Published in final edited form as:

Behav Processes. 2015 July ; 116: 43–49. doi:10.1016/j.beproc.2015.04.015.

Renewal, Resurgence, and Alternative Reinforcement Context

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Abstract

Resurgence, relapse induced by the removal of alternative reinforcement, and renewal, relapse induced by a change in contextual stimuli, are typically studied separately in operant conditioning paradigms. In analogous treatments of operant problem behavior, aspects of both relapse phenomena can operate simultaneously. Therefore, the purpose of this study was to examine a novel method for studying resurgence and renewal in the same experimental preparation. An alternative source of reinforcement was available during extinction for one group of rats (a typical resurgence preparation). Another group experienced an operant renewal preparation in which the extinction context was distinguished via olfactory and visual stimuli. A third group experienced alternative reinforcement delivery in the new context, a novel combination of typical resurgence and renewal preparations. Removal of alternative reinforcement and/or a change in context induced relapse, relative to an extinction-only control group. When alternative reinforcement was delivered in a novel context, the alternative response was less persistent relative to when extinction of the alternative response took place in the context in which it was trained. This methodology might be used to illustrate shared (or distinct) mechanisms of resurgence and renewal, and to determine how delivering alternative reinforcement in another context may affect persistence and relapse.

Keywords

operant conditioning; lever press; resurgence; renewal; operant renewal; relapse

1. Introduction

Extinction, or removal of reinforcement that was previously contingent upon an operant response, can be an effective means of response suppression. On the other hand, the suppression of an operant response during extinction can be transient, and relapse of the response can occur when conditions change. For example, operant renewal is a relapse phenomenon that occurs when contextual stimuli present during the extinction of an operant

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response are changed. In animal studies of renewal, contextual stimuli can consist of a flashing versus steady operant chamber illumination (Podlesnik & Shahan, 2009), a distinctive scent (e.g., Bouton et al., 2011), stripes on the side of the operant chamber (e.g., Todd et al., 2012), and/or a combination of multiple such olfactory and visual stimuli (Bouton et al., 2011; Todd et al., 2012). For example, a rat might be trained to press a lever to receive a food pellet in one context (context A), but moved to a novel context (B) where no food is available for the target response (i.e., extinction). Even when the target response decreases to low levels, renewal of the operant response can occur despite continued extinction if the rat is returned to context A, or placed in a novel context (C). Understanding renewal is important because the phenomenon suggests that even when there is successful reduction of operant problem behavior, such as a period of abstinence from drugs while in a treatment facility, operant behavior may be susceptible to relapse with a change in context, such as returning home from treatment.

Operant relapse can also occur when alternative reinforcement introduced during extinction is removed, a phenomenon called resurgence (e.g., Leitenberg et al., 1970; Leitenberg et al., 1975; Winterbauer & Bouton, 2010; Winterbauer & Bouton, 2012; Winterbauer et al., 2013; Sweeney & Shahan, 2013a; Sweeney & Shahan, 2013b). After training an operant target response (e.g., a lever press), extinction is introduced for the target and alternative reinforcement is introduced for a different response (e.g., a chain pull or a press to a different lever). During target extinction plus alternative reinforcement, target response rates decrease and alternative response rates increase. When alternative reinforcement is removed via extinction of the alternative response, resurgence of the target response often occurs. Alternative reinforcement is an important aspect of many behavioral interventions (e.g., Lloyd & Kennedy, 2014; Petscher et al., 2009; DeFulio et al., 2009). Therefore, empirical work that tests potential predictors of resurgence is important to pursue.

