The Psychological Record (2022) 72:325–330
https://doi.org/10.1007/s40732-020-00455-6

BRIEF COMMUNICATION

Time-Out During Alternative Reinforcement Does Not Reduce Resurgence: An Exploratory Study

Alexander L. Houchins[1] · Catherine L. Williams[1] · Claire C. St. Peter[1]

Accepted: 21 December 2020 / Published online: 14 January 2021

Abstract

Resurgence of previously suppressed behavior can occur when differential reinforcement is discontinued. Recent research has investigated strategies to mitigate resurgence, including punishing the target response during alternative reinforcement. A punishment strategy consisting of reinforcer loss contingent on the target response (response cost) does not appear to attenuate resurgence, but these effects had not been replicated with other negative-punishment procedures, such as timeouts. This study investigated effects of timeouts on subsequent resurgence when adults responded to earn points during a computer task. Timeouts did not affect subsequent resurgence. These findings, in combination with previous research, suggest that negative punishment may not reduce the likelihood of subsequent resurgence.

Keywords Human operant · Negative punishment · Resurgence · Single-subject design · Timeout

Resurgence is the reemergence of a previously reinforced response after that response has been extinguished and reinforcement conditions for an alternative response have worsened (Lattal et al., 2017). Evaluations of resurgence typically consist of three phases. In the first (*target-reinforcement*) phase, a target response is reinforced. In the second (*alternative-reinforcement*) phase, the target response is no longer reinforced, and an alternative response is reinforced. During this phase, target-response rates often decrease and alternative-response rates often increase. In the third (*resurgence-test*) phase, reinforcement conditions for the alternative response worsen. Most often, neither target nor alternative responses are reinforced (i.e., extinction) during this phase. If rates of target responding during the resurgence-test phase increase above those in the alternative-reinforcement phase, resurgence is said to have occurred (Kestner, Romano, St. Peter, & Mesches, 2018).

The likelihood and magnitude of resurgence are affected by the contingencies during the alternative-reinforcement phase (St. Peter, 2015), including punishment of the target response. For example, resurgence was less likely when target responding of nonhumans (rats or fish) was punished with electric shock than when it resulted in no programmed consequences during the alternative-reinforcement phase (Kestner, Redner, Watkins, & Poling, 2015; Kuroda, Gilroy, Cançado, & Podlesnik, 2020). Yet, effects of different forms of punishment on resurgence are not well-established. In three studies with human participants, negative-punishment procedures (in the form of point loss) did not reduce resurgence. In a study by Okouchi (2015), humans worked at a computer to earn points exchangeable for money. One group of participants experienced negative punishment (in the form of point loss) during the alternative-reinforcement phase, but the other group did not. Across groups, there was no difference in the likelihood of resurgence. This finding has been replicated using both within-subject (Kestner, Romano, et al., 2018) and group-design (Bolívar & Dallery, 2020) methods. In these replications, responding of college students was compared across alternative-reinforcement conditions in which target responding produced either no programmed consequences or contingent point loss. There was no impact of the negative-punishment contingency on subsequent resurgence of target responding even when the magnitude of point loss was increased (Bolívar & Dallery, 2020).

Previous studies (Bolívar & Dallery, 2020; Kestner, Romano, et al., 2018; Okouchi, 2015) examined only one of many possible forms of negative punishment (point loss). Another common negative-punishment procedure is timeout

✉ Claire C. St. Peter
claire.stpeter@mail.wvu.edu

[1] West Virginia University, 53 Campus Drive, Morgantown, WV 26506, USA

from positive reinforcement (Zabel, 1986), which is a response-dependent period of time during which reinforcers cannot be earned. Like response cost, a timeout is a negative-punishment procedure that effectively suppresses problem behavior in a variety of contexts (Brantner & Doherty, 1983; Donaldson & Vollmer, 2011; Vegas, Jenson, & Kircher, 2007). Although both are forms of negative punishment, a timeout may differ from response cost regarding subsequent resurgence because a timeout period may be more salient to participants than is point loss, though, to our knowledge the relative salience of time out and point loss has not been experimentally evaluated. However, the impacts of timeouts during alternative-reinforcement on subsequent resurgence have not been evaluated to date. Therefore, the purpose of the present study was to explore possible effects of timeouts on resurgence of nonclinical human behavior.

