JOURNAL OF APPLIED BEHAVIOR ANALYSIS 2018, 51, 854–865 NUMBER 4 (FALL)

RESURGENCE WITH AND WITHOUT AN ALTERNATIVE RESPONSE

RYAN T. KIMBALL AND MICHAEL E. KELLEY

THE SCOTT CENTER FOR AUTISM TREATMENT AND THE FLORIDA INSTITUTE OF TECHNOLOGY

CHRISTOPHER A. PODLESNIK

THE SCOTT CENTER FOR AUTISM TREATMENT AND THE FLORIDA INSTITUTE OF TECHNOLOGY AND THE UNIVERSITY OF AUCKLAND

ALEX FORTON AND BRANDY HINKLE

THE SCOTT CENTER FOR AUTISM TREATMENT AND THE FLORIDA INSTITUTE OF TECHNOLOGY

Resurgence is the reemergence of a previously reinforced response that occurs after the elimina tion or reduction of reinforcement for an alternative response. Resurgence is problematic in the context of treatment because the reemergence of a previously reinforced destructive response could be detrimental to treatment gains. In the current translational study, we examined a mod ified resurgence procedure in which the alternative response was either present or absent during extinction. Four participants were exposed to three phases that consisted of (1) reinforcement of a target response, (2) extinction of the target response and differential reinforcement of an alter native response, and (3) extinction of both responses. Results for four out of five assessments showed greater resurgence when the alternative response was absent during Phase 3. Results sug gest that more robust resurgence might occur if the alternative response is not available as opposed to the alternative response contacting extinction.

Key words: differential reinforcement, extinction, resurgence

Determining that an intervention effectively addresses a behavioral challenge requires a dem onstration that the intervention is successful not only when implemented under ideal condi tions, such as by a highly trained clinician in a highly controlled setting, but also in the face of challenges in the natural environment (Baer, Wolf, & Risley, 1968; Stokes & Baer, 1977). Research has shown that commonly used behavioral interventions, such as functional communication training (FCT), can deteriorate following treatment periods when exposed to treatment challenges such as delays to reinforce ment or intermittent reinforcement of problem behavior (e.g., Fisher, Thompson, Hagopian, Bowman, & Krug, 2000; Hagopian, Fisher, Sullivan, Acquisto, & LeBlanc, 1998; Hanley, Iwata, & Thompson, 2001; Vollmer, Roane, Ringdahl, & Marcus, 1999).

Treatment relapse often refers to the failure of a treatment after an initially successful inter vention period (Pritchard, Hoerger, & Mace, 2014). Laboratory models of treatment relapse for behavioral interventions include several variations of response, contingency, and context arrangements that model common environ mental conditions that threaten otherwise suc cessful interventions. For example, renewal models arrange competition between the effects of contingencies and stimulus context on behavior (see Podlesnik, Kelley, Jimenez Gomez, & Bouton, 2017, for a review). Kelley, Liddon, Ribeiro, Greif, and Podlesnik (2015)

This study was based on a thesis submitted in partial fulfillment of the first author's Master of Science degree from the Florida Institute of Technology. This experiment was carried out under approval IRB # 16-037 granted by the Florida Institute of Technology. Ryan T. Kimball is now at the University of Nebraska Medical Center's Munroe-Meyer Institute.

Address correspondence to Ryan T. Kimball, Center for Autism Spectrum Disorders, 985450 Nebraska Medi cal Center, Omaha, Nebraska 68198 (email: ryan.kimball@unmc.edu)

doi: 10.1002/jaba.466

demonstrated renewal in a three-phase arrange ment in which target responding produced rein forcement on a fixed-ratio (FR) 1 schedule in Context A. Next, the experimenters extinguished target responding in Context B. Subjects then returned to Context A with target responding still under extinction; the resumption of respond ing in this context, despite the continuation of programmed extinction for target responding, defines the relapse phenomenon of renewal. These data suggest that successful interventions might be threatened by changes in context, even if treatment fidelity remains high.

Resurgence is another model of treatment relapse. Resurgence refers to the reemergence of an extinguished target response after placing a more recently reinforced alternative response on extinction (Doughty & Oken, 2008; Epstein, 1983). This relapse type differs from renewal in that resurgence is associated with a change in reinforcement conditions for the alternative response rather than a change in context (cf. Bouton, Winterbauer, & Todd, 2012; Trask, Schepers, & Bouton, 2015; Winterbauer & Bou ton, 2010). Epstein (1983) presented a three stage model for studying resurgence with pigeons. In Phase 1, key pecks were reinforced on a variable-interval (VI) 1-min schedule. In Phase 2, key pecks were placed on extinction while alternative or incompatible responses, such as head turns and wing raises, were reinforced. Finally, in Phase 3, both key pecks and alterna tive responses were placed on extinction. The resumption of key pecks in Phase 3 defines the process of resurgence.

Interest in the resurgence phenomenon has increased among applied researchers in recent years as a conceptual and experimental frame work for understanding variables that might threaten otherwise effective interventions. For instance, FCT requires placing problem behav ior on extinction and reinforcing a communica tive response (e.g., a card exchange). However, in naturalistic environments, caregivers may fail to respond to an appropriate communicative response (i.e., extinction or extinction-like integrity lapses may occur; Volkert, Lerman, Call, & Trosclair-Lasserre, 2009), and labora tory models of these integrity failures have been shown to result in the resurgence of problem behavior (Fuhrman, Fisher, & Greer, 2016; Lieving, Hagopian, Long, & O'Connor 2004; Petscher, Rey, & Bailey, 2009; Saini, Fisher, & Pisman, 2017; Volkert et al., 2009).

