Serial and Concurrent Response Presentation: Their Effects on Resurgence

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SERIAL AND CONCURRENT RESPONSE PRESENTATION: THEIR EFFECTS ON RESURGENCE

by

Michael P. Kranak

A dissertation submitted to the Graduate College
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Thank you all.

Michael P. Kranak
Serial response training (SRT) may mitigate resurgence of a target response when compared to teaching a single alternative response. However, the necessity of the serial presentation of alternatives is yet to be determined. We hypothesized teaching alternative responses at the same time (concurrent response training [CRT]) may be as effective as, and more efficient than, SRT. We used a multielement design embedded within an ABC resurgence arrangement in a human operant arrangement in three studies. Twenty-seven undergraduate students enrolled in a psychology course participated. In Study 1, we compared CRT to differential reinforcement of a single alternative response (traditional DRA). In Study 2, we compared CRT, SRT, and traditional DRA. In Study 3, we implemented CRT and made real-time, data-based decisions regarding phase length rather than standard a priori phase-change criteria. We found both CRT and SRT resulted in greater persistence of alternative responses and suppression of target responses than traditional DRA. CRT and SRT also comparably mitigated resurgence of target responding. However, we also included two inactive control responses. Observed responding on those control responses indicate that persistence and resurgence during extinction may be attributed to extinction-induced behavioral variability or induction.
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INTRODUCTION

Behavior analysts have a longstanding history of producing meaningful behavior change for individuals who engage in challenging behaviors. In particular, they reduce challenging behaviors and replace them with socially acceptable alternatives. Typically, behavior change agents will use an empirically supported treatment called Functional Communication Training (FCT) in order to teach individuals socially acceptable, alternative communication responses to replace challenging behaviors (Carr & Durand, 1985; Tiger, Hanley, & Bruzek, 2008). FCT is a differential reinforcement of alternative responses (DRA) procedure that involves identifying the function of and reinforcers for the challenging behavior and subsequently selecting and explicitly teaching an alternative response while extinguishing the challenging behavior. It also involves developing procedures and protocols to ensure the socially acceptable alternative response will continue to occur following treatment (Reichle & Wacker, 2017). Tiger and colleagues (2008) reported FCT has contributed to and resulted in positive outcomes for both children and adults with and without intellectual and developmental disabilities. It has been used to reduce challenging behaviors including aggression and self-injury, inappropriate sexual behavior (Fyffe, Kahng, Fittro, & Russel, 2004), stereotypy (Wacker et al., 1990), and inappropriate communication responses (Frea & Hughes, 1997; Mace & Lalli, 1991).

However, despite the data on the efficacy of FCT and other behavior-analytic treatments, a gap in research still remains between initial treatment improvements and long-lasting persistence of those improvements (Mace et al., 2010; Osnes & Lieblein, 2003). One reason for lack of persistence of FCT’s positive effects and the continuance of challenging behaviors is resurgence (Ringdahl & St. Peter, 2017). Resurgence is the recurrence of a previously reinforced response when another, alternative response is placed on extinction (Epstein, 1983, 1985).
Resurgence can be described in three phases (Lattal et al., 2017; Lieving & Lattal, 2003; Ringdahl & St. Peter, 2017). First, an initial behavior is reinforced (Response A), which can be thought of as the initial problem behavior. Then, an alternative response is reinforced (Response B), which can be thought of as the functional communication response (FCR), while Response A is placed on extinction. This is analogous to DRA/FCT treatment for challenging behavior. Last, both responses are placed on extinction, or the reinforcement parameters for the alternative response may be worsened (Lattal et al., 2017). This might occur in FCT, if a care provider cannot reinforce the FCR for some reason. In this third phase, if Response A increases or reemerges, even though reinforcers are not being delivered for it, resurgence has occurred.

Resurgence, thus, can have serious implications regarding DRA/FCT treatment of challenging behavior. Mace and colleagues (2010) demonstrated the persistence- and resurgence-strengthening effects DRA procedures can have on problem behaviors. Their results revealed that target behaviors for all three participants persisted longer and resurged more when extinction followed DRA compared to when it did not. This suggests that reinforcing FCRs in FCT can strengthen not only the FCR, but also concurrently strengthen other topographies in the same response class (e.g., problem behavior). In applied settings, it is possible that FCRs may contact extinction due to several factors. These factors can include introduction of a novel task, extended periods of extinction, removal of the communication modality, concurrent schedules for FCRs and problem behavior (Wacker et al., 2011), lapses in treatment integrity (St. Peter Pipkin, Vollmer, & Sloman, 2010), or thinning of reinforcement schedules (Greer, Fisher, Saini, Owen, & Jones, 2016). Moreover, individuals may emit FCRs at a high rate, or at times where a caregiver cannot provide reinforcement for the FCR (Hagopian, Fisher, Thibault-Sullivan,
Acquisto, & LeBlanc, 1998), further increasing the likelihood of FCRs contacting extinction after periods of DRA.

Taken together, this research shows many different variables can affect resurgence. As a result, researchers have begun to evaluate additional variables that, when manipulated, can ameliorate resurgence (cf. Kestner & Peterson, 2017). Some of these variables are the inclusion or exclusion of stimuli associated with alternative reinforcement (Wacker et al., 2013), the use of fixed-time delivery of reinforcement during extinction (Marsteller & St. Peter, 2014), increasing rates of reinforcement for an alternative response (Reed & Clark, 2011), changing the density of schedules of reinforcement (Kuroda, Cancado, & Podlesnik, 2016), and training two mand topographies rather than one (Hoffman & Falcomata, 2014). Given the prevalence of FCT as an intervention for problem behavior, research for how to best implement that procedure would be helpful. Training multiple mands may be one way the procedure can be strengthened to reduce the occurrence of resurgence.

One interesting approach is to train multiple mands as replacement responses. Perhaps teaching the participant more than one replacement response would prevent resurgence because the participant would have another behavior other than problem behavior in his/her repertoire that is associated with reinforcement. In addition to potentially mitigating resurgence of problem behavior, teaching more than one alternative response could improve generalization and maintenance of those desirable FCRs (i.e., persistence). Indeed, programming for generalization and maintenance is one of the hallmarks of behavior-analytic technology (Stokes & Baer, 1977). Stokes and Baer (1977) recommended teaching and training multiple exemplars as one strategy to increase generalization. One way to train multiple exemplars is one at a time, introducing them in a serial fashion (i.e., serial response training [SRT]).
Hoffman and Falcomata (2014) and Berg et al. (2015) piloted treatment packages consisting of training two mands rather than just one. After teaching and subsequently placing both mands on extinction, Hoffman and Falcomata (2014) observed an increased rate and persistence of the first mand and slightly elevated rates of the second mand. Rates of aggression were not as high as mands during extinction. The latencies for the resurgence of aggression were also longer than that of the mands. These results suggest that there may be utility in training more than one alternative communicative response to prevent resurgence. However, it is unclear from this research (a) how many alternative responses should be trained, (b) in what manner they should be trained and, (c) in what context responses should be trained. And, in contrast to Hoffman and Falcomata (2014), Berg et al. (2015) did not appear to reduce resurgence. In their study with individuals that had a history of problem behavior, they observed an initial persistence of the most recently reinforced mand in the final extinction phase, but problem behavior quickly resurged. Given the consistent resurgence of problem behavior for both of Berg and colleagues’ (2015) participants, additional investigations of training multiple mands is certainly warranted.

Lambert, Bloom, Samaha, Dayton, and Rodewald (2015) extended Hoffman and Falcomata (2014) and Berg et al. (2015) and evaluated the effects of one versus multiple alternative responses in a human operant arrangement. When multiple responses were taught, they were introduced serially. Three individuals diagnosed with developmental disabilities participated. Dependent variables consisted of arbitrary alternative responses, such as activating a toggle light switch, rocker light switch, slide light switch, cord switch, and personal alarm. Activating one of those switches was designated the target behavior and served as an analog to problem behavior. All other switches were alternative responses, serving as analogs to FCRs.
Their experiment consisted of a control (traditional DRA/FCT) and test component (SRT), both of which consisted of an FR 1 reinforcement schedule for responding. Each component occurred in one of two different rooms. The control component consisted of teaching participants to activate one of the switches (a single alternative response) while placing the previously taught target switch activation response on extinction. This was analogous to traditional DRA/FCT with extinction. The test component (SRT) involved placing the previously taught target switch response on extinction while reinforcing three separate switch alternatives sequentially. This was analogous to teaching FCT but with multiple mands. They placed all switch alternatives on extinction during resurgence testing. One alternative switch was available for traditional DRA extinction tests. All alternative response switches were available for SRT extinction tests. Results showed that teaching the participants multiple alternative responses using serial procedures increased the total amount of alternative responding during FCT. It also decreased resurgence of the target response when the alternative responses were placed on extinction during the test phase. An interesting finding was that responses resurged in the reverse order that they were trained. That is, the most recently taught alternative came back first, followed by the second most recent, and up to the first alternative response taught. These results further support Hoffman and Falcomata’s (2014) findings that teaching more than one alternative response can be an effective way of mitigating resurgence.

