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Evaluating resurgence procedures in a human operant laboratory

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ABSTRACT

Resurgence of previously extinguished behavior may occur when a recently reinforced alternative response is placed on extinction. Understanding the conditions that produce and reduce resurgence is important for both basic and applied researchers. Research on resurgence of human behavior may benefit from methods that facilitate comparison and replication of nonhuman animal studies. These studies often include an inactive control response to differentiate resurgence from extinction-induced variability. In contrast, human research typically does not. Sweeney and Shahan (2016) tested a brief, trial-based procedure that included an inactive control response with human participants, but they did not observe resurgence. The current study extended their methods by examining four different conditions in a free-operant task lasting < 1 h. Modifications across conditions included changing the number of response options available in each phase and how signals associated with each response were presented. Only one condition resulted in responding resembling resurgence. Our results suggest the utility of the inactive control response and the influence of contextual cues in human research should be investigated further.

1. Introduction

The reoccurrence of previously extinguished behavior is a phenomenon of both basic and applied importance. Basic researchers seek to understand the underlying processes that contribute to the reemergence of a response that has stopped occurring. For applied researchers, successful treatment outcomes may be undone if potentially dangerous problem behavior reoccurs. Parsing out the variables that influence the reemergence of extinguished behavior provides researchers with a more robust understanding of reinforcement history effects on current behavior. Better understanding of controlling variables may subsequently lead to the development and refinement of clinical methods to reduce or prevent reemergence of extinguished problem behavior.

One form of reemergence, resurgence, has received significant interest in behavioral research. Resurgence can be defined as the reoccurrence of previously extinguished behavior when reinforcement for an alternative response is withheld (Epstein, 1983). Stated differently, a behavior that was previously reinforced and subsequently extinguished may reoccur if a recently reinforced alternative behavior no longer contacts reinforcement. For example, reinforcers for an adaptive alternative behavior may not be delivered when a client leaves the treatment environment. This may result in a return to a previously extinguished problem behavior.

Laboratory methods for studying resurgence are most often conducted in three phases. In Phase I, a target response is shaped and reinforced. In Phase II, reinforcement is withheld for the target response and provided contingent upon an alternative response. In Phase III, reinforcement is withheld for both responses (see Doughty and Oken, 2008 and Lattal and St Peter Pipkin, 2009 for reviews). This final phase is called the "resurgence test." Consider the following example: In Phase I, a pigeon receives 3-s access to grain for pecking on key A which leads to an increase in pecks on that key. In Phase II, pecking on key A no longer results in reinforcement (i.e., key A pecks are extinguished). Instead, the pigeon must peck on key B to receive grain. Pecking on key A subsequently decreases and pecks on key B increase. In Phase III, pecks on both keys are placed on extinction. Resurgence is indicated by an increase in rates of pecking key A from the end of Phase II to the beginning of Phase III.

In the preceding scenario, only two responses are available to the pigeon throughout the experiment. Although the use of just two responses is common to many studies of resurgence (e.g., Schepers and Bouton, 2015; Winterbauer and Bouton, 2010; Winterbauer et al., 2013), researchers have also varied the number of responses available to the organism. For example, other studies have included a third, inactive control response that is available throughout the entire experiment but is never reinforced (e.g., Craig and Shahan, 2016; Sweeney and Shahan, 2013a,b; Sweeney and Shahan, 2016). Including a control response may provide a measure of extinction-induced variability (Doughty and Oken, 2008; Epstein, 1983). Under this arrangement, resurgence is identified by exclusive or higher levels of

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responding on the previously extinguished target response relative to the control response. In contrast, extinction-induced variable responding is identified if the organism emits levels of control responding in the third phase that are higher than previous phases and undifferentiated from target responding. Thus, rates of control responding in the third phase can help distinguish extinction-induced variability from resurgence (i.e., response recovery; Doughty and Oken, 2008; Sweeney and Shahan, 2016).

Laboratory studies with nonhuman animals in the basic literature have examined the influence of several variables on resurgence including rates of alternative reinforcement, duration of target response extinction, and reinforcer type. With respect to rates of alternative reinforcement, several studies have shown that lean or thinned schedules of reinforcement in Phase II are less effective at suppressing the target response but can reduce resurgence in Phase III (e.g., Craig et al., 2016; Craig and Shahan, 2016; Leitenberg et al., 1975; Exp 3; Sweeney and Shahan, 2013b; Winterbauer and Bouton, 2012; cf. Winterbauer and Bouton, 2010). Researchers have also studied the influence of Phase II duration (i.e., how long the target response contacts extinction). For example, Leitenberg et al. (1975, Exp 4) found that longer Phase II durations reduced resurgence, whereas Winterbauer et al. (2013, Exp 2) did not. Further, Schepers and Bouton (2015) and Sweeney and Shahan (2013a) observed successive reductions in target responding during extinction tests that alternated with alternative reinforcement. However, Schepers and Bouton (2015, Exp 3) found a reduction in resurgence in the group that received repeated extinction tests during alternative reinforcement relative to a group that received constant alternative reinforcement, whereas Sweeney and Shahan (2013a, Exp 2) did not. Finally, resurgence also occurs when the target and alternative responses are maintained by different reinforcers (e.g., cocaine versus sucrose; Craig et al., 2016; Podlesnik et al., 2006; Winterbauer et al., 2013, Exp 3).