There are other forms of integrity failure fol lowing FCT that may also create extinction-like conditions and therefore support the resurgence of problem behavior. For instance, many chil dren who experience FCT use an alternative or augmentative communication system that requires transportable materials, such as a com munication book, picture cards, or a speech generating device. If these materials are lost or not immediately available to the client when a relevant establishing operation is arranged, the unavailability of a reinforceable response may also create extinction-like conditions and set the occasion for resurgence. However, few studies have evaluated resurgence under these conditions, so it is not clear if resurgence is more or less likely under conditions in which the response alternative is absent. Conceptually, it is not understood if resurgence occurs due to the absence of reinforcement or as a result of a response contacting an extinction contingency. If a response is required to contact extinction, then conditions in which a response is pre vented by the absence of materials should fail to produce resurgence.

Wacker et al. (2013) examined resurgence of destructive behavior when the availability of an alternative response was restricted with a child with escape-maintained problem behavior. In Phase 1, parents provided escape from demands contingent on the occurrence of destructive behavior. In Phase 2, parents introduced FCT by blocking all instances of destructive behav ior, implementing escape extinction, and pro viding breaks following touches of a card with the word play affixed to a microswitch button.

Lastly, in Phase 3, therapists discontinued rein forcement for the communicative response and tested for resurgence of destructive behavior during two conditions. In one condition, the microswitch was present but the play card was removed; in the second condition, the micro switch was absent entirely. Wacker et al. found resurgence in both conditions with no differ ence in the pattern or magnitude of respond ing. These results suggest that resurgence could be a result of the unavailability of reinforce ment, and that the unreinforced occurrence of an alternative response may not be necessary for this phenomenon to occur.

In a related study, Podlesnik and Kelley (2014) investigated differences between the typical resurgence procedure (stimulus present) and a modified resurgence procedure (stimulus absent) in pigeons. In the typical resurgence procedure, target responding on the right key was reinforced on a VI 60-s schedule in Phase 1. Alternative responses on the left key were reinforced on a VI 60-s schedule in Phase 2. Phase 3 consisted of extinction for both responses. This condition modeled a scenario in which an individual has the means to com municate, but the response contacts extinction. In the modified resurgence condition, proce dures were identical to the typical resurgence procedure except for the exclusion of the dis criminative stimulus that signaled the availabil ity of alternative reinforcement (i.e., keylight turned off) during Phase 3. The modified resurgence procedure modeled a situation in which a parent or caregiver lost the communi cation card necessary for FCT. Results again showed resurgence in both conditions at similar levels, but a more abrupt resurgence in the modified procedure. Thus, a gap exists between the applied (Wacker et al., 2013) and basic research findings (Podlesnik & Kelley, 2014). However, these studies differed in terms of sub jects, response topographies, stimuli associated with response opportunities, and schedules of reinforcement programmed for target and alternative responses. Thus, the extent to which we can compare the results of these studies is limited given the differences in procedures. For this reason, a systematic replication of Podle snik and Kelley is warranted.

In the present study, we conducted a trans lational investigation of the role of stimuli contributing to resurgence (see also Kelley et al., 2015; Liggett, Nastri, & Podlesnik, 2018) to replicate and extend the findings from Podlesnik and Kelley (2014) to a labora tory study with humans. Specifically, we compared the levels and patterns of resurgence across two different arrangements character ized by the availability and restriction of the alternative response during Phase 3 in which reinforcement was unavailable.

METHOD

Participants, Setting, and Materials

Nate, Andy, Connor (4-year-old males), and Sean (5-year-old male) participated in this study. Nate, Andy, and Connor were diag nosed with Autism Spectrum Disorder (ASD), and Sean was neurotypical. These individuals were the first four to respond to research recruitment flyers who met the inclusion cri teria of demonstrating (a) mastery of at least one task that could be measured in a free operant format (e.g., sorting, matching, letter/ number tracing, etc.) and (b) the ability to sit in a chair or on the floor for at least 5 min while abstaining from significant problem behavior that could interfere with the study. All experimental sessions were conducted at an early intervention facility. Nate, Andy, and Sean participated in cubicle work areas and Connor participated in padded treatment rooms. Materials present during sessions included (a) participant-specific task materials, (b) furniture such as one table and two chairs, and (c) equipment for data collection such as a computer and a camera.

Pre-experimental Assessment

Experimenters exposed participants to paired-stimulus preference assessments (Fisher et al., 1992; data available upon request). Assessments included six to eight items, includ ing tangible items (i.e., toys) for Nate and Andy, and edible items for Connor and Sean. Each stimulus was presented in a paired array with every other stimulus twice, with each stimulus balanced in presentation on the left side and right side. The purpose of this assess ment was to identify high-preference stimuli to deliver as reinforcers in the forthcoming sessions. For Nate and Andy, the highest preferred items were iPads. For Connor and Sean, the highest preferred edibles were Skittles.