Method

Participants

Six university students recruited from psychology courses participated. Each received extra credit based on the duration of time they spent in the study, independently of responding during the experiment. Data sets from two of the six participants were excluded from analysis due to programming errors. All participants were female, Caucasian, and reported no color-vision impairments. P3, P4, and P6 were 19 years old; P5 was 21 years old.

Setting

The experiment was conducted in a 4.1-m by 3.0-m room in a university laboratory containing office furniture, a Dell® desktop computer with a 12-cm × 15-cm screen, attached mouse, and keyboard. The keyboard was stowed during the experiment; responses were made using only the mouse. While seated at the computer, the participant faced away from a one-way mirror.

A custom Visual Basic program displayed the experimental task. When an on-screen start button was clicked, three, 6.0-cm by 1.3-cm black rectangles appeared. The rectangles were situated equidistant from the top and bottom of the screen, and the center of each rectangle was 10.0 cm from the center of the next rectangle. A response was defined as clicking whereas the cursor was over one of the rectangles. Clicks on the leftmost and rightmost rectangles were designated as target and alternative responses, respectively. Clicks on the center rectangle were designated as control responses. Each time a rectangle was clicked, it turned gray for 100 ms, then returned to black. All three rectangles remained present following a response on any rectangle, unless the response was reinforced according to the VI 2-s schedule (in which case all rectangles disappeared during the consummatory response, as described below).

A point counter was visible throughout the session. When a point was earned, all three rectangles disappeared, a white box appeared in the center of the screen with the text "+1", and a "Collect Point" button appeared below the box. When the "Collect Point" button was clicked, the number displayed in the point counter was increased by one and all rectangles reappeared. Points were not exchangeable for money or other backup reinforcers.

Experimental Design

Experimental control was demonstrated within-subject using a multi-element design embedded in a reversal design. Each participant completed the study in a single appointment, which was divided into two 60-min sessions with a 5-min break between sessions. Each session consisted of three 20-min phases: a target-reinforcement (baseline) phase, an alternative-reinforcement phase, and a resurgence-test phase. Two components, signaled by red or blue backgrounds, alternated every 2 min within each phase. Component order was counterbalanced across participants and within-participant across replications.

Procedure

Preexperimental Procedure The participant placed all belongings (including watches or other timing devices) on a table out of reach of the computer workstation. Once the participant was seated in front of the computer, the experimenter said, "Your job is to earn as many points as possible. It is up to you to figure out how to earn points. The instructions on the screen [a button labeled 'Start'] are the only ones you will receive. When you are done, please knock on the door behind you."

The experimenter monitored the participant through the one-way mirror. If the participant engaged in any behavior incompatible with attending to the computer screen (e.g., putting their head down), the experimenter entered the testing room and said, "Please attend to the experiment." This reminder was only necessary once (for P6, during the middle of the first Resurgence-Test phase).

Baseline Clicks on the left rectangle (target responses) were reinforced according to a variable-interval (VI) 2-s schedule, which was generated using the Fleshler and Hoffman (1962) progression (n = 10). Clicks on the other two rectangles or anywhere else on the screen resulted in no programmed consequences. Both components were identical during baseline (other than alternation of the background color).

Alternative Reinforcement Regardless of component, clicks on the right rectangle (alternative responding) were reinforced on a VI 2-s schedule that was created identically to the one used in baseline. However, contingencies for target responding differed across components. The component signaled by a blue background was associated with extinction for target behavior; clicks on the middle (control) or left (target) rectangles continued to result in the rectangle flashing gray, but no other consequences. The component signaled by a red background was associated with a timeout for target behavior; clicks on the middle (control) rectangle caused the rectangle to flash gray (but no other consequences) and each target response was immediately followed by a timeout. During the timeout, the background turned gray and text reading "Timeout" appeared between the score counter and the response rectangles. The rectangles remained visible during timeouts, and continued to flash gray when clicked but no points were delivered. Target responses reset a 2-s timeout timer; responses on other rectangles did not reset timeout or result in points. The timeout ended after a 2-s period with no target responses. After the timeout, the background changed back to red, the "Timeout" text disappeared, and the VI schedule for alternative responding resumed. Timeouts did not affect the component duration. If the component ended during a timeout, the timeout was discontinued early.