Lambert and colleagues’ (2015) results are interesting, especially from a clinical standpoint. Given that their results, and those of Hoffman and Falcomata (2014), showed a suppression of the target response following SRT, it may be important to consider teaching multiple mands rather than one mand during FCT. Doing so may decrease resurgence if a single mand is not reinforced, which may lead to better maintenance effects. However, there were
several limitations to Lambert et al. (2015). First, it is unclear whether the lack of resurgence on
the target switch and more responding on the alternative switches was the result of extinction-
induced variability or the SRT procedure. In other words, did other responses emerge as a
function of the serial teaching, or would those responses have emerged anyway due to an
extinction burst? One way to address this question is to include a control response in the set up.
A control response is a response that is never reinforced. If responding on the control response
occurs during the test phase, then it is likely the emergence of other responses is due to
extinction-induced variability. If there is no responding on the control response during the test
phase, then one could attribute emergence of those trained responses to the serial training. Thus,
the inclusion of a control response can help determine if increased alternative responding is a
behavior already in the person’s repertoire reemerging versus response novelty (new responses
emerging) (Sweeney & Shahan, 2016). Most basic research with non-human animals includes a
control response, but the human operant studies on resurgence are variable in their inclusion of a
control response. The human operant studies on resurgence that include teaching multiple
alternatives do not generally include a control response. Studies of this nature that include a
control response would be a valuable addition to the literature.

Next, and similar to the exclusion of a control response, another potential confound is the
different number of switches present across the conditions of the study. Specifically, multiple
response stimuli were available during the resurgence test following SRT, while only one
response stimulus was available during the resurgence test that followed traditional DRA.
Therefore, it is unclear if the observed effects were a function of SRT, a participant having more
than one alternative response in his/her repertoire (i.e., a larger response class), or both.
Clinically, if the effects were a function of the individual having a larger a response class in his
or her repertoire, it may be important to determine whether or not the alternative responses should be trained one at a time (serially) or at the same time (concurrently). For example, Carrasquillo and Ringdahl (in press) conducted a study similar to Lambert et al. (2015). They evaluated teaching multiple alternative responses compared to only one alternative in a human operant arrangement with nine undergraduates. However, rather than use SRT, they used a multiple schedule approach. That is, in the multiple alternatives component, four alternating alternative responses were available compared to only one. Their results showed that multiple response alternatives resulted in less resurgence of target responding and greater persistence of alternatives compared to a single alternative during the extinction test. A subsequent applied study by Lambert, Bloom, Samaha, and Dayton (2017), however, did not replicate these results, further demonstrating the need for additional research on the value of teaching multiple replacement responses.

Assuming teaching multiple alternatives does, in fact, mitigate resurgence, the specific approach to teaching multiple alternatives (e.g., using SRT or a multiple schedule) remains unclear. Thus, future research is needed to investigate whether alternative responses need be introduced serially, or if they can be introduced concurrently and have similar effects on resurgence (Shahan & Craig, 2017).

Rather than train exemplars one at a time, serially, concurrent response training (CRT) involves training multiple exemplars (either responses or stimuli) to mastery at the same time from the onset of training. CRT has been well-researched regarding skill acquisition (cf. Wunderlich & Vollmer, 2017; Wunderlich, Vollmer, Dolandson, & Phillips, 2014). Although relatively few studies have directly compared SRT and CRT (e.g., Panyan & Hall, 1978; Stokes & Baer, 1972; Wunderlich & Vollmer, 2017; Wunderlich, et al., 2014), CRT has been shown to
result in better generalization and maintenance than SRT. For example, Schroeder and Baer (1972) directly compared SRT and CRT on the acquisition of vocal imitation. They found that SRT and CRT were comparable regarding number of trials needed to acquire the three designated targets to mastery. CRT, however, resulted in substantial increases in successful imitation of untrained targets during probe trials. Whereas SRT resulted in either minimal increases or substantial decreases in accuracy regarding untrained targets. Panyan and Hall (1978) also compared SRT and CRT on the acquisition of either vocal imitation or letter tracing. Panyan and Hall’s (1978) results were very consistent with Schroeder and Baer’s (1972). They found minimal differences in amount of time and sessions need to reach mastery using each training method. However, CRT resulted in increases in accuracy on novel task probes; SRT did not.

In some cases, CRT was also more efficient than SRT. That is, it took less time for individuals to reach mastery (Wunderlich & Vollmer, 2017; Wunderlich, et al., 2014). Given the promising results of CRT in the skill acquisition arena, it is interesting that only SRT has been investigated with regard to reducing problem behavior and increasing FCRs (e.g., Lambert et al., 2017, 2015). By not evaluating CRT in an FCT context, researchers may be failing to identify a potential effective method to decreasing resurgence of problem behavior and increasing persistence of FCRs (Bloom & Lambert, 2015).

Summary and Purpose of Dissertation

In summary, resurgence has been shown to be a robust phenomenon (Volkert, Lerman, Call, & Trosclair-Lasserre, 2009; Wathen & Podlesnik, 2018). It is a potential issue for long-term maintenance of FCT results (Carrasquillo & Ringdahl, in press). Many researchers have addressed how FCT can be implemented in novel ways to reduce the probability of resurgence of
problem behavior and maintain appropriate responding. Researchers have suggested that training multiple mands may be an effective modification of traditional DRA/FCT (Berg et al., 2015; Carrasquillo & Ringdahl, in press; Hoffman & Falcomata, 2014; Lambert et al., 2015, 2017). However, it remains unclear from their research whether the mands should be taught serially or all at once (i.e., concurrently). Furthermore, there were several confounds in their studies such as the lack of a control response to rule out extinction-induced variability.

Given the conflicting findings of some human operant and applied studies, it is likely that translational studies could benefit from more thoughtful incorporation of clinical aspects as part of these studies (Lambert et al., 2017). For example, human operant studies often make a priori decisions regarding phase length to control for reinforcement history, while applied studies tend to make data-based decisions regarding phase length and changes. This results in variable reinforcement histories, which could account for different findings across studies. It would be interesting to incorporate more clinical decision-making models into translational research.

The purpose of the current investigation was to evaluate the effects of two DRA/FCT procedures that each teach the same number of alternative responses but in a different way – serially or concurrently – in a human operant arrangement. In addition, we included two control responses, and data-based decision making in one experiment to further extend the literature. Four research questions were posed:

1. What are the effects of SRT and CRT on the resurgence of a target response during extinction after training multiple alternative responses?
2. What are the effects of SRT and CRT on the persistence of alternative responses during extinction?
3. To what extent does extinction-induced behavioral variability account for resurgence or persistence?

4. How similar are participant patterns of responding during a human-operant task when phase changes are based on participant performance to patterns from a priori phase length studies?

METHOD

This investigation was divided into three experiments. Experiment 1 compared single DRA and CRT. Experiment 2a compared single DRA, CRT, and SRT. Experiment 2b compared CRT and SRT. Experiment 3 utilized CRT as a standalone treatment using real-time, data-based decision making. Typically, human operant experiments determine phase lengths a priori, whereas applied researchers determine phase length based on participant responding. This experiment was done to identify whether making decisions based on participant data rather than a priori affected outcomes, and to more closely represent applied contexts.

Experimental Design and General Procedures

A multielement design embedded within the ABC resurgence phases was used. Phases A (target response reinforcement), B (alternative response reinforcement), and C (extinction) were consistent across all experiments. Experiments 1 and 2b contained two alternating components; each phase lasted 20 min with the exception of Experiment 2b’s Phase B (21 min). Experiment 2a contained three alternating components; Phase A and C lasted 12 min, Phase B lasted 36 min. Experiment 3 contained one component; phase lengths varied depending on participant performance. The single-DRA component had a blue background stimulus. The CRT component had a gold background stimulus. The SRT components had a mauve background stimulus. Each
component presentation lasted 2 min. Each component was saved as its own file after the 2 min presentation ended. Component presentation order was randomized before each experiment.

Following completion of each participant’s research session, he or she was asked to complete a post-session questionnaire (Appendix A). After participants completed the questionnaire, the experimenter then provided a debriefing (Appendix B) explaining the purpose and implications of the experiment.

**Participants, setting, and materials.** Twenty-seven undergraduate students, 21 females and 6 males, participated in the experiment (see Tables 1 through 4 for participant demographics). Eight participants completed Experiments 1, 2a, and 2b, respectively. Three participants completed Experiment 3. All participants were enrolled in an introductory psychology class at a Midwestern university. Participants earned course points and were entered into a raffle to win one of two Samsung™ Galaxy tablets, regardless of study outcome. This study was approved by the Western Michigan University Human Subjects Institutional Review Board (see Appendix C). Informed consent was obtained for all participants prior to the start of their participation in the study (see Appendix D).