Although typically studied separately in animal studies of relapse, it may be useful to consider the renewal and resurgence phenomena together. In analogous treatments of operant problem behavior, predictors of both relapse phenomena are often operating simultaneously. For example, an outpatient child with intellectual or developmental disability may receive differential reinforcement of alternative behavior (DRA) treatment that successfully reduces problem behavior in a school or clinic setting (e.g., Volkert et al., 2009). Following treatment, the child may not only be subject to lapses in treatment integrity where alternative reinforcement is removed or reduced (i.e., resurgence), but also to the change in contextual stimuli that are associated with moving from the clinic to the home, which may trigger renewal. In light of this, the purpose of this study was to examine a novel method for studying resurgence and renewal in the same experimental preparation in order to provide richer analysis of the potential contributors to relapse of operant responding that may occur in clinical settings.

We conducted an assessment of persistence and relapse across four groups of rats (1) resurgence, (2) renewal, (3) compound, and (4) control following equal baseline acquisition of the target response (a lever press). In the resurgence group, alternative reinforcement was introduced for a chain pull response during extinction of the target response and removed during the relapse test (i.e., typical resurgence). In the renewal group, wall stripes and pine

scent were introduced during the extinction of the target response and removed during the relapse test (i.e., typical renewal). In the compound group, both alternative reinforcement and novel contextual stimuli were introduced during extinction of the target response and removed during the relapse test (combined resurgence and renewal). For the control group, extinction was introduced without alternative reinforcement or novel stimuli and nothing was altered during the relapse test.

By combining the variables that trigger renewal and resurgence together, we can examine the effects of alternative reinforcement and context change, and also assess how the delivery of alternative reinforcement in a novel context may affect the persistence and relapse of the target response. This design also compares the persistence of the alternative response when alternative reinforcement is delivered in the same context as it is removed (as in typical resurgence) relative to the persistence of the alternative response when alternative reinforcement was delivered in a different context. The assessment of resistance to change of the alternative response is practically important because the persistence of a desirable replacement behavior should be considered alongside any differences in relapse when choosing how to deliver alternative reinforcement.

2. Method

2.1 Subjects

The experiment used eight rats for each of four experimental groups, for a total of 32 experimentally naïve male Long-Evans rats (Charles River, Portage, MI, USA). This sample size is comparable to a similar between-groups resurgence study that detected a difference between groups using eight subjects per group (Sweeney & Shahan, 2013a). The animals were 71–80 days old when they arrived at the research facility. Rats were individually housed in a climate controlled colony room with a 12-h light cycle that began at 7:00 a.m. Rats were allowed ad libitum water access in their home cages and were maintained at approximately 80% of free feeding weight by food received in the session (Bio-Serv 45 mg dustless precision pellets) and daily post-session supplemental feedings (Harlan Teklad Rodent Diet 8604).

2.2 Apparatus

Experimental sessions occurred in one of four Colbourn modular operant chambers, the details of which have been described previously (Podlesnik et al., 2006). Two, non-retractable response levers were located on the left and on the right of the food magazine where pellets were delivered. The response lever wall and opposite, rear chamber wall were both metal, and the two side walls were clear Plexiglas. When in place, the striped stimuli were attached to the outside of the two clear, Plexiglas walls. The laminated striped stimuli sheets were 25.4-cm wide by 17.8-cm tall. The stripes alternated between black and white, ran vertically, and were 2.5-cm wide. A small hole in the center of the ceiling allowed for a 30.5-cm metal response chain to be dropped into the operant chamber, which extended to approximately .64-cm above the grid floor.

2.3 Procedure

The experiment compared performance between groups across three phases, baseline acquisition of the target response (Phase I), extinction treatment in which reinforcement was no longer available for the target response (Phase II), and continued extinction of the target response with a manipulation expected to induce relapse in some groups (Phase III).

2.3.1 Pretraining—Because the rats were naïve, prior to the experiment proper, subjects were trained to eat from the food magazine in the operant chamber in two, 30-min training sessions where food was delivered on a variable-time (VT) 60-s schedule.