Response Measurement and Interobserver Agreement

Experimenters collected frequency data for each dependent measure using a computer equipped with specialized data-collection soft ware. For Nate, the target and alternative responses consisted of ring stacking on two dif ferent ring stackers (grasping a ring with the hand and placing the ring on top of the stacker with the hole of the ring meeting the spire of the ring stacker). For Andy, the target and the alternative responses consisted of placing large balls into one of two tall plastic bins (grasping a ball with the hand and placing the ball into the bucket so that the ball visibly contacted the bottom of the bucket). Over the course of the study, Andy occasionally engaged in an alterna tive, competing play response, defined as grasp ing a ball with the hand and throwing the ball further than 15 cm from the bucket. For Con nor and Sean, the target and alternative responses consisted of sorting of colored blocks (grasping a block with the hand and placing it into the corresponding colored bucket so that the block visibly contacted the bottom of the bucket).

neously with the primary observer or via video recordings during 45%, 41%, 30%, and 53% of sessions for Nate, Andy, Connor, and Sean, respectively. Interobserver agreement was calcu lated by comparing observers' records on an interval-by-interval basis using the exact agree ment method. That is, each observer's scoring record was divided into equal 10-s intervals, and we compared observer's records of the number of responses within each interval. If the number of scored responses was identical, we coded the interval in agreement, and if the number of scored responses was nonidentical, we coded the interval in disagreement. We then summed number of intervals in agreement, divided by the total number of intervals in a session, and converted this quotient into a per centage. Mean agreement for target responding was 95%, 97%, 87%, and 84% for Nate, Andy, Connor, and Sean, respectively. Mean agreement for alternative responding was 99%, 99%, 88%, and 89% for Nate, Andy, Connor, and Sean, respectively. Mean agreement for alternative play responding exhibited by Andy was 88%.

Experimental Design

The standard three-phase resurgence arrange ment (see Podlesnik & Kelley, 2015) was used in this study, and it included (a) reinforcement of the target response, (b) reinforcement of an alternative response plus extinction for the tar get response, and (c) extinction for both responses. Additionally, a two-component mul tiple schedule was incorporated into Phase 3. One condition consisted of a typical resur gence condition and the other consisted of a modified resurgence condition (described below). To minimize any potential sequence effects, the conditions of Phase 3 were intro duced in a counterbalanced order of ABBA BAAB (Barlow & Hayes, 1979). Nate and Connor were exposed to the modified

condition first; Andy and Sean were exposed to the typical condition first. Note that Andy was exposed to a second, three-phase arrangement in an attempt to replicate his results. The experiment lasted 7 days for Sean, Connor, and Andy's first exposure. Andy's second exposure was 15 days, and Nate's exposure lasted 8 days. Experimenters typically conducted two to four sessions per day. Phase changes were intro duced within days and responding was tested under extinction conditions across more than one day.

Procedure

In each phase, the experimenter presented one or two free-operant tasks to the participant and stated, “You can do (task) as much or as little as you want.” The experimenter did not provide any additional response prompts to the participants during the study. All sessions for Nate and Andy lasted 5 min. For Connor, the therapist terminated the sessions after 15 edible reinforcer deliveries or 5 min, whichever occurred first. We used visual inspection and steady-state logic to determine phase changes during the experiment. Engagement with the tangible item delivered as reinforcement did not compete with the participants’ ability to engage in the target or alternative response, but experi menters did not deliver additional reinforcer access if the participant responded during rein forcement intervals. Experimenters blocked Andy’s alternative play responses (data available upon request) during Andy’s second exposure to the experimental design starting at session 20.

Phase 1: Reinforcement of a target response. During this condition, the experimenter pre sented the participants with a free-operant task. Initially, experimenters provided one edible item or 20-s access to a tangible item contin gent on target responses on a fixed-ratio (FR) 1 schedule of reinforcement. Once responding was considered stable through visual inspection, we then thinned the schedule of reinforcement from a FR 1 schedule to a variable-ratio (VR) 2 schedule. We selected a VR 2 schedule for two reasons. First, we chose a VR 2 schedule to promote target response persistence during Phase 3 via decreased discriminability of the extinction contingency (i.e., partial reinforce ment; Nevin & Grace, 2005). Second, descrip tive research on the naturally delivered consequences for problem behavior suggests these behaviors typically operate on an approxi mation of an intermittent schedule (Mace & Lalli, 1991; McKerchar & Thompson, 2004; Thompson & Iwata, 2001); thus a VR-2 schedule seemed a better approximation of the natural baselines for which Phase 1 served as an analog.

Phase 2: Reinforcement of an alternative response (DRA). These sessions were identical to Phase 1 except that the target response was placed on extinction, the experimenter intro duced the alternative-response materials into the experimental context, and the experimenter rein forced alternative responses with edibles or 20-s tangible access on an FR 1 schedule of reinforce ment. We chose an FR 1 schedule of reinforce ment for the alternative response to decrease the likelihood of persistent alternative responding during the resurgence test (i.e., partial reinforce ment extinction effect [PREE]; Mackintosh, 1974) and because a functional communication response is typically reinforced on an FR 1 sched ule during early stages of FCT (Tiger, Hanley, & Bruzek, 2008).

Phase 3: Resurgence test – alternative response present. These sessions were identical to Phases 1 and 2 in that both target and alternative response materials were present, but both target and alternative responses were placed on extinc tion (i.e., resulted in no programmed conse quences). This condition is an analog to treatment fidelity failure in which a caregiver stops responding to a functional communica tion response.

Phase 3: Resurgence test – alternative response absent. The alternative response was absent from the experimental context during all tests for resurgence in this condition. The target response continued to result in no programmed consequence. This condition is an analog to a treatment integrity failure in which a caregiver does not provide an individual with the mate rials necessary to engage in a functional com munication response.