Contrary to the wealth of research on resurgence using nonhuman animals, research on resurgence with humans is scant but remains important for several reasons. For example, replicating and extending nonhuman animal literature demonstrates the generality of resurgence to humans. Additionally, resurgence procedures using humans will show the extent to which the same variables that influence resurgence in nonhuman animals influence responding in humans. Such research may lead to new insights that inform additional investigations of how resurgence can be reduced in clinical populations.

Although comparatively small, resurgence research with humans is a growing body of literature that has examined the phenomenon under a variety of conditions (Kestner and Peterson, 2016). For example, researchers have demonstrated that resurgence will occur with humans when two response options are available and reinforced on interval or ratio schedules, providing initial evidence for generality of the phenomenon (e.g., Kuroda et al., 2016; Marstellar and St Peter, 2012; Romano and St. Peter, 2016). In addition, King and Hayes (2016) found that contexts associated with reinforcement influenced the reoccurrence of behavior in a procedure where three responses were reinforced in the presence of different colored screens. The resurgence test represented one of those colors, and the response reinforced in the context of that color was the most likely of the three responses to reoccur. Finally, a translational study by Lambert et al. (2015) examined whether training multiple alternative behaviors would reduce resurgence of an arbitrary response in adults with developmental disabilities. Resurgence was greatly mitigated in the component where multiple alternatives were trained but occurred as expected in the component where only one alternative was trained. This study provides preliminary evidence for one promising way to reduce resurgence with humans.

Notably, one recent study did not observe resurgence with human participants. Sweeney and Shahan (2016) examined resurgence during brief discrete trial procedures that included a third control response. In each phase, participants chose one of three shapes and earned points based on the contingencies in effect for each phase (i.e., points were awarded for selecting the target shape in Phase I, the alternative shape in Phase II, and points were never awarded for selecting the control shape). Across seven conditions, the authors manipulated the number of trials presented in Phase I and the probability of reinforcement for the target and alternative responses in Phases I and II. Resurgence (i.e., target responding that was "readily distinguishable" from control responding) did not occur. These results contrast with studies using nonhuman animals that do not show appreciable differences in control responding across phases when a control response is present (e.g., Craig and Shahan, 2016; Sweeney and Shahan, 2013b). Thus, including a control response may clarify behavioral processes in these preparations for both human and nonhuman responding.

The current study used the exploratory framework exemplified by Sweeney and Shahan (2016) to assess a computer-based free operant procedure that participants could complete in one session lasting less than 1 h. We included a control response per their recommendations. However, we used a free operant arrangement instead of discrete trials to more closely replicate methods used in nonhuman animal research. Rather than manipulate the duration of Phase I or the probability of reinforcement in Phases I and II (Sweeney and Shahan, 2016), we sought to determine if changing the number of response options and signals in each phase would result in resurgence with human participants. We predicted that changing the number of response options and signals would influence resurgence based on previous research suggesting that context influences this phenomenon (e.g., King and Hayes, 2016). We assessed whether changes to the number of response options or signals increased rates of target responding at the onset of Phase 3, relative to any increases in control responding.

2. Methods

2.1. Subjects

Twenty-five undergraduate college students (mean age = 19 yrs, SD = 1.8) attending a large university in the southeastern United States participated. Seventeen students identified as female, and seven identified as male. One participant did not provide demographic information. All were enrolled in an introductory psychology course and received course credit for their participation. Participants were assessed for color blindness prior to their participation as red and green stimuli were included throughout the experiment.

2.2. Apparatus

The experimental task was presented in a campus laboratory room on a desktop computer or laptop. Participants used a computer mouse to complete the experimental task and a computer keyboard to answer the reflection task. All conditions were coded using Visual Basic 2013 Community Edition. Code for the task can be found at the website: https://github.com/BHAT-RC/resurgence.

2.3. Stimuli

Appendix A contains screenshots of the stimuli in each phase across all conditions. Target, alternative, and control "levers" were visible on the computer screen located approximately 4 cm below three colored circles (hereafter called "signals"). These signals were 1.7 cm in diameter and spaced 6.4 cm apart horizontally across the screen. The levers were grey and were always presented against a white background. Levers were 6 × 1.3 cm in perimeter and were spaced horizontally across the screen with 4 cm between the ends of the levers, approximately 10 cm from the middle of one lever to the middle of the next. Finally, text boxes were located in the upper right corner of the screen with the label "Bank," which displayed the points the participant had earned. Signal colors and the presence or absence of levers were manipulated across conditions to determine whether these variables influenced resurgence (described below).