All sessions took place in a university office. Sessions took approximately 1 hr to complete. The office was 2.0 m X 1.8 m and contained one 5.7 m X .6 m table, three chairs, one Asus laptop equipped with Windows 10, and a computer mouse. No other materials were necessary.

**Apparatus and experimental stimuli.** All phases of the experiment were conducted using the Asus laptop computer, a computer mouse, and the experimental computer program. The program was created and coded specifically for this experiment using Microsoft Visual Basic. The program consisted of six 2.54 cm x 1.9 cm, colored buttons (green, brown, blue,
purple, navy, and black) arranged in a horizontal line, the written instructions, “Click buttons to earn points,” and a corresponding point bin below each button (see Figure 1 for a screenshot of the program). All buttons were present for all components across all phases. Each button represented a unique response option. Prior to the start of the study, buttons were randomly assigned as the target (purple button), alternative (brown, green, and navy), or control responses (blue and black). These assignments remained the same for the duration of the study. Any button that was active (i.e., clicks on that button resulted in delivery of points) delivered one point on an FI 5-s schedule. Below each button was a hidden counter, not visible to participants, that tracked total number of clicks on that specific button. When a participant earned a point, a textbox containing the words, “Point Earned!” appeared. Participants clicked, “Okay,” to continue clicking buttons. Before each research session, the experimenter tested the program to ensure the program was running correctly (e.g., clicked buttons to make sure correct button(s) were active on each component, correct buttons were inactive on designated components, extinction tool buttons were all inactive). The program functioned correctly during the entire study.

![Figure 1. Screenshot of program.](image)

**Dependent variables and measurement.** All responses, single mouse clicks, were recorded for target, alternative, and control responses. Responses were measured across all
phases, regardless if a button was active. The computer automatically recorded responses. Thus, the need for an additional, independent human observer was eliminated. Sessions were recorded using Windows Problem Steps Recorder (PSR). PSR timestamped all sessions. Results were visually analyzed using both absolute response rates and proportion of baseline data.

**Experiment 1 Procedures**

**Phase A.** During Phase A, clicks on the target response (i.e., purple button) were reinforced on an FI 5-s schedule in both components. Clicks on any other buttons were never reinforced. This phase consisted of 10 alternating 2-min components. The only changes between components were the background color and point totals.

**Phase B.** During Phase B, clicks on the target response were placed on extinction. They did not result in the delivery of points. In the single-DRA component, clicks on only one alternative response (i.e., the brown button) were reinforced on an FI 5-s schedule. In the CRT component, clicks on three alternative responses (i.e., the brown, green, and navy buttons) were all reinforced on an FI 5-s schedule. This phase also consisted of 10 alternating 2-min components. The only changes between components were the background color and point totals.

**Phase C.** The arrangement for Phase C was the same as Phases A and B. However, all responses in both components were placed on extinction. Responding on any button did not result in the delivery of points.

**Experiment 2a Procedures**

**Phase A.** Procedures and experimental preparation for Phase A were similar to those of Phase A in Experiment 1 except for two differences: (1) there were three alternating 2-min components rather than 10, and (2) there were three possible components (single DRA, CRT, and SRT) rather than two.
**Phase B.** Procedures and experimental preparation for Phase B were similar to Phase B in Experiment 1 except for the inclusion of the SRT component, phase length, and number of component presentations. Phase B consisted on 18 alternating 2-min components. Single-DRA and CRT components were the same as Phase B in Experiment 1. For the SRT component, the three alternative responses were reinforced sequentially on an FI 5-s schedule, each for two rounds. Clicks on the first alternative (i.e., brown) were reinforced for only the first two SRT component presentations. Clicks on the second alternative (i.e., green) were reinforced for only the next two SRT component presentations. Clicks on the third alternative (i.e., navy) were reinforced for only the last two SRT component presentations.

**Phase C.** The arrangement for Phase C was the same as Phase A. However, all responses in all three components were placed on extinction.

**Experiment 2b Procedures**

**Phase A.** Procedures and experimental preparation for Phase A were identical to Phase A in Study 1.

**Phase B.** During Phase B, clicks on the target response were placed on extinction. They did not result in the delivery of points. In the CRT component, clicks on three alternative responses (i.e., the brown, green, and navy buttons) were all reinforced on an FI 5-s schedule. For the SRT component, the three alternative responses were reinforced sequentially on an FI 5-s schedule, each for two rounds. Clicks on the first alternative (i.e., brown) were reinforced for only the first two SRT component presentations. Clicks on the second alternative (i.e., green) were reinforced for only the next two SRT component presentations. Clicks on the third alternative (i.e., navy) were reinforced for only the last two SRT component presentations. This
Phase also consisted of 11 alternating 2-min components. The only changes between components were the background color and point totals.

**Phase C.** Procedures and experimental preparation for Phase C were identical to Phase C in Study 1.

**Experiment 3 Procedures**

Unlike Experiments 1 and 2, Experiment 3 did not have a priori phase lengths. Instead, phase lengths were determined using real-time participant data and data-based decision making. Phases had to have a minimum of three data points with either a stable or increasing trend in Phases A and B. Experiment 3 was intended to mimic using CRT in a clinical context. Thus, Phase C did have a maximum of 10 component presentations given extinction of alternative responses being countertherapeutic.

**Phase A.** During Phase A, clicks on the target response (i.e., purple button) were reinforced on an FI 5-s. Clicks on any other buttons were never reinforced. Only one component was presented (i.e., CRT). Component presentations lasted 2 min. Phase A consisted of five (Participant 25), three (Participant 26), and four (Participant 27) presentations, respectively. The experimenter graphed number of clicks on the target responses after each component presentation.

**Phase B.** Phase B was similar to Phase B in the first three studies. However, only the CRT component was presented. Clicks on the target response were on extinction. The CRT component was the same as Studies 1, 2, and 2a. Presentations were the same as Phase A. Phase B consisted of eight (Participant 25), six (Participant 26), and three (Participant 27) presentations, respectively. The experimenter graphed number of clicks on the target and alternative responses after each component presentation.
Phase C. All responses were on extinction in Phase C. Phase C consisted of 10 component presentations for all three participants. The experimenter graphed number of clicks on the target and alternative responses after each component presentation.

RESULTS AND DISCUSSION OF EXPERIMENTS 1, 2 AND 3

Experiment 1

Overall resurgence of target responding. The top panel of Figure 2 depicts the resurgence of target responding that occurred during Phase C. These data are expressed as a proportional mean, calculated by dividing the mean number of responses Phase C by the mean number of responses during Phase A. Proportional rates of resurgence of target responding (i.e., as proportion of Phase A responding) in Phase C was higher in the single-DRA component compared to the CRT component for all eight participants.
Figure 2. Average proportion of baseline (Phase A) of target responses (resurgence; top panel) during Phase C (extinction) and average proportion of baseline (Phase B) of alternative responding (persistence; bottom panel) during Phase C (extinction) of Experiment 1.
**Overall persistence of alternative responding.** The bottom panel of Figure 2 depicts the persistence of alternate responding that occurred during Phase C. These data are expressed as a proportional mean, calculated by dividing the mean number of responses during Phase C by the mean number of responses during Phase B. Total mean proportional rates of persistence of alternative responding in Phase C was higher in the CRT component compared to the single-DRA component for all eight participants.

**Resurgence and persistence.** All eight participants demonstrated resurgence of target responding during Phase C in both components. Two patterns of responding related to reinforcing alternative responses using either single DRA or CRT were observed. The first pattern consisted of elevated rates of persistence of concurrently-trained alternative responses compared to the single-DRA alternative response. Similar levels of resurgence of target responding in both single DRA and CRT were observed in Pattern 1. This pattern is depicted for one representative participant in Figure 3.
Figure 3. Experiment 1 results for Participant 2 including proportion of Phase A responding of target responses during the resurgence test phase (Phase C; extinction; top panel); proportion of Phase B responding of alternative responses during the resurgence test phase (Phase C; extinction; middle panel); and responses per component of target and alternative responding across Phases A, B, and C.
The top panel of Figure 3 shows the resurgence of target responding during extinction (Phase C) expressed as a proportion of Phase A responding. Proportions on the top panel of Figure 3 were calculated by dividing number of target responses during individual components in Phase C by the mean number of target responses across components in Phase A. Resurgence of target responding for Participant 2 in Phase C was similar in both the single-DRA and CRT component. 

The middle panel of Figure 3 shows the overall persistence of alternate responding, expressed as proportion of Phase B alternative responding for Participant 2. Data depicted on the middle panel of Figure 3 were calculated by dividing the number of alternative responses during individual components in Phase C by the mean rates of alternative responding across components in Phase B. Persistence of alternative responding for Participant 2 in Phase C was higher in the CRT component compared to the single-DRA component. 