RESULTS

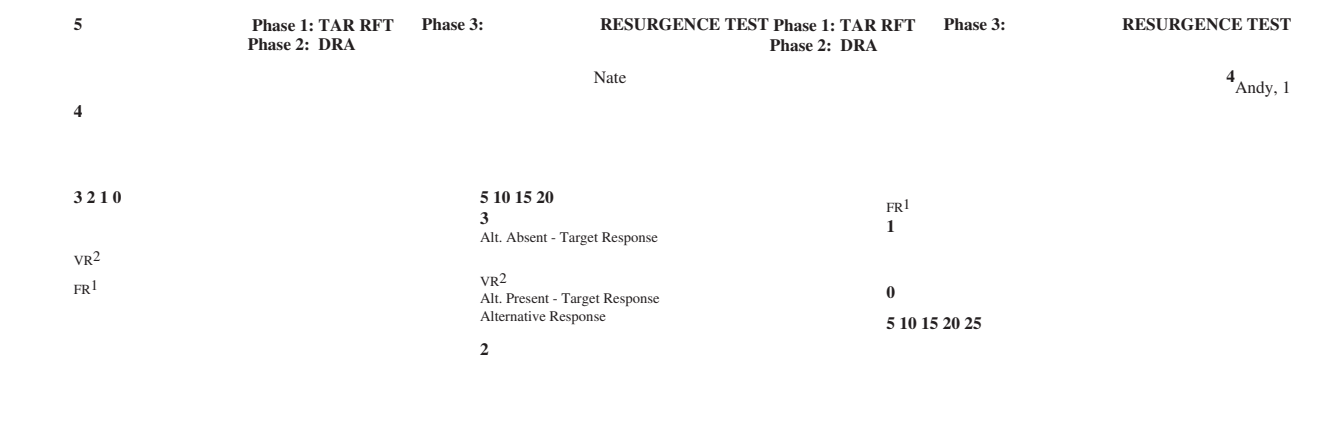
Results for all participants are depicted in Figure 1. For all participants, reinforcement increased target responding under both FR 1 and VR 2 (Phase 1) schedules—an analog for the development of problem behavior. DRA and extinction of target responding (Phase 2) reduced target behavior to zero or

near zero levels, which serves as an analog for interven tions such as FCT. The principal comparison from the experiment consisted of comparing target responding during the Phase 3 resurgence test when the alternative response was present (represented by closed circles) and absent (represented by open circles). Phase 3 served as an analog comparison of resurgence during treatment challenges of applied significance, such as when alternative behavior contacts extinction or the mechanism for the alternative response is lost (e.g., the exchangeable card). Some level of resurgence was observed in both conditions for all participants, with the excep tion of Nate during the resurgence test in which the alternative response was present. In four out of five applications (i.e., Nate, Andy [2], Connor, and Sean), resurgence was greater in the test condition in which the alternative response was absent relative to resurgence when the alternative response was present. However, it is important to note that Andy's second exposure to the procedures produced highly variable responding.

Figure 2 displays the mean and individual differences in the overall magnitude of resur gence during the alternative response present and absent resurgence tests of Phase 3 across all participants. Resurgence data from both data sets for Andy are included in Figure 2. We cal culated the mean magnitude of resurgence for each test condition (i.e., alternative response present and absent) for individual subjects by dividing the sum of response rates in each resurgence test by the number of extinction ses sions in that test condition. On average, data from this experiment show that the magnitude of resurgence was greater when the alternative response was absent (M = 4.8 rpm) relative to when the alternative response was present (M = 2.1 rpm) across participants.

DISCUSSION

In this translational study, we evaluated the resurgence of extinguished target responses both when the recently reinforced alternative response was present but placed on extinction (typical resurgence procedure; Podlesnik & Kel ley, 2014) and when the alternative response was absent (modified resurgence procedure; Podlesnik & Kelley, 2014). The data from this study are generally consistent with past research examining the treatment-relapse phenomenon of resurgence, a reemergence of an extinguished target response when a functionally equivalent and more recently reinforced alternative response is placed on extinction (Epstein, 1983; Kuroda, Mizutani, Cançado, & Podle snik, 2017a, 2017b; Lieving et al., 2004; Podlesnik & Kelley, 2014; Volkert et al., 2009; Wacker et al., 2013). These data replicate and extend those of Podlesnik and Kelley (2014), and suggest that practitioners should be selec tive when choosing alternative response topog raphies in DRA preparations. Specifically, more resurgence occurred when the alternative response was absent during a resurgence test compared to when the alternative response was present. These data provide evidence that the manner in which a treatment is challenged might affect the level of resurgence. For exam ple, resurgence may occur at higher rates if the



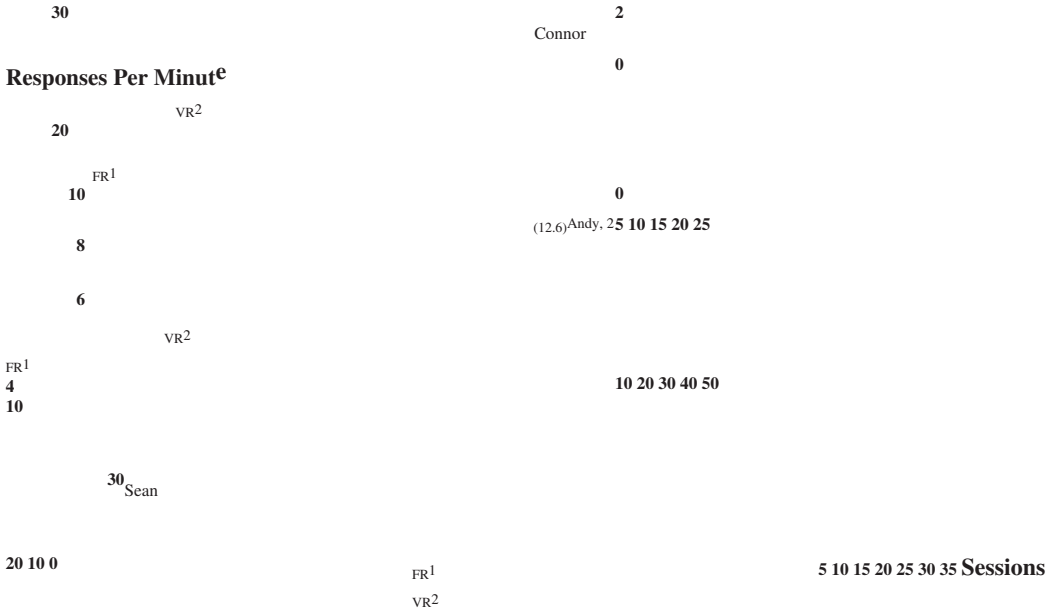


Figure 1. Displays responses per minute of target and alternative responding across Phase 1, Phase 2, and Phase 3 of the resurgence arrangement for Nate, Connor, Sean, and Andy.