2.3.2 Phase I—Phase I was implemented identically for all rats, where a food pellet was delivered for pressing the target (right) lever on a variable-interval (VI) 45-s schedule of reinforcement for 10 daily, 25-min sessions. Presses to the inactive (left) lever were recorded but had no programmed consequences. There was no change overdelay in place during Phase I. Due to a software error, experimental data were not saved on the fifth session of Phase I for four rats, one from each experimental group. After Phase I, groups were randomly assigned, with the caveat that the groups should not differ in terms of mean target response rates for the last five sessions of Phase I.

2.3.3 Phase II—During Phase II, reinforcement for pressing the target lever was discontinued in all groups for a fixed length of 15 sessions. Other experimental manipulations implemented during Phase II differentiated the four experimental groups: Resurgence, Renewal, Compound, and Control. For the Resurgence group, extinction of the target response was accompanied by alternative reinforcement for pulling the chain. Alternative reinforcement, when delivered, was the same 45-mg pellet delivered during Phase I but on a VI 10-s schedule. There was a changeover delay in place such that chain pulls could not produce food if a target response had occurred during the last 3 seconds. For the Renewal group, extinction of the target response occurred in a different operant chamber that had black and white vertical stripes stimuli on the wall and 10 ml of pine-scented cleaner on a paper towel beneath a blue guard under the chamber floor grid. The chain was introduced but pulling never produced food. In the Compound group, extinction occurred in a novel chamber with stimuli as in the Renewal group, but chain pulling also produced alternative reinforcement. In the Control group, the chain was introduced but never produced food, and the rat remained in the same chamber as Phase I.

2.3.4 Phase III—During Phase III, any rat that was in a different chamber for Phase II was returned to the original chamber and no striped stimuli or pine-scent were used, but all chambers had the alternative response chain. No food was available for any response during Phase III, which lasted 4 sessions.

3. Results

Table 1 displays the average target, alternative, and inactive response rates as well as obtained food rates across all phases of the experiment for the four groups. Group assignment following Phase I ensured approximately equal mean baseline target response rates across groups. Figure 1 displays acquisition of the target response across Phase I for

the four groups to which the rats were subsequently assigned. A repeated measures ANOVA conducted examining target response rates for the last five sessions of Phase I as a function of the assigned group confirmed no significant differences ($F(3, 28) = .006, p = .999, \eta_p^2 = .001$). Figure 2 displays target response rates across Phases II and III for all groups. Target response rate reliably decreased across Phase II in all groups, and alternative response rates increased in the two groups that received alternative reinforcement (Compound and Resurgence; See Figure 3).

3.1 Phase II Target Response Analytic Strategy

Statistical analyses were conducted to test whether target responses decreased across sessions of Phase II (1), whether there was an overall disruptive impact of alternative reinforcement on target responses during Phase II (2), if there was an overall disruptive impact of context change during Phase II (3), if the pattern of target response decrease across Phase II differed as a function of alternative reinforcement (4) or context change (5), and whether the effect of alternative reinforcement was different when delivered in a novel context (6). These hypotheses were tested using repeated-measures ANOVA with a within-subjects factor of Phase II Session, between subjects factors of Alternative Reinforcement (whether alternative reinforcement was present or absent; present for groups Resurgence and Compound and absent for groups Renewal and Control) and Context Change (whether the context change relative to Phase I was present or absent; present for groups Renewal and Compound and absent for groups Resurgence and Control), and target response rates during Phase II as outcome variable. This factorial design is displayed in Table 2. A main effect of Phase II Session tests whether target responses change across Phase II sessions (1), a main effect of Alternative Reinforcement would indicate an overall impact of alternative reinforcement on target responses during Phase II (2), a main effect of Context Change would indicate an overall impact of a change in context on target responses during Phase II (3), a Phase II Session $\times$ Alternative Reinforcement interaction (4) or a Phase II $\times$ Context Change interaction (5) would indicate that the pattern of target response decrease across Phase II depended on the presence of alternative reinforcement (4) or context change (5), respectively. A significant Alternative Reinforcement $\times$ Context Change interaction would indicate that the effect of alternative reinforcement delivery was different depending on whether there was a change in context during Phase II.