The bottom panel of Figure 3 shows the absolute number of target and alternative responses across all phases and components for Participant 2. This pattern was the most frequently observed pattern ($N = 6$).

The second pattern consisted of slightly elevated rates of concurrently-trained alternative responses. However, the overall level of alternative and target responding was very similar between both components. Figure 4 depicts the results for Participant 4 (Pattern 2).
Figure 4. Experiment 1 results for Participant 4 including proportion of Phase A responding of target responses during the resurgence test phase (Phase C; extinction; top panel); proportion of Phase B responding of alternative responses during the resurgence test phase (Phase C; extinction; middle panel); and responses per component of target and alternative responding in Experiment 1 across Phases A, B, and C.
The top panel of Figure 4 shows the resurgence of target responding during extinction (Phase C) expressed as a proportion of Phase A responding. Proportions on the top panel of Figure 4 were calculated by dividing number of target responses during individual components in Phase C by the mean number of target responses across components in Phase A. Resurgence of target responding for Participant 4 in Phase C was similar in both the single-DRA and CRT component. The middle panel of Figure 4 shows the overall persistence of alternate responding, expressed as proportion of Phase B alternative responding for Participant 4. Data depicted on the middle panel of Figure 4 were calculated by dividing the number of alternative responses during individual components in Phase C by the mean rates of alternative responding across components in Phase B. Persistence of alternative responding for Participant 4 in Phase C was comparable for both CRT and single-DRA component, but CRT was slightly greater. The bottom panel of Figure 4 shows the absolute number of target and alternative responses across all phases and components for Participant 4. Pattern 2 was observed in two participants.

Appendices E, F, and G contain individual graphs for proportion of baseline responding during Phase C (resurgence), proportion of alternative responding during Phase C (persistence), and responses across all phases and components for all Experiment 1 participants.

**Experiment 2a**

**Overall resurgence of target responding.** The top panel of Figure 5 depicts the resurgence of target responding that occurred during Phase C.
Figure 5. Average proportion of baseline (Phase A) of target responses (resurgence; top panel) during Phase C (extinction) and average proportion of baseline (Phase B) of alternative responding (persistence; bottom panel) during Phase C (extinction) of Experiment 2a.
These data are expressed as a proportional mean, calculated by dividing the mean number of responses Phase C by the mean number of responses during Phase A. Proportional rates of resurgence of target responding (i.e., as proportion of Phase A responding) in Phase C was highest in the single-DRA component for four out of eight participants (Participants 10, 13, 14, and 15); two out of eight in the CRT component (Participants 11 and 12); and two out of eight in the SRT component (Participants 9 and 16).

**Overall persistence of alternative responding.** The bottom panel of Figure 5 depicts the persistence of alternate responding that occurred during Phase C. These data are expressed as a proportional mean, calculated by dividing the mean number of responses during Phase C by the mean number of responses during Phase B. Total mean proportional rates of persistence of alternative responding in Phase C was highest in the single-DRA component for two participants (Participant 14 and 15); highest in CRT for four participants (Participants 10, 11, 12, and 13); and highest in SRT for two participants (Participants 9 and 16).

**Resurgence and persistence.** All eight participants demonstrated resurgence of target responding during Phase C in both components. One most-common pattern of responding related to reinforcing alternative responses using either single DRA, CRT, or SRT were observed. The first pattern consisted of elevated rates of persistence of concurrently- and serially-trained alternative responses compared to the alternative response reinforced using single DRA. Similar levels of resurgence of target responding in single DRA, CRT, and SRT were observed in Pattern 1. This pattern is depicted for one representative participant in Figure 6.
Figure 6. Experiment 2a results for Participant 9 including proportion of Phase A responding of target responses during the resurgence test phase (Phase C; extinction; top panel); proportion of Phase B responding of alternative responses during the resurgence test phase (Phase C; extinction; middle panel); and responses per component of target and alternative responding in across Phases A, B, and C.
The top panel of Figure 6 shows the resurgence of target responding during extinction (Phase C) expressed as a proportion of Phase A responding. Proportions on the top panel of Figure 6 were calculated by dividing number of target responses during individual components in Phase C by the mean number of target responses across components in Phase A. Resurgence of target responding for Participant 9 in Phase C was similar in both the single-DRA, CRT, and SRT components. The middle panel of Figure 6 shows the overall persistence of alternate responding, expressed as proportion of Phase B alternative responding for Participant 9. Data depicted on the middle panel of Figure 6 were calculated by dividing the number of alternative responses during individual components in Phase C by the mean rates of alternative responding across components in Phase B. Persistence of alternative responding for Participant 9 in Phase C was highest in the SRT component compared to the single-DRA and CRT components. The single-DRA component resulted in the least amount of persistence. The bottom panel of Figure 6 shows the absolute number of target and alternative responses across all phases and components for Participant 9. Pattern 1 was the most frequently observed pattern \((N = 4)\).

Participants 10, 11, 14, and 15 displayed four idiosyncratic patterns of responding. Participant 10’s pattern consisted of elevated rates of persistence of concurrently- and serially-trained alternative responses compared to the alternative response reinforced using single DRA. Similar levels of resurgence of target responding in CRT and SRT were observed in Participant 10’s pattern. However, resurgence of target responding was noticeably higher for single-DRA. Participant 11 demonstrated an initial persistence of alternative responding of concurrently-trained responses in the first CRT component during Phase C. No responding occurred in the second component presentation for all components in Phase C. Participant 14 demonstrated comparable resurgence of target responding across all components in Phase C, as well as similar
rates of persistence in the first of each component presentation in Phase C. However, the second single-DRA component showed a substantial increase in alternative responding, greater than either CRT or SRT. Participant 15’s data show similar, low rates of both persistence and resurgence across all components during extinction.

Appendices H, I, and J contain individual graphs for proportion of baseline responding during Phase C (resurgence), proportion of alternative responding during Phase C (persistence), and responses across all phases and components for all Experiment 2a participants.

**Experiment 2b**

**Overall resurgence of target responding.** The top panel of Figure 7 depicts the resurgence of target responding that occurred during Phase C. These data are expressed as a proportional mean, calculated by dividing the mean number of responses Phase C by the mean number of responses during Phase A. Proportional rates of resurgence of target responding (i.e., as proportion of Phase A responding) in Phase C was higher in the SRT component compared to the CRT component for all but one participant (Participant 22).
Figure 7. Average proportion of baseline (Phase A) of target responses (resurgence; top panel) during Phase C (extinction) and average proportion of baseline (Phase B) of alternative responding (persistence; bottom panel) during Phase C (extinction) of Experiment 2b.
**Overall persistence of alternative responding.** The bottom panel of Figure 7 depicts the persistence of alternate responding that occurred during Phase C. These data are expressed as a proportional mean, calculated by dividing the mean number of responses during Phase C by the mean number of responses during Phase B. Total mean proportional rates of persistence of alternative responding in Phase C was higher in the CRT component compared to the SRT component for all but two participants. Persistence was equal between SRT and CRT for one participant (Participant 20); persistence was greater in the SRT component for one participant (Participant 22).

**Resurgence and persistence.** All eight participants demonstrated resurgence of target responding during Phase C in both components. Two patterns of responding related to reinforcing alternative responses using either single CRT or SRT were observed. The first pattern consisted of elevated rates of persistence in both the CRT and SRT components. Similar levels of resurgence of target responding in both CRT and SRT were observed in Pattern 1. This pattern is depicted for one representative participant in Figure 8.
Figure 8. Experiment 2b results for Participant 22 including proportion of Phase A responding of target responses during the resurgence test phase (Phase C; extinction; top panel); proportion of Phase B responding of alternative responses during the resurgence test phase (Phase C; extinction; middle panel); and responses per component of target and alternative responding in across Phases A, B, and C.
The top panel of Figure 8 shows the resurgence of target responding during extinction (Phase C) expressed as a proportion of Phase A responding. Proportions on the top panel of Figure 8 were calculated by dividing number of target responses during individual components in Phase C by the mean number of target responses across components in Phase A. Resurgence of target responding for Participant 22 in Phase C was slightly higher in CRT than SRT, but followed similar patterns. The middle panel of Figure 8 shows the overall of persistence of alternate responding, expressed as proportion of Phase B alternative responding for Participant 22. Data depicted on the middle panel of Figure 8 were calculated by dividing the number of alternative responses during individual components in Phase C by the mean rates of alternative responding across components in Phase B. Persistence of alternative responding for Participant 22 in Phase C was slightly higher in the SRT component compared to CRT, but followed similar patterns. The bottom panel of Figure 8 shows the absolute number of target and alternative responses across all phases and components for Participant 22. Pattern 1 was the most frequently observed pattern ($N = 6$).

