Effects of Response Effort on Resurgence

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Abstract The present study examined response effort during resurgence tests. Six children were trained to place balls in baskets that were placed either close (.0254 m) or far away (1.829 m or .9 m). Resurgence was assessed using a linear strip design, where responses were reinforced on a variable-interval 10-s schedule or put on extinction. During resurgence tests, minimal to low rates of resurgence associated with the greater response effort (i.e., placing a ball in the basket further way) were observed across all six participants, regardless of distance.

Keywords Resurgence · Response effort · Behavioranalysis · Translational science

Resurgence has been defined as the recurrence of a previously reinforced operant placed on extinction when a second alternative operant is placed on extinction (e.g., Lieving et al., 2004; Sweeney & Shahan, 2013). Linear resurgence models typically consist of three sequential phases. In the first phase, one operant (R_1) is placed on

a reinforcement schedule. In the second phase, R_1 is placed on an extinction schedule while an alternative operant (R_2) is placed on a reinforcement schedule. During the final phase, both operants (R_1 and R_2) are placed on an extinction schedule. Resurgence occurs if R_1 recurs in the final phase. Research on resurgence has identified differences in resurgence rates according to the density of reinforcement schedules (Winterbrauer & Bouton, 2012), magnitude of reinforcement (Podlesnik & Shahan, 2010), and schedules of reinforcement (Marsteller & St. Peter, 2014; Volkert, Lerman, Call, & Trosclair-Lasserre, 2009). Research in clinical settings has observed resurgence of a target behavior following the extinction of functionally equivalent mands (Marsteller & St. Peter, 2014; Volkert et al., 2009; Wacker, Harding, Morgan, Berg, Schieltz, Lee, et. al., 2013) and across response-class hierarchies of problem behavior (Lieving et al., 2004).

While applied research on resurgence is promising, it is still unknown the extent to which response effort mediates rates of resurgence. If the response effort for one response option is lower than the response effort required to obtain reinforcement for another response option, an individual is more likely to engage in the response with the lower response effort requirement (e.g., Zhou, Goff, & Iwata, 2000). Understanding how to mitigate resurgence from occurring during periods of extinction, particularly in relation to variation in response effort, is an important next step (see also Sweeney & Shahan, 2013). It would appear that if problem behavior required additional response effort than a functionally equivalent response, then resurgence rates during periods of extinction may occur at or below baseline rates. Therefore, the current study examined the extent to which resurgence would occur across responses with varying response effort.

Implications for Practice • Replication of previous research on resurgence with children with emotional disturbances

- First investigation into the role of response effort on rates of resurgence
- Demonstrates the impact of response effort requirements on the mitigation of rates of resurgence
- Highlights the importance of identifying response effort when considering treatment interventions

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Method

Participants, Settings, and Materials

Six students, (83 % male) enrolled in a behavioral health agency in the Midwest, participated in the study. Lance was a 14-year old diagnosed with attention deficit hyperactivity disorder (ADHD) and oppositional defiance disorder (ODD). Simon was a 10-year old diagnosed with emotional behavioral disorder (EBD). Spencer was a 7-year old diagnosed with ADHD-NOS (not otherwise specified), ODD, and EBD. Luke was a 5-year old diagnosed with ODD. Morgan was a 7-year old female diagnosed with ADHD and ODD. Kyle was an 8-year old diagnosed with ADHD, separation anxiety, and ODD. Parental consent and participant assent were granted prior to the start of the study.

All sessions took place in a room (3.04 by 3.65 m) that contained a table, desk, chairs, a computer, and other office supplies. Materials included data sheets, two white baskets, tokens, reinforcers (e.g., tablets, toys, etc.), a video recorder and tripod, a small cardboard box, foam balls, one red and one white pillow, iPhone, and headphones.

Response Definitions and Measurement

The target response was removing a ball from a cardboard box in the center of the room and placing the ball into a basket that corresponded to the contextual stimuli (i.e., white and red pillows). Response one (R_1) was defined as taking a ball from the cardboard box, moving to the basket, and placing the ball in the basket further away (.9 m away for participants Lance, Simon, and Spencer; 1.829 m away for Luke, Morgan, and Kyle). Response two (R_2) was defined as taking a ball from the cardboard box and placing it in the basket next to the participant (.0254 m). Correct responding was defined as the number of balls placed in the correct basket according to contextual stimuli (e.g., white pillow was paired with the basket closest to the participant; red pillow was paired with the basket further away), which was subsequently converted to rate. Dropping more than one ball at a time was scored as one response.