Resurgence-Test (Extinction) Phase Clicking on any of the rectangles briefly turned the rectangle gray. There were no points or timeouts delivered throughout the phase, although the background colors continued to alternate.

Debriefing After the second session, the participant completed a demographic survey and was debriefed about the purpose of the experiment.

Data Analysis

Time-in duration was calculated for each component by subtracting the duration spent in the consummatory response (defined as the presentation of the "Collect Point" button to a click on that button) and the duration of a timeout (when applicable) from the 2-min component duration. Response rates were calculated by dividing the count of clicks on each rectangle during time-in by the time-in duration. Resurgence was defined as an increase in rates of target responding during any component of the extinction phase relative to the last two alternative-reinforcement component presentations for that condition (similar to Kestner, Romano, et al., 2018).

Results

Figure 1 displays rates of target responding for each participant during each 2-min component (see Supplemental Materials for similar figures of the alternative and control responses). During baseline (labeled BL on the graphs), rates of target responding were nearly identical across components for all participants, suggesting that the change in background color alone did not systematically affect responding. During alternative reinforcement (labeled ALT on the graphs), both conditions reduced target-

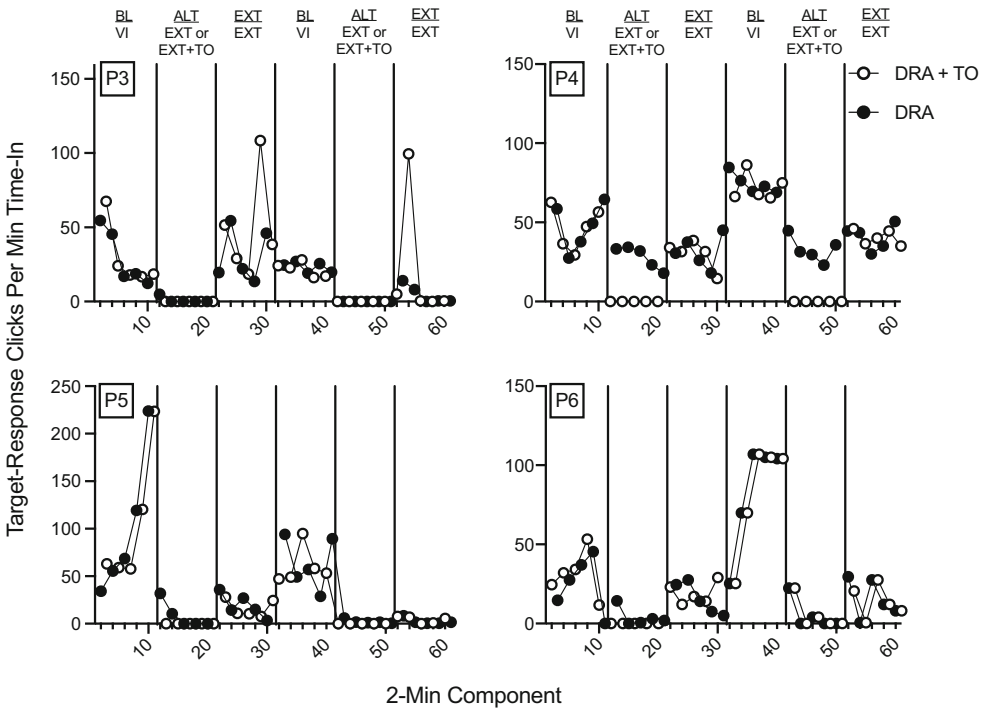

Fig. 1 Target-response rate per 2-min component across conditions over two sessions. Filled circles represent responding during components with extinction and differential reinforcement, and open circles represent responding during components with timeout and differential reinforcement for the target and alternative responses, respectively. Note that the scale of the *y*-axis differs across participants