The second pattern consisted of comparable resurgence of target responding across all components in Phase C, as well as similar rates of persistence in all components in Phase C. This pattern is depicted for one representative participant in Figure 9.
Figure 9. Experiment 2b results for Participant 18 including proportion of Phase A responding of target responses during the resurgence test phase (Phase C; extinction; top panel); proportion of Phase B responding of alternative responses during the resurgence test phase (Phase C; extinction; middle panel); and responses per component of target and alternative responding in across Phases A, B, and C.
The top panel of Figure 9 shows the resurgence of target responding during extinction (Phase C) expressed as a proportion of Phase A responding. Proportions on the top panel of Figure 9 were calculated by dividing number of target responses during individual components in Phase C by the mean number of target responses across components in Phase A. Resurgence of target responding for Participant 18 in Phase C was initially higher in SRT than CRT, but quickly decreased to rates similar to CRT. The middle panel of Figure 9 shows the overall of persistence of alternate responding, expressed as proportion of Phase B alternative responding for Participant 18. Data depicted on the middle panel of Figure 8 were calculated by dividing the number of alternative responses during individual components in Phase C by the mean number of alternative responses across components in Phase B. Persistence of alternative responding for Participant 18 in Phase C was slightly higher in the SRT component compared to CRT in the first component presentation, but quickly decreased. The bottom panel of Figure 9 shows the absolute number of target and alternative responses across all phases and components for Participant 18. SRT resulted in more persistence in the first component presentation of Phase C, but afterwards decreased. Pattern 2 was observed for two participants.

Appendices K, L, and M contain individual graphs for proportion of baseline responding during Phase C (resurgence), proportion of alternative responding during Phase C (persistence), and responses across all phases and components for all Experiment 2b participants.

**Experiment 3**

Figures 10, 11, and 12 depict resurgence of target responding (top panels) and persistence of alternative responding (middle panels) during Phase C expressed as proportions of baseline or alternative responding, for Participants 25, 26, and 27, respectively. The bottom panel of Figures 10, 11, and 12 shows absolute number of target and alternative responses across phases.
Figure 10. Experiment 3 results for Participant 25 including proportion of Phase A responding of target responses during the resurgence test phase (Phase C; extinction; top panel); proportion of Phase B responding of alternative responses during the resurgence test phase (Phase C; extinction; middle panel); and responses per component of target and alternative responding across Phases A, B, and C.
Figure 11. Experiment 3 results for Participant 26 including proportion of Phase A responding of target responses during the resurgence test phase (Phase C; extinction; top panel); proportion of Phase B responding of alternative responses during the resurgence test phase (Phase C; extinction; middle panel); and responses per component of target and alternative responding across Phases A, B, and C.
Figure 12. Experiment 3 results for Participant 27 including proportion of Phase A responding of target responses during the resurgence test phase (Phase C; extinction; top panel); proportion of Phase B responding of alternative responses during the resurgence test phase (Phase C; extinction; middle panel); and responses per component of target and alternative responding across Phases A, B, and C.
CRT resulted in more persistence of alternative responses compared to resurgence of target responses. However, target responses did reemerge in Phase C. All three participants engaged in high rates of target responding in Phase A. Moreover, they all demonstrated steady-state responding on alternative responses during Phase B. These data closely mimic those seen in applied contexts. Participants reacted to contingencies in a similar manner to when phase lengths were determined a priori. Thus, it may be possible to conduct human operant research using data-based decision making rather than a priori phase length criteria.

**Control Response Analysis**

Figure 13 depicts the average number of target, alternative, and control responses that occurred during Phase C for Experiments 1 and 2. Responding on control responses occurred more than responding on target responses for both experiments across all components. The average number of responses on control responses was also greater than the average number of alternative responses in the single-DRA component in Phase C across Experiments 1 and 2a. However, alternative responding in the SRT and CRT components during Phase C was greater than control responding in Experiment 2.
Figure 13. Average number of responses per target, alternative, and control responses for Experiments 1, 2a, and 2b.
Figure 14 depicts the average number of control responses per phase for Experiments 1 and 2. Participants responded on control responses across all three phases of both experiments. Responding on control responses was comparable across all components during Phase A for all experiments. Responding on control responses was greatest for all components during Phase C (i.e., extinction) for Experiments 1 and 2b. For Experiment 2a, responding control responses was highest during SRT and CRT components for Phase B. Across all experiments, responding on control responses was lowest during the CRT component of Phase B. Phase B CRT components were the only time more than one response resulted in the delivery of points.

Additionally, Appendices G, J, and M all depict control responses for individual participants.
Figure 14. Average number of control responses per phase for Experiments 1, 2a, and 2b.
GENERAL DISCUSSION

Persistence of Alternative and Resurgence of Target Responses

One purpose of this study was to further investigate the effects of reinforcing more than one alternative response, either serially or concurrently, on the resurgence of a target response during extinction. Consistent with previous research (e.g., Carrasquillo and Ringdahl, in press; Hoffman & Falcomata, 2014; Lambert et al., 2015) results of the current investigation support teaching more than one alternative response as opposed to only one alternative response. Indeed, both CRT and SRT resulted in greater persistence of alternative responses compared to single DRA during extinction. Additionally, overall, CRT and SRT resulted in greater suppression of targeting responding (i.e., mitigation of resurgence) compared to single DRA during extinction. However, the difference in suppression between CRT and SRT was comparable.

CRT and SRT resulted in greater persistence of alternative responses. However, neither substantially differentiated itself from the other. That is, CRT resulted in greater persistence for some participants compared to SRT. SRT resulted in greater persistence for some participants compared to CRT. However, the differences in persistence was overall minor. This implies that both CRT and SRT are viable modification options to FCT, so as long as more than one response is taught. By teaching multiple alternatives, we may be increasing the likelihood of those behaviors persisting during extinction challenges rather than target/problem behavior resurging (Kimball, Kelley, Podlesnik, Forton, & Hinkle, 2018). Teaching multiple exemplars during skill acquisition programs results in greater generalization and maintenance (Stokes & Baer, 1977). Additionally, CRT resulted in earning more reinforcers (i.e., points) compared to both SRT and single DRA in Experiments 1 and 2 (see Appendix N). Therefore, teaching more than one alternative response in an FCT context is implicitly pragmatic.
Another reason an alternative response (i.e., mand) may persist more than other responses, either other alternatives or problem behaviors, is that it is more preferred than other responses (Berg et al., 2015). From a clinical standpoint, it may be worth evaluating mand preference and focus on training the preferred FCR. In fact, Reichle and Wacker (2017) state that, when designing FCT programs, one should choose an alternative response that is both more efficient and preferred than the problem behavior. If a learner prefers the FCR more than the problem behavior, the likelihood of treatment success and maintenance may be greater. Furthermore, if they prefer one FCR over the other, persistence of one FCR may continue to maintain more than other FCRs and problem behavior. By teaching more than one alternative response, it may be possible to raise the probability of a learner preferring at least one of the FCRs more than the problem behavior because he or she has more options from which to choose. In essence, we are equipping individuals with a problem solving repertoire by providing them socially acceptable, desirable alternatives to use when one response does not contact reinforcement.

The Necessity to Include Control Responses

Consistent with the findings of the current study, Carrasquillo and Ringdahl (in press) and Lambert and colleagues (2015, 2017) evaluated reinforcing multiple alternatives as a way to mitigate resurgence of target responding, as well as increase persistence of alternative responding. Lambert et al. (2015) and Carrasquillo and Ringdahl (in press) both consistently demonstrated stronger persistence of alternative responding and suppression of target responding during extinction tests during their multiple response alternative components, respectively. Lambert and colleagues’ (2017) results showed initial persistence of alternative responding before problem behavior quickly reemerged. However, Carrasquillo and Ringdahl (in press) and
Lambert et al. (2015, 2017) all noted the exclusion of a control response from their experimental arrangement as a limitation. Moreover, they did not have all response options available in all phases or components. Without inclusion a control response, it is difficult to say if resurgence or persistence was truly observed during the extinction phases of those studies. Or, rather, responding during extinction could be attributed to extinction-induced behavioral variability. This study included two control responses, as well as kept the number of response options consistent across all phases. Interestingly, despite never being active, responding on control responses was observed in all phases in Experiments 1 and 2. Average responding on control responses was higher than target responding (Figure 13) in all components. These data suggest that responding observed during extinction could be attributed to induction or extinction-induced behavioral variability. Data in Appendices G, J, and M also support that responding observed in Phase C could potentially be due to induction or extinction-induced behavioral variability. Therefore, caution must be taken when interpreting studies of this nature that have not, or do not, include at least one control response.

Clinical Limitations, Translational Answers?