Procedure

All participants first completed a multiple stimulus without replacement preference assessment (MSWO; DeLeon & Iwata, 1996) to identify a hierarchy of five preferred items. All items identified were placed on a closed economy (i.e., reinforcers were available only within session) within the agency to ensure participants only accessed the items during the study.

Following completion of the MSWO, all participants completed resurgence testing. Three phases were assessed using a

linear strip design. Prior to each session, the researcher read the following instructions to the participant:

For the next 10 minutes, you will earn tokens that you can exchange at the end of the session. You can earn tokens by grabbing a foam ball from the box and placing it in either basket. However, you won't get a token every time. If you have any questions, please ask them now. After I put my headphones in, I cannot talk to you.

After answering any questions, the researcher put on the headphones and started the session. The researcher developed a variable-interval 10-s schedule of reinforcement, which was played on the iPhone to signal to the researcher when to deliver the reinforcer. The researcher wore headphones that were connected to the iPhone to ensure participants could not hear the reinforcer signal. During each 10-min session, tokens were either delivered contingent upon responding (phases I and II) or were withheld (phase III). Token delivery consisted of the researcher adding a token to the token board, which was located on the table in sight of the participant. Across phases, the researcher continued to add foam balls to the cardboard box to ensure participants could continue to place balls into the baskets. At the end of each session, participants exchanged tokens for 5-min access to items identified by the MSWO. A cancellation contingency was used to control for delivery of reinforcement following incorrect responses. If the response placed on extinction occurred during the last 3 s of the interval, reinforcement was not delivered.

Phase I: VI 10/Ext The purpose of this phase was to establish reinforcement for R_1 . Reinforcement for R_1 was delivered on a variable-interval (VI) 10-s schedule while R_2 was on extinction. The contextual stimulus for phase I was a red pillow. Upon completion of each interval, the researcher added one token to the participant's token board contingent upon engagement in R_1 and recorded the session time.

Phase II: Ext/Yoked VI The purpose of this phase was to establish reinforcement for R_2 , while R_1 was placed on extinction. The contextual stimulus for phase II was a white pillow. During phase II, a yoked fixed time (FT) schedule of reinforcement was derived from the time in which R_1 received reinforcement during phase I to control for equal magnitude of reinforcement. In order to yoke the schedule, the researcher developed a reinforcement schedule off the recorded time obtained during phase I. The reinforcement schedule began as soon as the participant placed a ball into a basket. Upon completion of the interval, the researcher added one token to the participant's token board.

Phase III: Ext/Ext The purpose of this phase was to determine whether or not resurgence would be observed when

reinforcement was removed for all responses. During this phase, both target behaviors were placed on extinction and tokens were not provided.

Interobserver Agreement and Treatment Integrity

Total count interobserver agreement (IOA) was collected by a second independent observer on all target and alternative responses for 20 % of the sessions. IOA was determined by dividing the smaller count of responses recorded by the larger count of responses recorded and multiplying by 100 to identify percent of agreement. IOA was 96 % for R_1 and 95 % for R_2 (range = 83 to 100 %). Treatment integrity was assessed on the extent to which the researcher followed the procedures for 20 % of sessions. Treatment integrity was calculated by dividing the actual number of opportunities for correct responding by the total number of opportunities, multiplied by 100. Treatment integrity was 100 %.

Results and Discussion

Figure 1 represents the rate of responding for all participants. Lance, Simon, and Spencer's response requirement for R_1 was to place a foam ball in a basket that was .9 m away, while Luke, Morgan, and Kyle's R_1 response effort was to place a foam ball 1.829 m away. Higher rates of R_1 were observed for all six participants during phase I (delayed response allocation for R_1 occurred with Simon). During phase II, all participants switched response allocation to the basket associated with decreased response effort (.0254 m away) within one to three sessions. During phase III (extinction), five of the six participants (all except Lance) decreased responding of both R_1 and R_2 to near zero levels between three and five sessions. Lance engaged in both R_1 and R_2 across all extinction sessions; R_1 resurged during the second and third sessions, while R_2 occurred every session at rates relative to the alternative reinforcement phase. Resurgence of R_1 occurred for four of six participants within the first extinction session regardless of distance (e.g., Spencer, Luke, Morgan, and Kyle).