response rates relative to baseline. However, target responding reduced more rapidly (P3, P5, and P6) or more substantially (P4) during the component that included a timeout, relative to the component that did not, in at least one replication of the alternative-reinforcement phase for each participant. Thus, a timeout appeared to function as a punisher for P4, and may have exerted punishment effects for other participants (although constrained by floor effects). Although changes in target responding for P4 suggested punishment, rates of alternative and control responding did not change systematically across conditions, suggesting weak experimental control for this participant.

During the resurgence-test phase (associated with extinction for all responses and labeled EXT on the graphs), resurgence occurred in both conditions and replications for all participants, although the magnitude of resurgence decreased in the replication for P3 and P5. This reduction in magnitude of resurgence is consistent with prior research on the use of reversal designs in human-operant resurgence experiments (e.g., Kestner, Diaz-Salvat, St. Peter, & Peterson, 2018). Despite the consistency of the overall resurgence effect during extinction, there was no clear differentiation in response rates between the conditions.

Figure 2 depicts relative mean response rates for each of the three rectangles during extinction. Data for each participant appears on a separate graph space, with each set of bars showing responding during one of the extinction phases. Participants engaged in never-reinforced responses (clicking the center rectangle) at rates comparable to target responding during extinction. In general, responding did not differ in overall rate or in allocation across the three rectangles during extinction across phases. Overall, the data presented in Figs. 1 and 2 demonstrate that including timeouts during alternative reinforcement did not suppress subsequent resurgence of target responding during extinction.