Limitations notwithstanding, Lambert, Bloom, Samaha, and Dayton (2017) sought to extend Lambert et al. (2015) to a clinically-relevant context. However, all other desirable effects observed in the 2015 investigation were not consistently replicated or observed. That is, a consistent decrease in problem behavior was not observed for either participant. Additionally, previously extinguished mands did not consistently reemerge. The magnitude of resurgence of problem behavior observed was significantly larger than what the authors observed for the analog target response in the 2015 study. The authors stated one reason for the difference in findings between the two studies might be the reinforcement history associated with the
behaviors. In the applied study, participants likely had years of functional reinforcement for problem behavior. Whereas the arbitrary responses reinforced in the 2015 study had shorter, more controlled histories. Another explanation may be the differences in response topographies. That is, extinction of alternative responses that are dissimilar from target responses can result in greater resurgence of the target response (Doughty, Da Silva, & Lattal, 2007). Target and alternative responses in many translational studies are very similar in nature, whereas alternative and target responses in applied studies were very different from each other. Taken together, both Lambert and colleagues’ investigations support training multiple mands, but additional research is needed on whether or not the serial presentation is an essential component.

Given Hoffman and Falcomata (2014) and Lambert and colleagues’ (2015) promising results, the results of Lambert et al. (2017) are interesting. Teaching multiple alternatives to increase persistence, generalization and maintenance of those FCRs, and reduce resurgence of problem behavior seems obvious. This is especially true considering the effectiveness of general-case programming (Horner, Jones, & Williams, 1985; Horner & McDonald, 1982; Horner, Sprague, & Wilcox, 1982; Horner, Williams, & Steverly, 1986). However, and again, the results Lambert et al. (2015) were not replicated in their 2017 investigation. It would appear that there is more to learn and refine with regards to teaching more than one alternative response in an FCT context.

Translational studies provide experimenters with a testing ground to problem solve. Researchers are able to take applied independent variables (e.g., multiple alternative responses) into more controlled settings to better understand the procedural ramifications (DeLeon, Perone, & Petursdottir, 2018). Moreover, DeLeon et al. (2018) also stated that if one cannot evoke a phenomenon in an applied setting, one must turn around and investigate why it did not occur.
Translational research is a way for us to better understand these potential modifications to FCT, and should be seen as a bridge and means of providing empirical support to potential applied solutions. Additionally, to incorporate more applied elements, data-based decision making in translational settings may be a viable option. Results of the current study suggest and support that similar effects and patterns of responding seen in a priori arrangements can occur if phase length is determined in real-time based on participant performance.

Limitations and Future Directions

Findings of the current study should be interpreted considering several limitations. First, component order was randomized at the start of each experiment, but order was not counterbalanced across participants. This was done in order to keep reinforcement histories consistent across participants, as well as to add another constant to the study. Future investigations should consider counterbalancing sequence of component presentations. Secondly, Experiment 2a had only two baseline and extinction exposures per component. This was done to keep study length consistent. However, results of Experiment 3 imply that session length need not be determined a prior. Thus, future studies may be able to vary phase length. Or, lengthen baseline and extinction phases depending on alternative response training style. Third, because the components shared the same alternative responses (i.e., the same buttons were designated alternative responses; brown was the only alternative for single DRA), generalization may have occurred between components. However, each component did have its own unique background stimuli to improve differentiation. Moreover, results indicate more even responding in CRT components compared to single DRA and SRT. That is, participants allocated responding across the three concurrently active buttons in CRT, rather than respond on only one of the active buttons in CRT. Future researchers ought to consider which buttons are active during a given
component, and if those buttons remain the same throughout a study. Fourth, and similarly, response topographies were the same for all responses. Target, alternative, and control responses all consisted of button clicks. Clicks on control responses were never reinforced, thus, it is possible that responding on those buttons occurred due to response induction. One option to possibly rule out induction as an explanation for responding on control responses may be to alter the topography of the control responses. Future investigators might examine the inclusion of control responses of different topographies. Lastly, Phase B CRT components had three active buttons, thus, participants could earn more points during CRT than single DRA or SRT components. Although this is a desirable benefit of CRT, it is possible that persistence of alternative responses during CRT components during Phase C could have been influenced by number or points earned in Phase B. Future researchers should consider manipulating the number of points available for SRT and single DRA components to ensure additional similarity between components.

Participants also responded on buttons that were not active. This includes control responses throughout the phases, as well as alternative responses in baseline. It is possible that participants generated rules that may have affected responding, along with the point contingencies (see Appendix O for Participant Debriefing Responses). If participants are going to self-generate rules, one approach researchers could take is to use rules from the onset of a study. That is, explicitly state that there are no patterns of responding needed to earn points. The addition of rules adds an additional layer of complexity to investigations of this nature. If resurgence or persistence is to be purely a result from reinforcement histories, the inclusion of rules may hinder those effects. This could be an interesting extension of this research.
Limitations notwithstanding, it still may be worthwhile to consider evaluating CRT with clinically-relevant behavior. Considering the novel, potential application of CRT to problem behavior, caution should be taken regarding severity of targeted problem behavior. Another interesting pursuit may be to evaluate preference for CRT or SRT in a choice arrangement in a human operant setting. One could expose participants to both CRT and SRT, then present them with corresponding choice cards representing access to either CRT or SRT to earn points. It would be interesting to see to which option individuals allocate choosing.

In conclusion, resurgence is one reason for the gap between initial treatment improvements and long-lasting maintenance of those improvements during FCT (Ringdahl & St. Peter, 2017). Typical DRA/FCT treatments mimic the standard resurgence arrangement (St. Peter, 2015). Given the prevalence and prominence of FCT as a treatment for problem behavior, investigating modifications to FCT that mitigate resurgence and improve persistence and maintenance of FCRs is well-vindicated. Results of the current study support previous studies’ findings of teaching more than one alternative response (e.g., Hoffman & Falcomata, 2014; Lambert et al., 2015). Both CRT and SRT could be potential modification options. However, one must be attentive to previous studies that have investigated teaching multiple alternatives, but did not include a control response. Indeed, researchers that are evaluating multiple alternative responses should strongly consider including a control response (Sweeney & Shahan, 2016). This line of research lends itself to both applied and translational future investigations. I hope the findings of this dissertation are beneficial to future endeavors seeking to better understand reinforcing multiple alternatives as a means to increase persistence and mitigate resurgence.
REFERENCES


Behavior Analysis, 42, 145–160.


Appendix A

Post-Session Survey
1. What do you think was the purpose of the task you completed? If you are not sure, please say so.

2. How did you make your decisions during the task? If you are not sure, please say so.

3. Did you have an overall strategy you used throughout the task? If so, what was the strategy? If not, please write, “I did not have a strategy.”

4. Did you change your strategy throughout the task? If so, how did it change? If not, please write, “It did not change.”

5. Please type any additional information you’d like to pass along.

6. What is your age? ______________

7. What year in school are you: ____________

8. With what gender do you identify: ______________

9. With what race do you identify: ____________________
Appendix B

Participant Debriefing
Participant Debriefing

- When working with individuals who engage in challenging behavior, behavior analysts use function-based interventions in order to decrease the problem behavior and increase an alternative, desirable behavior. Function refers to why a behavior occurs. Common functions include attention, access to tangibles, escaping a demand, or the behavior itself may be automatically maintained.

- A common function-based intervention is Functional Communication Training, or FCT. FCT typically involves withholding reinforcement for the challenging behavior, while explicitly teaching and reinforcing one alternative response.
  - In the computer task, the clicks on the first button that earned points were an analog to challenging behavior.

- FCT is very effective. However, despite its effectiveness, there are situations in which a problem behavior may reemerge.
  - This reemergence is a form of behavioral relapse called resurgence.

- Given the effectiveness and widespread use of FCT, it is important to look at potential modifications to FCT to decrease the likelihood a challenging behavior will resurgence.

- One potential modification is to teach multiple alternatives in a serial fashion. That is, to teach and reinforce alternative A, then B, then C, and so on. While reinforcing the next response, the previous response does not result in reinforcement.
  - In the computer task, there may have been a condition in which alternative buttons were reinforced one after another, but not at the same time.

- However, there are some questions about the previously mentioned modification. It is unclear if the serial presentation is an essential component to the modification. We propose that potentially teaching and reinforcing all alternatives at once may be just as efficacious, as well as more efficient.
  - There may have been a condition in which multiple buttons were active and resulted in point delivery.

- Our goal for this experiment is to determine if the serial presentation is crucial or not, and to help inform future research and treatment recommendations.
Appendix C

HSIRB Approval Letter
Date: September 20, 2018

To: Stephanie Peterson, Principal Investigator
    Michael Kranak, Student Investigator for dissertation

From: Amy Naugle, Ph.D., Chair

Re: IRB Project Number 18-09-23

This letter will serve as confirmation that your research project titled “Serial and Concurrent Response Presentation: Their Effects on Resurgence” has been approved under the exempt category of review by the Western Michigan University Institutional Review Board (IRB). The conditions and duration of this approval are specified in the policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note: This research may only be conducted exactly in the form it was approved. You must seek specific board approval for any changes to this project (e.g., you must request a post-approval change to enroll subjects beyond the number stated in your application under “Number of subjects you want to complete the study”). Failure to obtain approval for changes will result in a protocol deviation. In addition, if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the IRB for consultation.