3.2 Phase II Target Response Results

There was a significant main effect of Phase II Session, which captured the overall decrease in target response rates across extinction sessions ($F(14, 392) = 33.97, p < .001, \eta_p^2 = .55$). There was a significant Phase II Session $\times$ Alternative Reinforcement interaction ($F(14, 392) = 2.84, p < .001, \eta_p^2 = .09$) and a significant Phase II Session $\times$ Context Change interaction ($F(14, 392) = 2.58, p = .001, \eta_p^2 = .08$), which suggests the effect of each of these manipulations differed as a function of Phase II session. Both of these interactions can be understood as the result of initially greater disruption in conditions in which there was alternative reinforcement and conditions in which there was context change, but that the difference as a function of these manipulations was reduced as target response rates reached

asymptotically lower rates in later extinction sessions. There was an overall main effect of Alternative Reinforcement ($F(1, 28) = 5.23, p = .03, \eta_p^2 = .16$), which captures the fact that target response rates were overall lower when alternative reinforcement was present during Phase II. There was no significant main effect of Context Change ($F(1, 28) = .09, p = .77, \eta_p^2 = .003$), and no significant Alternative Reinforcement $\times$ Context Change interaction ($F(1, 28) = .73, p = .40, \eta_p^2 = .03$). The lack of significant main effect of Context Change indicates that overall, target response rates were not significantly lower or higher as a function of a change in context during Phase II. The lack of significant Alternative Reinforcement $\times$ Context Change interaction suggests that effect of alternative reinforcement delivery did not depend on whether it was delivered in a different context.

3.3 Phase III Analytic Strategy

To examine the effect of alternative reinforcement removal and context change on relapse of the target response, we compared target response rates on the final session of Phase II and the first session of Phase III using repeated-measures ANOVA with within subjects factor of Transition (Last Phase II v. First Phase III), and between subjects factors of Alternative Reinforcement (conditions in which alternative reinforcement had been in place during Phase II, Resurgence and Compound v. conditions with no history of alternative reinforcement, Renewal and Control), and Context Change (conditions that experienced a context change, Renewal and Compound v. those with no context change, Resurgence and Control). We used this analysis to examine whether target response rates changed as a function of alternative reinforcement removal (Transition $\times$ Alternative Reinforcement interaction), or as a function of a change in context (Transition $\times$ Context Change interaction). A significant Transition $\times$ Alternative Reinforcement $\times$ Context Change interaction term would indicate the effect of alternative reinforcement removal on the first session of Phase III depended on the context in which alternative reinforcement was delivered.

The persistence of the alternative response across Phase III was also examined as a function of group for the Resurgence and Compound groups. Alternative responses were not examined in absolute response rates (and were examined as a proportion) because of the visual difference in alternative response rates for some of the final sessions of Phase II. Individual alternative response persistence on the first day of Phase III was considered as a proportion of the average alternative response rate for the last five sessions of Phase II and then mean persistence was compared as a function of group using a t test. It is worth noting that this differs from typical resistance to change analyses, which are usually examined within-subjects as a function of condition (or multiple schedule component) rather than across groups. The results of this analysis are displayed in Figure 4.

3.4 Phase III Results

There was a significant main effect of Transition ($F(1, 28) = 27.70, p < .001, \eta_p^2 = .50$) demonstrating an overall increase from the last session of Phase II to the first session of Phase III. There was a significant Transition $\times$ Alternative Reinforcement interaction ($F(1,$

28) = 5.40, $p = .03$, $\eta_p^2 = .16$) and a significant Transition $\times$ Context Change interaction ($F(1, 28) = 7.11$, $p = .01$, $\eta_p^2 = .20$), demonstrating increases in target response rates in the transition to Phase III as a function of alternative reinforcement removal and context change, respectively. There was no significant Transition $\times$ Alternative Reinforcement $\times$ Context Change interaction ($F(1, 28) = 1.66$, $p = .21$, $\eta_p^2 = .06$), meaning that the effect of alternative reinforcement removal on the first session of Phase III did not depend on the context in which alternative reinforcement was delivered.