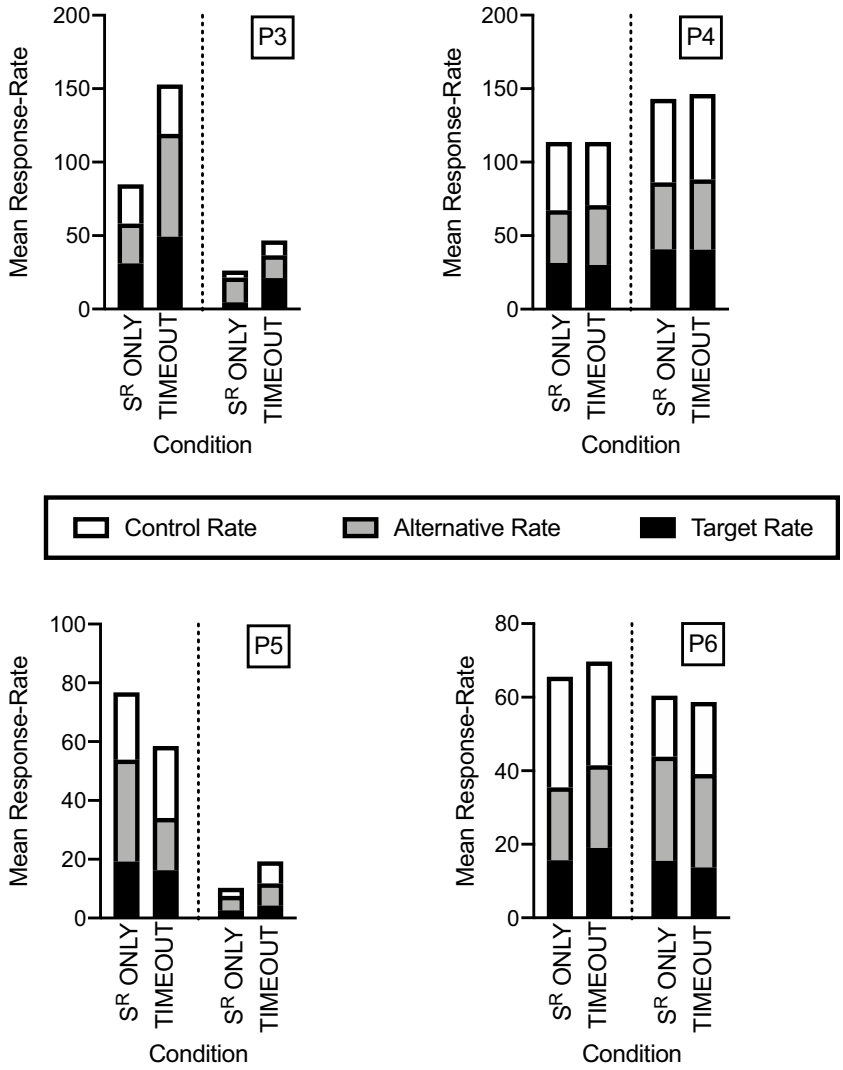

Fig. 2 Mean responding across the three response options (rectangles) during extinction phases. The bars before the dotted vertical line show responding during the first extinction phase; those after the dotted line show the second extinction phase. Data are graphed separately for each participant

Discussion

The current study evaluated the impacts of timeouts during alternative reinforcement on subsequent resurgence. Although there was evidence that a timeout functioned as a punisher during the alternative-reinforcement phase, it had no clear effects on subsequent resurgence. These results replicate previous studies that found few impacts of response cost, another form of negative punishment, on subsequent resurgence of human behavior (Bolívar & Dallery, 2020; Kestner, Romano, et al., 2018; Okouchi, 2015). These replications occurred despite differences in types of negative punishment and details of experimental arrangement. In combination, these experiments suggest that, although inclusion of negative-punishment procedures may improve initial response suppression, they do not meaningfully reduce resurgence.

The minimal impact of negative punishment on subsequent resurgence contrasts with effects obtained with positive punishment, which has reliably decreased subsequent resurgence (Kestner et al., 2015; Kuroda et al., 2020; Nall & Shahan, 2019). Although positive and negative punishment are thought to operate through similar fundamental processes, the discrepancies in findings regarding resurgence suggest that there may be differences in mechanisms that could be further explored. A next step would be to compare effects of positive and negative punishment procedures on resurgence directly within the same study using a robust experimental design.

Subsequent research should also consider how resurgence is defined. In the current study, resurgence was defined as an increase in target-response rates during extinction relative to response rates at the end of the alternative-reinforcement phase. By this definition, resurgence occurred for all participants during both conditions. Although this is a common definition of resurgence (Kestner, Romano, et al., 2018; Lattal et al., 2017), it does not differentiate target responding due to resurgence from that due to extinction-induced variability. Resurgence and variability could be distinguished by comparing rates of target responding to rates of a control response that is never reinforced, but interpretations from such comparisons may be limited (Lattal & Oliver, 2020). In the current study, defining resurgence in comparison to a control response would have decreased the overall occurrence of resurgence, but would not have resulted in emergence of differential resurgence across conditions.

The current findings may be limited in their generality. Like other studies evaluating punishment on subsequent resurgence (Bolívar & Dallery, 2020; Kestner, Romano, et al., 2018; Okouchi, 2015), we targeted arbitrary responses that were reinforced according to rich and predictable schedules for the sole purpose of the experiment. This translational approach permits control over potentially important variables, like phase duration and recent reinforcement history, but outcomes may not generalize to responses and environments that are more complex. We know of no published evaluations of resurgence of clinically significant challenging behavior following interventions with and without punishment procedures. Such studies would be necessary before clear recommendations can be established about the inclusion of punishment in procedures designed to change socially significant behavior. In addition, further research with clinical populations could examine the impact of including or excluding timeout duration from overall results. However, until such clinical studies are available, the existing data provide little justification for including punishment as a strategy to promote long-term treatment effects in the face of extinction-like challenges.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s40732-020-00455-6.

Author Note This study was completed in partial fulfillment of the requirements for a bachelor's degree by the first author, under the supervision of the second and third authors.