materials needed to contact reinforcement during FCT are absent, compared to conditions in which the alternative response contacts extinction.

One parsimonious explanation for the pre sent results might be that the presence of the alternative response during extinction arranges for response competition between the target and the alternative response (Podlesnik & Kelley, 2014). That is, when the alternative response is present during extinction, alloca tion of behavior may be divided between the target and the alternative response. However, if the alternative response is absent during extinction, behavior may be allocated exclu sively towards the target response. Support for this hypothesis awaits further research on the behavioral processes that underlie resurgence

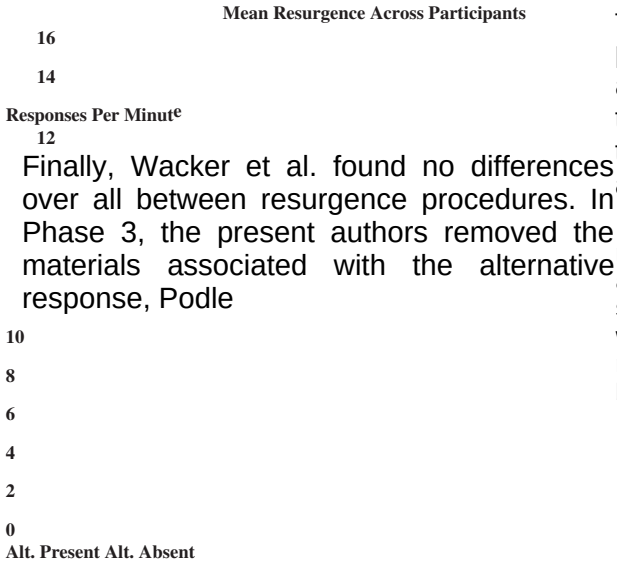


Figure 2. Bars display mean difference in overall mag nitude of resurgence between tests when the alternative response was present and absent across all sessions of extinction across participants. The lines with the closed circles depict the differences in magnitudes of resurgence for individual subjects between resurgence tests.

Finally, Wacker et al. found no differences over all between resurgence procedures. In Phase 3, the present authors removed the materials associated with the alternative response, Podlesnik and Kelley (2014) removed the discrimina tive stimulus for the alternative behavior, and Wacker et al. modified the microswitch that functioned as the alternative response. It is possi ble that the participants in the Wacker et al. study engaged in similar responding in the typical and the modified conditions because the experimenters did not arrange for the alternative during different stimulus and reinforcement conditions.

The data in the current study, in comparison with those of Podlesnik and Kelley (2014) and Wacker et al. (2013), include some important similarities and

differences. Despite resurgence occurring in all three studies, the specific details of the modified resurgence conditions likely con tributed to three different effects when compar ing typical and modified procedures. Specifically, Podlesnik and Kelley (2014) demonstrated that target responding in the typical Phase 3 resur gence test first occurred at lower levels, before increasing to high levels and then decreasing towards zero levels (i.e., a bitonic change in responding). They found a different pattern of target responding in the modified Phase 3 resur gence test. When experimenters removed the dis criminative stimulus for the alternative response, target responding immediately increased and then decreased throughout the resurgence test (i.e., a monotonic change in responding; see Podlesnik & Kelley, 2015; Shahan & Craig, 2017, for relevant discussions). The current study found differences in levels of resurgence, but generally not in the patterns of resurgence.

response itself to be present or absent during extinction. That is, they only modified its visual properties by removing the attached card from the microswitch. One hypothesis is that the con ditions are more salient when the opportunity to engage in the alternative response is present or absent as in the current study and the study con ducted by Podlesnik and Kelley (2014). At the very least, results of these studies suggest that additional research is warranted to discover the specific stimulus conditions that influence parameters of resurgence. For example, changing aspects of the antecedent stimulus conditions when assessing resurgence can enhance resur gence (e.g., Bai, Cowie, & Podlesnik, 2017; Kin caid, Lattal, & Spence, 2015). In other words, levels of resurgence may change depending on clinicians' use of signals for DRA treatments or if there are simultaneous changes in context during resurgence tests.

Collectively, the data from the current study and the results of Podlesnik and Kelley (2014) show that different resurgence-testing condi tions can affect resurgence differently (e.g., level and/or pattern). While these studies examined the presence or absence of alternative stimuli, Volkert et al. (2009) assessed the effects of both extinction and schedule thinning on resurgence. All of these findings may be relevant for appli cation, because treatments can be challenged in many different ways. It is reasonable to assume that parents, teachers, or caregivers may fail to signal the availability of reinforcement

(Podlesnik & Kelley, 2014), lose the materials needed to engage in the alternative response (current study), or inadvertently thin reinforce ment schedules (Volkert et al.). Further research could examine the relative contribution of these challenges to treatment both in isolation and in combination.