A t test comparing alternative response persistence as a function of group revealed a significant difference between Resurgence and Compound [$t(14) = 2.20$, $p = .045$, $d = 1.10$], where the alternative response tended to be less persistent for the Compound group, which received alternative reinforcement in a different context.

4. Discussion

The present experiment combined variables that contribute to both resurgence and renewal into the same preparation and allowing examination of the roles of alternative reinforcement and context change during analog treatment and relapse, as well as how they may interact to produce differences in target response rates. In the compound group, we observed relapse of the target response following alternative reinforcement delivered in another context. The magnitude of relapse following alternative reinforcement removal did not depend on whether alternative reinforcement was delivered in the same or a different context. This leaves open the possibility that the relapse observed in the Compound group was primarily the result of the change in context (renewal), the removal of alternative reinforcement (resurgence), or a combination of these two factors.

Behavioral momentum theory (e.g., Nevin, 1974), would suggest that the relapse observed in the compound group was primarily the result of a change in contextual stimuli, rather than the removal of alternative reinforcement. According to behavioral momentum theory, alternative reinforcement that is delivered in the same context as baseline reinforcement might decrease the target behavior when alternative reinforcement is in place, but it will strengthen the stimulus-reinforcer relationship of the context and increase subsequent persistence and relapse in that context (see Shahan & Sweeney, 2011, for discussion). This is consistent with the inclusion of all sources of reinforcement in the context as contributors to the stimulus-reinforcer relationship of the context, whether the reinforcer is delivered contingent on the target response, response-independently, or contingent on an alternative response (Nevin et al., 1990). On the other hand, alternative reinforcement delivered in a novel context B ought to contribute only to the persistence of operant responses in context B, not in the baseline stimulus-context A. The change in context from B returning to A would still be expected to induce renewal, but because alternative reinforcement is delivered in a different context, relapse in a group that experiences alternative reinforcement in a novel context B should be no greater than a group that received ordinary extinction in the context B (i.e., typical renewal). In general, behavioral momentum theory has treated renewal and resurgence as separate phenomena (e.g., Podlesnik & Shahan, 2009; Podlesnik &

Shahan, 2010; Sweeney & Shahan, 2013a), which suggests that factors that attenuate resurgence may not determine the magnitude of renewal, and vice versa.

The context-change hypothesis of resurgence (e.g., Todd et al., 2014), by contrast, considers resurgence to be a special case of contextual renewal rather than resurgence and renewal representing distinct relapse phenomena. It is suggested that presence of alternative reinforcement during extinction of the target response serves as contextual cue, as does the removal of alternative reinforcement following treatment. In other words, this account suggests that resurgence is a type of ABC renewal where baseline reinforcement of the target response is context A, alternative reinforcement plus extinction of the target response is context B, and the removal of alternative reinforcement is a novel context C. In this view, resurgence occurs because the extinguished contingency learned during treatment is not generalized to the novel context without alternative reinforcement. Accordingly, the relapse conditions in this experiment are all inducing renewal where the context change that challenges generalization of extinction learning has different definitions. It is not clear whether context change without alternative reinforcement (our renewal condition) or context defined by alternative reinforcement (our resurgence condition) ought to produce greater relapse, but presumably alternative reinforcement delivered in a different context (our compound condition) would serve as an additional obstacle to generalization and perhaps result in greater relapse than either typical resurgence or renewal. Our data suggest that relapse in the combined condition did not depend on whether alternative reinforcement was delivered in a different context, but it is possible that under different experimental conditions a difference between compound relapse and renewal could occur. It is also possible that resurgence and renewal manipulations both induce what would be close to a ceiling of relapse observed, and that each additional obstacle to generalization would result in less of an increase in the observed relapse effect; therefore the delivery of alternative reinforcement in another context would serve to make no large difference in relapse. Further work that combines preparations to study renewal and resurgence phenomena simultaneously could help to determine whether renewal and resurgence represent independent relapse phenomena, or at least whether renewal and resurgence are sufficiently different that variables governing one may not necessarily impact the other.