Reapproval of the project is required if it extends beyond the termination date stated below.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: September 19, 2019
Appendix D

Consent Form
You’ve been invited to participate in a research project, entitled, “Serial and Concurrent Response Presentation: Their Effects on Resurgence.” This consent document will explain the purpose of this research project and will go over all of the time commitments, the procedures used in the study, and the risks and benefits of participating in this research project. Please read this consent form carefully and completely and please ask any questions if you need more clarification.

What are we trying to find out in this study?
We are investigating two types of response presentation and how they affect responding and response allocation on a computer task. We want to see if the order in which responses are presented affects the allocation of button clicks.

What information is being measured in this study?
We will be measuring number of clicks per button.

Where will this study take place?
This study will take place in a small office breakout room in Wood Hall (Wood Hall 2510).

What is the time commitment for participating in this study?
Should you choose to participate, you will be asked to participate in one experimental session, lasting approximately 60 minutes.

What will you be asked to do if you choose to participate in this study?
If you choose to participate in this study, you will be asked to click buttons to earn points on a computer program, as well as fill out a post-session survey.

What are the risks of participating in this study and how will these risks be minimized?
There are no known risks to participating in this study.

What are the benefits of participating in this study?
Potential benefits include: (a) contributing knowledge to the discipline of behavior analysis regarding alternative response presentation and suppression of initial responses, (b) learning more about behavioral principles, and (c) understanding factors taken into consideration when designing behavioral interventions.

What are the costs of participating in this study?
There are no costs other than your time commitment.
**What is the compensation for participating in this study?**
If you choose to participate, you will have the opportunity to win one of two Samsung Galaxy tablets, as well as earn points for class.

**Who will have access to the information collected during this study?**
All your personal information will be kept confidential (no one will know) and will only be shared among members of the research team (the principal investigator, Stephanie Peterson; the student investigator, Michael Kranak; and the research assistant, Dionysian Josts).

**What if you want to stop participating in this study?**
You may choose to stop the study at any time. Nothing bad will happen to you if you chose to stop the study. The people from the university can also decide to stop your participation in the study without your consent.

If you have any questions before or during the study, you can contact the primary investigator, Stephanie Peterson, Ph.D. at (269) 387-4479 or stephanie.peterson@wmich.edu. You may also contact the Chair, Human Subjects Institutional Review Board at 269-387-8293 or the Vice President for Research at 269-387-8298 if questions arise during the course of the study.

This consent document has been approved for use for one year by the Human Subjects Institutional Review Board (HSIRB) as indicated by the stamped date and signature of the board chair in the upper right corner. Do not participate in this study if the stamped date is older than one year.

--------------------------------------------------------------------------------------------------

I have read this informed consent document. The risks and benefits have been explained to me. I agree to take part in this study.

Please Print Your Name

Participant’s signature                         Date

Researcher’s signature                         Date
Appendix E

Experiment 1, Individual Participant Target Responses during Phase C as Expressed as Proportion of Baseline (Phase A)
Appendix F

Experiment 1, Individual Participant Alternative Responses during Phase C as Expressed as Proportion of Alternative Responding (Phase B)
Appendix G

Experiment 1, Individual Participant Responses per Component
Target Response
Reinforcement

Alternative Response
Reinforcement

Extinction

Consecutive 2-min Components

Responses per Component

Participant 7

Target Response
Reinforcement

Alternative Response
Reinforcement

Extinction

Consecutive 2-min Components

Responses per Component

Participant 8

Consecutive 2-min Components

Participant 8

Responses per Component
Appendix H

Experiment 2a, Individual Participant Target Responses during Phase C as Expressed as Proportion of Baseline (Phase A)
Appendix I

Experiment 2a, Individual Participant Alternative Responses during Phase C as Expressed as Proportion of Alternative Responding (Phase B)
Concurrent

Single

Serial

Proportion of Alternative Responding

Participant 15

Extinction Session

Participant 16

Extinction Session
Appendix J

Experiment 2a, Individual Participant Responses per Component
Consecutive 2-min Components

Responses per Component

Target Response Reinforcement

Alternative Response Reinforcement

Extinction

Participant 15

Participant 16
Appendix K

Experiment 2b, Individual Participant Target Responses during Phase C as Expressed as Proportion of Baseline (Phase A)
Concurrent Serial Extinction Session

Proportion of Baseline Responding

Participant 17

Concurrent Single Extinction Session

Proportion of Baseline Responding

Participant 18

Concurrent Serial Extinction Session

Proportion of Baseline Responding

Participant 19
Proportion of Baseline Responding

Extinction Session

Concurrent

Single

Participant 20

Participant 21

Participant 22
Concurrent

Single

Proportion of Baseline Responding

Participant 23

Concurrent

Serial

Concurrent

Participant 24
Appendix L

Experiment 2b, Individual Participant Alternative Responses during Phase C as Expressed as Proportion of Alternative Responding (Phase B)
Concurrent
Serial

Extinction Session

Proportion of Alternative Responding

Participant 17

Participant 18

Participant 19
Concurrent
Serial
Extinction Session
Proportion of Alternative Responding
Participant 20
Participant 21
Participant 22
Concurrent Extinction Session

Proportion of Alternative Responding

Extinction Session

Participant 23

Participant 24
Appendix M

Experiment 2b, Individual Participant Responses per Component
Responses per Component
Consecutive 2-min Components

Target Response
Reinforcement

Alternative Response
Reinforcement

Extinction

Participant 19

Responses per Component
Consecutive 2-min Components

Target Response
Reinforcement

Alternative Response
Reinforcement

Extinction

Participant 20
Appendix N

Reinforcement Rates for Phase B for All Components in Experiment 1 (first table), 2a (second, third, and fourth tables), and 2b (fifth table)
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Appendix O

Post-Session Survey Questions and Responses
1. **What do you think was the purpose of the task you completed? If you are not sure, please say so.**

**Experiment 1: Participants 1 – 8**

I think it was to see if I would click on a button more if it got reinforced. I think the second half was to see how many times I would press each button without reinforcement and if my frequency of pressing buttons would decrease.

Maybe to see how quick people realized which boxes/numbers would award them points and which one wouldn’t. though I am unsure on the last several where there weren’t any boxes that gave out points.

Testing frequency of pushing buttons (sometimes specific ones) and how it is effected by different extinction events. Some buttons are reinforced (give the participant a point) at different rounds, and sometimes these buttons lose their reinforcing ability (no point). There were many rounds with different combinations of reinforcement/extinction The last five rounds or so were void of any reinforcement.

I’m not completely sure I think it was to see how many times I would click the buttons and get absolutely no points.

I’m not sure what the purpose was.

I’m not completely sure I think it was to see how many times I would click the buttons and get absolutely no points.

I think the purpose of this task is to know the concentration MAYBE

Not totally sure, but possibly reinforcement had something to do with it depending on what points you for from what color.

**Experiment 2a: Participants 9 – 16**

To monitor the behavior and detecting patterns in the button pushing and trying to problem solve in order to find a sequence of buttons to obtain a point.

I have no idea

Absolutely no clue

To see if I recognized patterns in clicking based on colored background? Idk

To try and find a pattern of how many clicks it takes to get a point
What I felt was the purpose was to see how many points you would get and to see if by the background what part of the experiment was going on. Also to see how many clicks you could do and what patterns the exercises were in.

A lot of things went through my mind, maybe the number of points I acquired, my attention span, the number of clicks. But I’m not sure what the purpose was.

The purpose of the survey is to determine at what point the suppression of initial responses begins. The beginning of the experiment establishes the alternative responses and reinforces these alternative responses with a point. I wonder if during the suppression phase of this experiment, if part of the purpose of the experiment is to see if some of the other alternative responses come up during a certain phase.

**Experiment 2b: Participants 17 – 24**

I am not sure the reason why.

To show how fast someone can learn and adapt to something without given any context and or the effects positive reinforcement has on someone’s behavior.

I’m not sure of the purpose. Possibly to measure our responses to things that are rewarded vs. things that aren’t.

I’m not sure

I think the purpose was to determine the pattern of button pushing by controlling certain buttons to give points.

I thought it was testing for reinforcement and learning and then towards the end extinction

I’m not sure what the purpose of the task was. If I had to guess maybe it had something to do with seeing how tired I got clicking the buttons and receiving no points towards the end

Reinforcement of button pressing the right color to earn points. Followed by extinction of the behavior

**Experiment 3: Participants 25 – 27**

I am not sure

I think it could have been to see if people would stop pressing buttons if they didn’t get any points for them.