Our data may also have relevance to rein forcement schedule-thinning procedures. Rein forcement schedule thinning is a gradual process of exposing behavior to a leaner schedule of reinforcement that more closely approximates the natural environment in order to establish a more practical treatment (Hagopian, Boelter, & Jarmolowicz, 2011). For example, after initial stages of FCT when alternative responses pro duce reinforcement on a dense schedule of rein forcement (e.g., FR 1), experimenters may introduce a multiple schedule in which thera pists arrange an alternation between signaled periods of reinforcement availability (S^D) and unavailability (S^Δ; see Saini, Miller, & Fisher, 2016, for a review). A few studies have described response restriction as an approach to schedule thinning in which the alternative response (e.g., exchangeable FCT card) is removed during periods in which reinforcement is unavailable (i.e., S^Δ periods; Fisher, Greer, Querim, & DeRosa, 2014; Roane, Fisher, Sgro, Falco mata, & Pabico, 2004). Our data suggest that higher levels of resurgence may occur during response restriction than when the alternative response is available. Further research is neces sary to test this hypothesis, but practitioners faced with the task of schedule thinning should consider each procedure's potential effects on the resurgence of problem behavior.

The resurgence data for Andy stand out from some of the other data sets. First, we observed less resurgence of target responding during Andy's first exposure to the Phase 3 resurgence test relative to the

other four data sets. Andy often engaged in an alternative play response that competed with target and alternative responding. Engagement in this alternative play activity may have minimized the degree of resurgence during periods in which extinction was programmed for all responding. These data are in general agree ment with a growing area of research showing that the promotion of alternative activity during delays to reinforcement or periods of extinction may reduce the reemergence of destructive behavior (e.g. Austin & Tiger, 2015; Ghaemma ghami, Hanley, & Jessel, 2016; Hagopian, Con trucci Kuhn, Long, & Rush, 2005; Rooker, Jessel, Kurtz, & Hagopian, 2013).

Second, in the first exposure to the Phase 3 resurgence test, low levels of resurgence occurred in the test with the alternative response absent, but a high rate of resurgence occurred for one session of the test when the alternative response was present. These data are in stark contrast to the levels of resurgence observed with Nate. That is, with Nate, we observed a robust resurgence in the test when the alternative response was absent, but resur gence did not occur in the test when the alter native response was present. On the other hand, when Andy's responding was exposed to the Phase 3 resurgence test for the second time, markedly higher levels of resurgence occurred in both resurgence conditions. These data are roughly consistent with the results of studies showing that lengthier training histories for tar get responses produce more resurgence relative to shorter training histories (Bruzek, Thomp son, & Peters, 2009; Doughty, Cash, Finch, Holloway, & Wallington, 2010; Winterbauer, Lucke, & Bouton, 2013). However, the block ing procedure for Andy's alternative play response during the second exposure to experi mental conditions may also have affected levels of resurgence. Future research might assess the effects of differential training histories on the likelihood and magnitude of resurgence. Such studies would provide insight into how an extensive history of reinforcement for problem behavior contributes to the resistance of prob lem behavior to treatment, and to the likeli hood of resurgence when treatment integrity is

challenged (Nevin & Wacker, 2013; Podle snik & DeLeon, 2015).

A possible limitation to the current study is that target and alternative responses were topographically similar with each participant (e.g., ring stacking on two different ring stackers with Nate). In contrast to the arrange ment from the current study, in applied situa tions, the target response (i.e., self-injurious behavior) is usually topographically disparate from the programmed alternative response (i.e., exchangeable FCT card). Accordingly, in the current study, the presence of the mate rials relevant to the target response in the modified resurgence test (i.e., alternative response absent) might have served as a dis criminative stimulus for the availability of reinforcement to a relatively greater extent than if the target response were topographi cally different from the alternative response.

The present findings suggest the topography of alternative responses taught during FCT could contribute to the likelihood of resur gence of problem behavior if that topography requires materials to exchange, select, or acti vate. Thus, a final implication of the present findings is that additional research should be directed toward examining the effects of FCT via vocal or sign-language responses on resur gence of problem behavior during reinforce ment schedule thinning. With a card exchange, treatment can be challenged both through failures to reinforce the card exchange, as well as losing the card. Because vocal or signing responses cannot be lost, resurgence of problem behavior might be less likely or severe if a replacement behavior con tacts extinction only, rather than the absence of alternative reinforcement due to the una vailability of the response.

REFERENCES

Austin, J. E., & Tiger, J. H. (2015). Providing alternative reinforcers to facilitate tolerance to delayed reinforcement following functional communication training. Journal of Applied Behavior Analysis, 48, 663-668. https://doi.org/10.1002/jaba.215

Baer, D. M., Wolf, M. M., & Risley, T. R. (1968). Some current dimensions of applied behavior analysis. Jour nal of Applied Behavior Analysis, 1, 91-97. https://doi. org/10.1901/jaba.1968.1-91

Bai, J. Y. H., Cowie, S., & Podlesnik, C. A. (2017). Quantitative analysis of local-level resurgence. Learn ing & Behavior, 45, 76-88.