Code Availability https://github.com/catstep93/timeoutresurgence

Data Availability Data files are publicly available at https://researchrepository.wvu.edu/

Compliance with Ethical Standards

Conflicts of Interest The authors declare no conflicts of interest.

Research Involving Human Participants The study was approved by the University Institutional Review Board.

Informed Consent All participants completed an informed-consent process and provided consent prior to participation.

References

Bolívar, H. A., & Dallery, J. (2020). Effects of response cost magnitude on resurgence of human operant behavior. *Behavioural Processes, 178*. https://doi.org/10.1016/j.beproc.2020.104187

Brantner, J. P., & Doherty, M. A. (1983). A review of timeout: A conceptual and methodological analysis. In S. Axelrod & J. Apsche (Eds.), *The effects of punishment on human behavior* (pp. 87–132). New York, NY: Academic Press.

Donaldson, J. M., & Vollmer, T. R. (2011). An evaluation and comparison of time-out procedures with and without release contingencies. *Journal of Applied Behavior Analysis, 44*(4), 693–705. https://doi.org/10.1901/jaba.2011.44-693.

Fleshler, M., & Hoffman, H. S. (1962). A progression for generating variable-interval schedules. *Journal of the Experimental Analysis of Behavior, 5*(4), 529–530. https://doi.org/10.1901/jeab.1962.5-529.

Kestner, K., Redner, R., Watkins, E. E., & Poling, A. (2015). The effects of punishment on resurgence in laboratory rats. *The Psychological Record, 65*, 315–321. https://doi.org/10.1007/s40732-014-0107-y.

Kestner, K. M., Diaz-Salvat, C. C., St. Peter, C. C., & Peterson, S. M. (2018). Assessing the repeatability of resurgence in humans: Implications for the use of within-subject designs. *Journal of the Experimental Analysis of Behavior, 110*(3), 545–552. https://doi.org/10.1002/jeab.477.

Kestner, K. M., Romano, L. M., St. Peter, C. C., & Mesches, G. A. (2018). Resurgence following response cost in a human-operant procedure. *The Psychological Record, 68*, 81–87. https://doi.org/10.1007/s40732-018-0270-7.

Kuroda T., Gilroy, S. P., Cançado, C. R. X., & Podlesnik, C. A. (2020). Effects of punishing target response during extinction on resurgence and renewal in zebrafish. *Behavioural Processes, 178*. https://doi.org/10.1016/j.beproc.2020.104191

Lattal, K. A., Cançado, C. R. X., Cook, J. E., Kincaid, S. L., Nighbor, T. D., & Oliver, A. C. (2017). On defining resurgence. *Behavioral Processes, 141*, 85–91. https://doi.org/10.1016/j.beproc.2017.04.018.

Lattal, K. A., & Oliver, A. C. (2020). The control response in assessing resurgence: Useful or compromised tool? *Journal of the Experimental Analysis of Behavior, 113*(1), 77–86. https://doi.org/10.1002/jeab.570.

Nall, R. W., & Shahan, T. A. (2019). Resurgence of punishment-suppressed cocaine seeking in rats. *Experimental & Clinical Psychopharmacology*, *10*. Advance online publication. https://doi.org/10.1037/pha0000317

Okouchi, H. (2015). Resurgence of two-response sequences punished by point-loss response cost in humans. *Mexican Journal of Behavior Analysis, 41*(2), 137–154. https://doi.org/10.5514/rmac.v41.i2.63744.

St. Peter, C. C. (2015). Six reasons why applied behavior analysts should know about resurgence. *Revista Mexicana de Análisis de La Conducta, 41*(2), 252–268.

Vegas, K. C., Jenson, W. R., & Kircher, J. C. (2007). A single-subject meta-analysis of the effectiveness of time-out in reducing disruptive classroom behavior. *Behavioral Disorders, 32*(2), 109–121. https://doi.org/10.1177/019874290703200204.

Zabel, M. K. (1986). Timeout use with behaviorally disordered students. *Behavioral Disorders, 12*(1), 15–21. https://doi.org/10.1177/019874298601200110.