We also found that the alternative response was more persistent during Phase III when alternative reinforcement was delivered in the same context relative to a different context. This is consistent with both behavioral momentum theory and recent experimental evidence that suggests operant responses are more persistent in the context in which they were originally trained (Bouton et al., 2013). Even if future studies detect differences in relapse of the target response as a function of alternative reinforcement context, the persistence of the alternative response (which is usually a desirable alternative to the target response) must be taken into account when deciding whether to deliver alternative reinforcement in a novel or familiar context.

Recent evidence suggests that the presence of a discriminative stimulus signaling reinforcement for the alternative response may contribute to the pattern of resurgence (Podlesnik & Kelley, 2014). In an experiment with pigeons, Podlesnik and Kelley observed that resurgence was of an initially greater magnitude when the stimulus that lit the

alternative response key was turned off during alternative reinforcement removal relative to when the alternative response key was illuminated during alternative reinforcement removal. However, the increase in target response rates seen during alternative reinforcement removal dropped at a faster rate when the alternative response key was not lit during alternative removal relative to when it was lit, making the resurgence function steeper in the condition without the alternative key light and leading to similar overall levels of resurgence in both conditions.

Podlesnik and Kelley's work (2014) differs from the present study in that the alternative key light present during alternative reinforcement treatment (which could arguably define a context, and its removal a context change) did not engender renewal on its own when presented without alternative reinforcement during extinction and without alternative removal when the stimulus was removed. Although the environmental stimuli were changed in our study, the alternative response (i.e., chain pull) continued to be available during alternative reinforcement removal. Pigeons tend to peck at negligible rates to unlit keys, and so when Podlesnik and Kelley removed the stimulus that signaled alternative reinforcement, they essentially removed the alternative response. In this study, although the alternative response was less persistent when extinguished in a context other than it was trained, we did not detect differences in relapse as a function of alternative response persistence. It is possible that complete removal of the alternative response may result in an entirely different pattern of relapse. The persistence of the alternative response and the effects of its availability will be important to understand, both because the alternative response is typically a desirable replacement behavior, and because the alternative response may contribute to the pattern of target response resurgence.

Our results may also be compared to recent data of Kincaid, Lattal, and Spence (2015), in which resurgence in three pigeons was greater when the removal of alternative reinforcement was accompanied by a change in the color of the key light relative to when alternative reinforcement was removed and there was no change in the color of the key light. In their study, a type of renewal manipulation (key color change) appeared to increase the magnitude of relapse, whereas in our study, the magnitude of relapse did not depend on whether alternative reinforcement was delivered in another context. A few key differences between the present study and that of Kincaid et al. should be noted. First, their comparisons between the key color change resurgence condition and the consistent key color resurgence condition was conducted within subjects using two concurrently available keys rather than between groups as in our study. This means that in their study, alternative reinforcement was delivered in the same stimulus conditions for both the typical resurgence key and renewal plus resurgence key, rather than delivered in a novel stimulus context as in our study. Kincaid et al. also used a differential reinforcement of other behavior (DRO) 20-s schedule of alternative reinforcement in which the alternative response is unmeasured. Because of less formal alternative response competition, DRO schedules of alternative reinforcement may result in a pattern of resurgence that is unlike resurgence following differential reinforcement of alternative behavior (DRA), as was used in the present study. We also do not know whether the stimulus key color change used as a renewal manipulation by Kincaid et al. would be likely to elicit renewal on its own, because there were only two alternative reinforcement conditions and no renewal alone condition as there was in our study. Because

of any of these differences, the results of these two studies may not be directly comparable. The sensitivity of resurgence to manipulations of context may be systematically examined as a function of these differences in future research.