Barlow, D. H., & Hayes, S. C. (1979). Alternating treat ments design: One strategy for comparing the effects of two treatments in a single subject. Journal of Applied Behavior Analysis, 12, 199-210. https://doi. org/10.1901/jaba.1979.12-199

Bouton, M. E., Winterbauer, N. E., & Todd, T. P. (2012). Relapse processes after the extinction of instrumental learning: Renewal, resurgence, and reac quisition. Behavioural Processes, 90, 130-141. https:// doi.org/10.1016/j.beproc.2012.03.004

Bruzek, J. L., Thompson, R. H., & Peters, L. C. (2009). Resurgence of infant caregiving responses. Journal of the Experimental Analysis of Behavior, 92, 327-343. https://doi.org/10.1901/jeab.2009-92-327

Doughty, A. H., Cash, J. D., Finch, E. A., Holloway, C., & Wallington, L. K. (2010). Effects of training history on resurgence in humans. Behavioural Processes, 83, 340-343. https://doi.org/10.1016/j.beproc.2009.12.001

Doughty, A. H., & Oken, G. (2008). Extinction-induced response resurgence: A selective review. The Behavior Analyst Today, 9, 27-33. https://doi.org/10.1037/ h0100644

Epstein, R. (1983). Resurgence of previously reinforced behavior during extinction. Behavior Analysis Letters, 3, 391-397.

Fisher, W. W., Greer, B. D., Querim, A. C., & DeRosa, N. (2014). Decreasing excessive functional communication responses while treating destructive behavior using response restriction. Research in Devel opmental Disabilities, 35, 2614-2623. https://doi. org/10.1016/j.ridd.2014.06.024

Fisher, W., Piazza, C. C., Bowman, L. G., Hagopian, L. P., Owens, J. C., & Slevin, I. (1992). A comparison of two approaches for identifying reinforcers for persons with severe and profound dis abilities. Journal of Applied Behavior Analysis, 25, 491-498. https://doi.org/10.1901/jaba.1992.25-491

Fisher, W. W., Thompson, R. H., Hagopian, L. P., Bowman, L. G., & Krug, A. (2000). Facilitating tol erance of delayed reinforcement during functional communication training. Behavior Modification, 24, 3-29. https://doi.org/10.1177/0145445500241001

Fuhrman, A. M., Fisher, W. W., & Greer, B. D. (2016). A preliminary investigation on improving functional communication training by mitigating resurgence of destructive behavior. Journal of Applied Behavior

Analysis, 49, 884-899. https://doi.org/10.1002/ jaba.338

Ghaemmaghami, M., Hanley, G. P., & Jessel, J. (2016). Contingencies promote delay tolerance. Journal of Applied Behavior Analysis, 49, 548-575. https://doi. org/10.1002/jaba.333

Hagopian, L. P., Boelter, E. W., & Jarmolowicz, D. P. (2011). Reinforcement schedule thinning following functional communication training: Review and rec ommendations. Behavior Analysis in Practice, 4, 4-16. https://doi.org/10.1007/BF03391770

Hagopian, L. P., Contrucci Kuhn, S. A., Long, E. S., & Rush, K. S. (2005). Schedule thinning following communication training: Using competing stimuli to enhance tolerance to decrements in reinforcer density. Journal of Applied Behavior Analysis, 38, 177-193. https://doi.org/10.1901/jaba.2005.43-04

Hagopian, L. P., Fisher, W. W., Sullivan, M. T., Acquisto, J., & LeBlanc, L. A. (1998). Effectiveness of functional communication training with and with out extinction and punishment: A summary of 21 inpatient cases. Journal of Applied Behavior Analysis, 31, 211-235. https://doi.org/10.1901/jaba. 1998.31-211

Hanley, G. P., Iwata, B. A., & Thompson, R. H. (2001). Reinforcement schedule thinning following treatment with functional communication training. Journal of Applied Behavior Analysis, 34, 17-38. https://doi. org/10.1901/jaba.2001.34-17

Kelley, M. E., Liddon, C. L., Ribeiro, A., Greif, A. E., & Podlesnik, C. A. (2015). Basic and translational eval uation of renewal of operant responding. Journal of Applied Behavior Analysis, 48, 390-401. https://doi. org/10.1002/jaba.209

Kincaid, S. L., Lattal, K. A., & Spence, J. (2015). Super resurgence: ABA renewal increases resurgence. Beha viour al Processes, 115, 70-73. https://doi.org/10.1016/ j.beproc.2015.02.013

Kuroda, T., Mizutani, Y., Cançado, C. R., & Podlesnik, C. A. (2017a). Operant models of relapse in zebrafish (Danio rerio): Resurgence, renewal, and reinstatement. Behavioural Brain Research, 335, 215- 222. https://doi.org/10.1016/j.bbr.2017.08.023

Kuroda, T., Mizutani, Y., Cançado, C. R., & Podlesnik, C. A. (2017b). Reversal learning and resurgence of operant behavior in zebrafish (Danio rerio). Behavioural Processes, 142, 79-83. https://doi. org/10.1016/j.beproc.2017.06.004

Lieving, G. A., Hagopian, L. P., Long, E. S., & O'Connor, J. (2004). Response-class hierarchies and resurgence of severe problem behavior. The Psycholog ical Record, 54, 621-634.

Liggett, A. P., Nastri, R., & Podlesnik, C. A. (2018). Assessing the combined effects of resurgence and reinstatement in children diagnosed with Autism Spectrum Disorder. Journal of the Experimental Analy sis of Behavior, 109, 408-421.

Mace, F. C., & Lalli, J. S. (1991). Linking descriptive and experimental analyses in the treatment of bizarre speech. Journal of Applied Behavior Analysis, 24, 553- 562. https://doi.org/10.1901/jaba.1991.24-553

Mackintosh, N. J. (1974). The psychology of animal learn ing. Oxford, UK: Academic Press.

