mitigating resurgence. These collective results suggest that one potential method for mitigating resurgence may be to transition from response-dependent to comparatively dense response-independent schedules of reinforcement during the maintenance stages of an intervention (i.e., after desirable response patterns have been established) when a clinician might expect the resurgence of problem behavior. It might be favorable to consider investigating the relapse-mitigation effects of providing continuous, noncontingent access to the functional reinforcer during anticipated treatment challenges (e.g., transition to a novel setting) in clinical settings because response-independent schedules, such as FT schedules of reinforcement, may increase the likelihood of adventitious reinforcement of problem behavior resulting in response-dependent reinstatement (DeLeon et al., 2005). Given the dearth of research in this area, future research is warranted to further explore potential mitigation strategies that clinicians may save for the latter stages of treatment or for situations that they may expect relapse to occur.

Behavioral Inoculation Against Multiple Forms of Relapse

Although conceptually distinct, relapse phenomena such as renewal and resurgence may be inseparable in practice from a clinician's point of view. For example, clinicians may find it challenging to determine if relapsed behavior returned due to the worsening of reinforcement conditions for the alternative response (i.e., resurgence) or a change in context (i.e., renewal). This possibility is supported by the extant relapse literature because programmed consequences have been shown to serve both antecedent (discriminative) and consequent (reinforcing) functions, either of which may impact relapse (e.g., Bouton & Trask, 2016; Trask & Bouton, 2016). Clinicians should also consider that relapse can be amplified when alternative-response extinction is paired with discriminable contextual changes (e.g., Alessandri & Cançado, 2020; Kincaid et al., 2015; Podlesnik et al. 2019). In other words, simultaneous context changes that often result in renewal may increase the magnitude of resurgence. For example, a novel therapist (i.e., change in context) may accidentally withhold reinforcement for an appropriate alternative response. Furthermore, the environmental conditions that produce resurgence and renewal also set the stage for the possibility of response-dependent reinstatement (e.g., if caregivers inadvertently reinforce the relapsed response; Liggett et al., 2018; Mitteer et al., 2021). In summary, clinicians may encounter challenges to treatment that result in the co-occurrence of multiple forms of relapse. Therefore, it is likely that efforts to mitigate one form of relapse (e.g., resurgence) are likely to be most effective when treatments are also designed to protect against other forms of relapse (e.g., renewal and reinstatement).

Conclusion

Researchers across the basic–applied continuum have demonstrated the generality of relapse phenomena across various responses, stimulus conditions, and populations (e.g., Browning & Shahan, 2018; Hoffman & Falcomata, 2014; Williams & St. Peter, 2020). This has been critical for determining the conditions under which relapse occurs so that clinicians might better understand the variables that influence treatment durability (e.g., Perrin et al., 2022). Nevertheless, now is the time for researchers to shift their focus to effective and practical relapse-mitigation procedures.

Clinicians should prepare for inevitable challenges to treatment success (Mace & Nevin, 2017; Wacker et al., 2011) by anticipating potential relapse at different points over time (Bouton, 2014). The high prevalence of resurgence and renewal of problem behavior support this assertion (e.g., Briggs et al., 2018; Muething et al., 2020). With the goal of relapse prevention, clinicians can insert relapse-mitigation procedures as safeguards into their clients' behavior intervention plans to increase the likelihood of behavioral inoculation against future relapse. A focus on behavioral inoculation does not imply a lack of confidence in the efficacy of traditional behavior-intervention strategies. The environments that shape and maintain behavior are ever changing. Behavioral inoculation can be thought of as ways to proactively combat the detrimental impact of future treatment challenges brought about by a dynamic environment. Clinicians wishing to incorporate strategies that promote behavioral inoculation against relapse should seek training on designing and implementing such procedures.

Our review identified many possible relapse-mitigation procedures, but there is much work to be done. Researchers in clinical settings should consider initiating lines of research concentrated on replicating findings from studies conducted in the laboratory but with socially significant behavior. For example, researchers have repeatedly demonstrated the renewal-mitigating effects of multiple-context training with nonhuman animals (e.g., Bernal-Gamboa et al., 2017), but little research exists on the efficacy of this mitigation procedure in clinical settings (cf., Fisher et al., 2015). Applied researchers may also need to occasionally move outside of their comfort zone of using within-subject experimental designs to detect mitigation effects, given that relapse has been shown to change in repeated within-subject tests (e.g., resurgence; Kestner, Diaz-Salvat, et al., 2018; Redner et al., 2022). Changes in relapse during repeated tests in a within-subject evaluation are problematic for detecting a mitigation effect. Finally, like Wathen and Podlesnik (2018), we too suggest continued refinement of the narrative accounts and quantitative models of relapse (e.g., Context Theory, BMT, and RaC). The development of these theories has driven relapse research forward. Notwithstanding those critical areas of research, improving the generalization and maintenance of behavior change (Baer et al., 1968; Stokes & Baer, 1977; Stokes & Osnes, 1989) has been a tenet of applied behavior analysis since its inception. Adopting the notion of behavioral inoculation against relapse represents an attempt to realize these early goals for the field.

Acknowledgments

Grants 2R01HD079113 and 5R01HD093734 from the National Institute of Child Health and Human Development provided partial support for this work.

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