The current study demonstrates resurgence in an understudied population, as all participants had an emotional behavioral diagnosis. Further, the current study is the first study to systematically analyze resurgence rates across response effort in humans. All participants engaged in the response paired with an increased response effort during extinction; interestingly, participants engaged in the increased response requirement (placing balls in a basket 1.829 m away) at lower rates during extinction when compared to participants exposed to a minimal response requirement (placing balls in a basket .9 m away). The findings of the current study are consistent with previous research on resurgence (e.g., Sweeney & Shahan, 2013; Wacker et al., 2013) and add to the growing

research on mitigating rates of resurgence in clinical settings (e.g., Marsteller & St. Peter, 2014; Volkert et al., 2009). When taken together with the differentiation of rates of resurgence during periods of extinction, it would appear that response effort (rather than magnitude of reinforcement) diminished resurgence rates during phase III. Response effort can reduce relative rates of resurgence during periods of extinction, which can have significant implications for behavior analysts developing behavioral intervention plans.

While the present study used arbitrary responses (e.g., placing balls into baskets), the findings herein support a step towards understanding how response effort affects relative rates of resurgence during periods of extinction. The current study suggests that selecting a functionally equivalent alternative behavior of less response effort than a targeted aberrant behavior would likely decrease relative response rates of the behavior that requires more effort to emit. Clinical implications of these findings suggest that behavioral service providers should consider the response effort of alternative responses when selecting treatment plans for aberrant behavior. For instance, when selecting an alternative response for property destruction (e.g., throwing heavy objects at walls), behavioral providers should consider the response effort of an alternative response (e.g., using signs, picture exchange systems, single-response requirements, etc.). While many behavioral providers may already be including this into their practice, including similar practices could help to minimize relative rates of resurgence during periods of extinction, thus increasing the probability of maintenance of the newly acquired alternative behavior.

These findings, however, must be interpreted in light of the following limitations. First, the use of instructions rather than magazine training was used, which could have impacted the degree to which participants responded during phase I. Second, the researcher delivering tokens may have served as a signal for reinforcement availability (e.g., researcher opening the bag, reaching in, etc.). Similarly, during extinction sessions, placing balls in the basket may have functioned as adjunctive behaviors (particularly for Lance). The researcher continued to move the balls from the baskets to the cardboard box, but sometimes this resulted in (a) participants laughing and treating it like a game, or (b) a ceiling effect (e.g., rates of responding became a function of the availability of balls). Having extra balls during all sessions and ignoring all forms of attention-seeking behaviors mitigated this limitation.

Future research should control for reinforcement delivery to ensure variability in responding is a result of the response effort, rather than variations in reinforcement schedules or influence from contextually controlled stimuli. Future research should consider alternative ways to quantitatively assess response effort. Response effort can be measured across temporal aspects of responding (e.g., fast vs. slow), frequency of responding (e.g., total number of responses needed to gain

Fig. 1 Responses per minute across participants. Closed squares represent R₁ while open circles represent R₂

access to a reinforcer), strength or energy expended (e.g., picking up 10 lbs vs. 1 lbs to gain access to a reinforcer), or distance traveled. The current study selected distance as the relevant feature as a starting point, given the ease with operational definitions and agreement across multiple observers. However, more information is needed to determine the extent to which different features of response strength impact rates of resurgence.

Finally, as previously mentioned, behavioral service providers may already be considering response effort within their practice. Future research should consider analyzing clinical data to determine if similar response patterns exist. Clinical

demonstrations of effects of response effort across functionally equivalent behaviors would assist the behavioral community with understanding the important role of response effort, particularly within clinical practice. While the current study is a first step towards translational research, a clinical demonstration with target behaviors of social significance can only help practitioners utilize this strategy in their own practice.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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