One possible limitation of our study design is that we used a relatively high rate of alternative reinforcement, a VI 10 s schedule. Using a high rate of alternative reinforcement may result in ceiling effects of resurgence because high rates of alternative reinforcement have been associated with greater response suppression during extinction of the alternative response, but relatively greater resurgence following alternative reinforcement removal (Leitenberg et al., 1975; Sweeney & Shahan, 2013a). It could be that the removal of lower rates of alternative reinforcement or those with differential response requirements, such as the DRO 20-s used by Kincaid et al. (2015), may result in resurgence that is more sensitive to the effects of a change in stimulus context than was resurgence in the present study. Another possible limitation is the fixed-time criterion of 15 sessions of Phase II may have resulted in our termination of Phase II when alternative response rates were in an upward trend for the Resurgence and Compound Groups. Our concern was that if we had conducted an extended period of extinction, particularly for the groups experiencing extinction plus alternative reinforcement, we would have reduced or even eliminated resurgence as has been demonstrated in past experiments (Leitenberg et al., 1975; Sweeney & Shahan, 2013b; c.f., Winterbauer, Lucke, & Bouton, 2013). Still, because of the fixed-time criterion, our results may not generalize to situations in which alternative reinforcement is implemented until alternative responses are trained to a stability criterion.

We have shown that it is feasible to simultaneously study resurgence and renewal using typical experimental preparations, and also to study a compound relapse preparation by delivering alternative reinforcement in a novel context. We observed relapse under conditions that should elicit resurgence, renewal, and in a compound condition, but not in an extinction-only control group. The effect of alternative reinforcement, both during extinction and relapse, did not depend on whether alternative reinforcement was delivered in a different context. When an alternative behavior was introduced and reinforced during extinction, the alternative response was more persistent when extinguished in the same context as it was trained. The general methodology used here might serve as a tool to further assess shared (or distinct) mechanisms of resurgence and renewal, and also to determine circumstances that promote alternative responding and lasting suppression of the target response.

Acknowledgments

We thank Charles C. J. Frye, Rusty W. Nall, Paul J. Cunningham, and Andrew R. Craig for helpful comments on a previous version of this manuscript. We also thank the research assistants and graduate students in the Utah State University behavior laboratory for their assistance in running the experiment.

Role of the Funding Source This research was supported in part by NIH grant R01HD064576. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

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Figure 1.

Mean target response rates for all groups during Phase I. At the end of Phase I, rats were randomly assigned to groups to ensure that mean target response rates did not differ significantly prior to entering Phase II. Each data point represents $n = 8$ for each group, with the exception of session five, for which $n = 7$ for each group (see procedure note). Note that standard error bars are displayed above the data only.

Figure 2.
Mean target response rates for all groups during Phases II and III. Note that standard error bars are displayed above the data only.

Figure 3. Mean alternative response rates for all groups during Phases II and III. Note that standard error bars are displayed above the data only.

Figure 4. Mean and standard error of alternative response persistence on the first session of Phase III as a proportion of the average of the last five sessions of Phase II for both experimental groups that received reinforcement for the alternative response.

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Table 2Factorial Experimental Design¹

	Context Change		
		<i>Present</i>	<i>Absent</i>
Alternative Reinforcement	<i>Present</i>	Compound (Group 3)	Resurgence (Group 1)
	<i>Absent</i>	Renewal (Group 2)	Control (Group 4)

¹ Table 2 illustrates the two between subjects factors (Alternative Reinforcement and Context Change) of the experimental design used as the basis for analyses of Phase II and Phase III target response rate data.