I believed it had something to do with testing reinforcement types
2. *How did you make your decisions during the task? If you are not sure, please say so.*

**Experiment 1: Participants 1 – 8**

I tried to get as many points as possible. If I did not get points, I would randomly click the buttons in patterns.

I first started by clicking random boxes until I got points. Then I realized which boxes gave points, so I only clicked those ones. In the last several where there weren’t any points given, I just randomly clicked wherever.

I would click on a button more often if I had received a point for doing so already in that round. Sometimes however, the first button I would click for a round would just be the button that was reinforced the most in previous rounds. There were some reoccurring patterns where two or three buttons would be reinforced at a time. When I was reinforced, I would also try to click the button(s) in the fastest/most efficient way to receive points at the highest rate possible.

Whatever patterns I noticed repeating I would continue to try them before they changed.

I made a lot of my decisions at first based off of patterns, such as pressing certain colors before others, but then I moved to time intervals, like pressing purple every 6 seconds or something like that.

Whatever patterns I noticed repeating I would continue to try them before they changed.

My decisions were to click on the middle.

Tried to find a pattern after hitting all colors a few times at the start of each round.

**Experiment 2a: Participants 9 – 16**

I usually just tried different patterns of button pushing, I would do trial and error runs until I hit a button and got a point. I also alternated when the buttons were changed and I tried different sequences.

Honestly, if there was a clear pattern then I would try to figure out the pattern. If not then I would just do like different song beats, I was singing in my head.

If it was only one color, I would time the times until I could click again mostly by using ABBA songs. If it was the three colors, I would just go in a loop because by the time I clicked the third one I could click the first one. If no points I stopped.

For the yellow background thing, I just remembered what I clicked previously so I did it again. For the ones where I got no points, I got bored so I just clicked in random patterns.
I counted out patterns until I found one that worked.

I made them by how many clicks it would take till I got a point on any active button or buttons

Every round I went through and clicked all the buttons at least once.

I made the decision based on trial and error. I tried a combination of button presses. During what I assume was the suppression phase, I tried many different combinations of button presses. Later, I made my decisions based on previously reinforced responses of the correct combination of button presses. I also made my decision randomly, under the circumstance that the reinforcer of the point would be contingent on about 10 button presses. Therefore, on occasion, I pressed 10 random buttons.

**Experiment 2b: Participants 17 – 24**

I would click until I got a point and then I noticed that on some of them there was a certain pattern to click in and then others where it was timed in between point distribution.

At first I clicked until I received a point, but then realized there was a pattern of the point resetting every 7ish seconds

I first found out which button(s) if any were giving me points. I then would try to figure out patterns that would require the least amount of clicks in order to get a point.

I keep on clicking until I get the first point then I keep on clicking the same rectangle

I chose buttons randomly until I saw a pattern of which buttons would give points and would usually push the same buttons back and forth.

I tried to look for patterns

It usually used the same boxes during the whole thing. Towards the end I clicked randomly

I clicked on each button to see if it awarded m points. The ones that did I kept clicking

**Experiment 3: Participants 25 – 27**

I would see which buttons were working to give me points and continue to click those buttons.

If certain colors gave me points I pressed those more often, but if none were giving me points then I pressed them all pretty equally.

In the study-A rounds I was able to count seconds in my head until I could receive my next point. Study-B I was able to cycle through the three boxes that provided reinforcers.
Study-C I clicked every box once and then would only continue pressing buttons out of boredom or curiosity

3. Did you have an overall strategy you used throughout the task? If so, what was the strategy? If not, please write, “I did not have a strategy.”

Experiment 1: Participants 1 – 8

I did not have a strategy

I would go through and click on the boxes until a point was given. Every few seconds a point would be available from that box, so I would then just click on that one box over and over again. The last few where there weren’t any points given I didn’t really have a strategy. I just clicked on every box several times

I covered some of my strategy in the prompt above. My strategy was to click buttons that were previously reinforced more often than those that were not. Sometimes I would just click all of the buttons without discretion just to find out which button would be reinforced for the round.

I tried to notice how many times I was clicking the button that was giving me the points and what color buttons I was pressing before and after I received the point

My strategy was pressing it every 10 seconds after a point was given.

I tried to notice how many times I was clicking the button that was giving me the points and what color buttons I was pressing before and after I received the point

No

Click all colors at the beginning of each round repeatedly, hoping to find some sort of pattern I could follow.

Experiment 2a: Participants 9 – 16

My strategy was to click all of them first and click them in a backwards order to see if any buttons would give me a point then I eliminated which buttons weren’t necessary to get the point

Kind of like before, I would either sing in my head or whatever or just figure out whatever pattern it was by counting how many times I had to click before I got a point.

I didn’t have a strategy other than remembering previous patterns and trying those again

Count out how many clicks it took before the point came
I would count how many clicks it would take to get a point on an active button or when it came to the 3 active buttons I would go in order and get points that way.

It depended on the round. The one where the green, brown, and navy were active I just cycled through and when only one was active I just clicked on it until the point became available again.

I feel as though I did have an overall strategy. In the beginning of the experiment, points were awarded contingent on alternative responses of 10 button clicks of the navy, brown, and green button. They were also contingent on the combination of the Navy, Brown, then Green button press. My strategy was to try these 4 different combinations throughout each experiment. During what I assumed was the suppression phase, I tried these four different combinations. I also tried different combinations during each phase knowing that on certain phases, 10 randomly clicked buttons would produce a reinforcer.

**Experiment 2b: Participants 17 – 24**

Click until you get a point and move as quickly as possible.

To click for every second that I counted so that I could get a point every 7\textsuperscript{th} second

Similar to the previous answer, I first found which button(s) were giving me responses, then tried various sequences to see which one would give me the quickest access to a point.

I did not have a strategy

My strategy was to first push each button from left to right until I found the one giving points then I would click either random buttons back to the point button or only the point button

I did not have a strategy

I would change back and forth clicking if there were multiple boxes that I was receiving points.

I clicked on the buttons after every 5 seconds

**Experiment 3: Participants 25 – 27**

I would try all the buttons until I found a pattern that worked.

Try and find the color that would give me the most points.

Counting seconds, and then going in a circle of clicks

4. *Did you change your strategy throughout the task? If so, how did it change? If not, please write, “It did not change.”*
Experiment 1: Participants 1 – 8

It did not change

I would just press buttons in random order

I was clicking the corners more often during the middle of the task, but then I realized that it was no more effective than just clicking in the center. When there was a complete extinction of all reinforcers, I would click on the buttons in a sort of systematic left to right sweeping motion until I gave up completely for the round.

I did not really change my strategy.

It changed from patterns to time intervals.

I did not really change my strategy.

No

Yes, towards the end, I started to not get points, so I just did it all at random at that point.

Experiment 2a: Participants 9 – 16

It eventually changed when I was given barely any points towards the end because when none of my strategies worked I just went in random order and even began to stop trying to find/obtain a point.

I went from counting how many clicks to just doing songs and hoping for the best.

Yes, at first it was just click randomly and see what happens. Then I thought I had to click other buttons before I could click the buttons that gave me points. Then I went to the above strategy.

It changed based on the color background

If it took more clicks, I would add those clicks into my count and see if a pattern occurred. Ex: 3 clicks then 6 then 9

I kept my strategy until it came to the point where you would click and get no points

Yes, based on the number of buttons that were active.

My strategy did not change. Until I got to what I assumed suppression phase, I attempted different combinations, though all under the same strategy.
Experiment 2b: Participants 17 – 24

Yes, I changed my strategy depending on whether or not my previous click got me a point or not.

Yes, at first I believed it was about how many clicks I had to do so I started clicking quickly, but then realized it was not about how many times you click but the time between clicks.

Yes. Toward the end when I wasn’t getting points, I was clicking just to pass time and make the awkward silence less awkward.

It did not change

It did change randomly sometimes. When the buttons stopped giving points, I started pushing buttons randomly and slowly stopped all together.

Did not change

I changed the strategy at the end when I realized I was not getting points no matter where I clicked

I changed the strategy when during one run multiple colors were being reinforced with points. But I made sure to click each button at least once to see if I got points

Experiment 3: Participants 25 – 27

Towards the end I was just trying to find a button to work

It did not change

Counting no longer worked so I had to search for a new pattern

5. Please type any additional information you’d like to pass along.

Experiment 1: Participants 1 – 8

N/A

Experiment 2a: Participants 9 – 16

The fastest ABBA song by far was Mamma Mia and the two slowest were Fernando and I have a dream.

Experiment 2b: Participants 17 – 24
Was very interesting to experience, and was nice to see how fast I could learn and adapt without context.

I felt weird not pushing buttons even though they stopped giving me points.

Nah it’s all good

Experiment 3: Participants 25 – 27

N/A