McKerchar, P. M., & Thompson, R. H. (2004). A descriptive analysis of potential reinforcement contin gencies in the preschool classroom. Journal of Applied Behavior Analysis, 37, 431-444. https://doi.org/10. 1901/jaba.2004.37-431

Nevin, J. A., & Grace, R. C. (2005). Resistance to extinc tion in the steady state and in transition. Journal of Experimental Psychology: Animal

Behavior Processes, 31, 199-212. https://doi.org/10.1037/0097-7403.31. 2.199

Nevin, J. A., & Wacker, D. P. (2013). Response strength and persistence. In G. J. Madden et al. (Eds.), APA handbooks in psychology: APA handbook of behavior analysis, vol. 2: Translating principles into practice (pp. 109-128). Washington, DC: American Psycholog ical Association. https://doi.org/10.1037/13938-005

Petscher, E. S., Rey, C., & Bailey, J. S. (2009). A review of empirical support for differential reinforcement of alternative behavior. Research in Developmental Disabilities, 30, 409-425. https://doi.org/10.1016/j. ridd.2008.08.008

Podlesnik, C. A., & DeLeon, I. G. (2015). Behavioral momentum theory: Understanding persistence and improving treatment. In F. D. DiGennaro Reed & D. D. Reed (Eds.), Autism service delivery: Bridging the gap between science and practice (pp. 327–351). New York, NY: Springer.

Podlesnik, C. A., & Kelley, M. E. (2014). Resurgence: Response competition, stimulus control, and rein forcer control. Journal of the Experimental Analysis of Behavior, 102, 231-240. https://doi.org/10.1002/ jeab.102

Podlesnik, C. A., & Kelley, M. E. (2015). Translational research on the relapse of operant behavior. Mexican Journal of Behavior Analysis, 41, 226-251.

Podlesnik, C. A., Kelley, M. E., Jimenez-Gomez, C., & Bouton, M. E. (2017). Renewed behavior produced by context change and its implications for treatment maintenance: A review. Journal of Applied Behavior Analysis, 50, 675-697. https://doi.org/10.1002/ jaba.400

Pritchard, D., Hoerger, M., & Mace, F. C. (2014). Treat ment relapse and behavioral momentum theory. Jour nal of Applied Behavior Analysis, 47, 814-833. https:// doi.org/10.1002/jaba.163

Roane, H. S., Fisher, W. W., Sgro, G. M., Falcomata, T. S., & Pabico, R. R. (2004). An alter native method of thinning reinforcer delivery during differential reinforcement. Journal of Applied Behavior Analysis, 37, 213-218. https://doi.org/10.1901/jaba. 2004.37-213

Rooker, G. W., Jessel, J., Kurtz, P. F., & Hagopian, L. P. (2013). Functional communication training with and without alternative reinforcement and punishment: An analysis of 58 applications. Journal of Applied Behavior Analysis, 46, 708-722. https://doi.org/10.1002/jaba.76

Saini, V., Fisher, W. W., & Pisman, M. D. (2017). Per sistence during and resurgence following noncontin gent reinforcement implemented with and without extinction. Journal of Applied Behavior Analysis, 50, 377-392. https://doi.org/10.1002/jaba.380

Saini, V., Miller, S. A., & Fisher, W. W. (2016). Multiple schedules in practical application: Research trends and implications for future investigation. Journal of Applied Behavior Analysis, 49, 421-444. https://doi. org/10.1002/jaba.300

Shahan, T. A., & Craig, A. R. (2017). Resurgence as choice. Behavioural Processes, 141(Part 1), 100-127. https://doi.org/10.1016/j.beproc.2016.10.006

Stokes, T. F., & Baer, D. M. (1977). An implicit technol ogy of generalization. Journal of Applied Behavior Analysis, 10, 349-367. https://doi.org/10.1901/jaba. 1977.10-349

Thompson, R. H., & Iwata, B. A. (2001). A descriptive analysis of social consequences following problem behavior. Journal of Applied Behavior Analysis, 34, 169-178. https://doi.org/10.1901/jaba.2001.34-169

Tiger, J. H., Hanley, G. P., & Bruzek, J. (2008). Func tional communication training: A review and practi cal guide. Behavior Analysis in Practice, 1, 16-23. https://doi.org/10.1007/BF03391716

Trask, S., Schepers, S. T., & Bouton, M. E. (2015). Con text change explains resurgence after the extinction of
operant behavior. Revista Mexicana De Análisis De La Conducta, 41(2), 187-210.

Volkert, V. M., Lerman, D. C., Call, N. A., & Trosclair Lasserre, N. (2009). An evaluation of resurgence during treatment with functional communication training. Journal of Applied Behavior Analysis, 42, 145-160. https://doi.org/10.1901/jaba.2009.42-145

Vollmer, T. R., Roane, H. S., Ringdahl, J. E., & Marcus, B. A. (1999). Evaluating treatment chal lenges with differential reinforcement of alternative behavior. Journal of Applied Behavior Analysis, 32, 9- 23. https://doi.org/10.1901/jaba.1999.32-9

Wacker, D. P., Harding, J. W., Morgan, T. A., Berg, W. K., Schieltz, K. M., Lee, J. F., & Padilla, Y. C. (2013). An evaluation of resurgence during functional communication training. The Psy chological Record, 63, 3-20. https://doi.org/10.11133/ j.tpr.2013.63.1.001

Winterbauer, N. E., & Bouton, M. E. (2010). Mecha nisms of resurgence of an extinguished instrumental behavior. Journal of Experimental Psychology: Animal Behavior Processes, 36, 343-353. https://doi.org/10. 1037/a0017365

Winterbauer, N. E., Lucke, S., & Bouton, M. E. (2013). Some factors modulating the strength of resurgence after extinction of an instrumental behavior. Learning and Motivation, 44, 60-71. https://doi.org/10.1016/j. lmot.2012.03.003

Received April 25, 2017
Final acceptance April 28, 2018
Action Editor, Jeffrey Tiger