WHAT COMES UP? ANALYZING PATTERNS OF RESURGENCE USING PORTL

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The term “resurgence” generally refers to the reappearance of certain behaviors during extinction. Different definitions describe these behaviors as previously reinforced, previously extinguished, or simply previously learned. At first glance, these definitions seem the same. And, researchers have not given much thought to the differences between them. However, these definitions could refer to different initial teaching procedures, and these differences may produce different results during extinction. The present study used the Portable Operant Research and Teaching Lab (PORTL) to examine how differences in the initial teaching procedure affected the behavior of college students during extinction. In the first condition, participants learned four behaviors. Each behavior was extinguished before the next behavior was taught. When all four behaviors were put on extinction, they resurged in the reverse order from how they were taught. A second condition followed the same procedure as the first with one difference. Each behavior was not extinguished before the next behavior was taught. When these four behaviors were put on extinction, they resurged in the order they were learned. These results indicate that the initial training procedure can influence the order in which behaviors appear during extinction.

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CHAPTER 1

INTRODUCTION

Clinicians have long noted that stress, frustration, or a traumatic event can lead people to revert to early forms of behavior. Psychologists have described this phenomenon as regression and considered it to be a defense mechanism (e.g., Lokko & Stern, 2015). For example, a child might not be receiving as much attention when their sibling is born. Consequently, the child might start wetting the bed again instead of appropriately getting attention from their parents. According to Keller and Schoenfeld (1950), these and other examples might be instances of a general principle, "if present behavior is not capable of getting reinforcement, one reverts to older forms of responses which were once effective" (see also Epstein, 1983).

In recent years, regression has often been studied more consistently referred to as resurgence in studies (Epstein, 1983). However, the definitions of regression and resurgence have varied in very subtle, but significant ways. For example, Catania (1991) defined regression as regression, "the reappearance of previously extinguished behavior during the extinction of more recently reinforced behavior (sometimes referred to as extinction-induced resurgence)" (p.459). Similarly, Epstein (1983) defined resurgence as, "when, in a given situation, recently reinforced behavior is no longer reinforced, behaviors that were previously reinforced under similar circumstances tend to recur" (p.255). Although these definitions might seem equivalent, the first explanation notes "previously extinguished behavior" while the second one emphasizes "previously reinforced behavior".

With all the subtle, but important, differences across these various understandings of resurgence, some broader examination of the term might be helpful. Lattal et al. (2017) analyzed the differences in the definitions of resurgence and identified five commonalities across all of

them. 1. None of the definitions identify exactly how to measure resurgence. 2. The target response has to be reinforced within the experiment. 3. The target response has to be extinguished at some point, while reinforcing the alternative response. 4. The alternative response has to be extinguished during the resurgence test phase. 5. None of the definitions include stimulus variables during resurgence. Lattal et al. (2017) suggested a new all-encompassing definition of resurgence, "resurgence currently can be understood as the transient recurrence, with consideration of the stimulus context, of some dimension of previously established but not currently occurring activity when reinforcement conditions of current behavior are worsened" (p.90).

The first commonality that Lattal et al. (2017) identified was that the definitions do not specify how to measure resurgence. Most previous research focused on measuring resurgence by how many responses occur or how much time is allocated to the alternative responses. They suggested that moment to moment changes of resurgent behavior displayed on a cumulative record both within and across sessions could be a useful measure. This would show not only the amount, but also the temporal ordering of responses. However, the temporal ordering was not typically reported because the majority of resurgence experiments analyzed only two behaviors. That is, only one alternative behavior can resurge (Leitenberg, 1970; Epstein, 1983; Podlesnik & Kelley, 2014; Craig & Shahan, 2016; Bouton & Trask, 2016).

When more than two alternatives have been used, experimenters are able to ask what comes first and what comes last in the resurgence test. For example, Reed and Morgan (2006) taught six rats to emit three response sequences on a continuous reinforcement schedule. Each response sequence had a different number of sessions as criterion for each rat. Results showed that the last trained sequence was the most emitted response for all rats, and the researchers

called this a recency effect. The first trained sequence was the next most emitted response, referred to as the primacy effect. Although, this experiment taught three sequences, the researchers did not report the order in which sequences were taught nor did they report the order in which sequences were emitted during the resurgence test. If the data were available, an analysis comparing the order in which responses were emitted versus frequency of responding during extinction might be of interest. Would the outcomes of resurgence based on frequency or order of responses during extinction be different?

Another commonality in the resurgence literature, is that the target response is reduced to a near zero level, while reinforcing the target response (Lattal et al., 2017). The researchers identified two procedures used to reduce target responding in previous research. The procedure most often used was extinction (Epstein, 1983; Lieving and Lattal, 2003). However, resurgence has also been studied in the absence of extinction. For example, Silva et al. (2008) used a differential reinforcement of other behavior schedule (DRO) to eliminate the target response. Thinning of reinforcement schedules with minimal extinction was also used to study resurgence (Bouton & Trask, 2016; Podlesnik & Shahan, 2009; Doughty et al., 2010).

Trump et al. (2020), reported several ways to study resurgence without extinction. However, resurgence without extinction might constitute a different phenomenon. For example, Mechner and Jones (2015) used the term reappearance to describe their results. They defined reappearance as, “behavior that occurred earlier in the individual’s history but not recently, without restoration of the conditions under which the earlier behavior occurred” (p. 63). However, they argued that extinction is “not the only cause of resurgence” (p.65). Ultimately, the question of whether the resurgence test produces different results for behavior that was trained with or without extinction remains unsolved.

The purpose of the present experiment is to analyze the order in which behaviors emerge during resurgence by comparing two types of training procedures, one with extinction of the target behaviors and the other without extinction of the target behaviors.

CHAPTER 2

METHODS

Participants

Six females between the ages of 18 and 25 participated in this study. All participants were enrolled in an undergraduate introductory behavior analysis course at the University of North Texas. All participants were recruited through an online research participation system called Sona. After completing the study, the participants earned one credit to use towards their grade in a behavior analysis course. None of the participants had previous experience with the apparatus used in this experiment (PORTL). The University of North Texas' Institutional Review Board approved this experiment before participants were recruited.

Setting and Materials

This experiment was conducted in a small 3' x 5' room in the Department of Behavior Analysis at the University of North Texas. The room included two chairs and a table. There was a clear space between the experimenter and learner before the experiment began. A laptop was placed to the left of the participant. A small cup was placed to the right of the participant as well as the learner data sheet with a pen, on the right side of the cup. The experimenter held a clicker in her right hand, while an Apple Watch® was on the experimenter's left wrist. The stimuli used in this study included eight small colored buttons of various shapes and sizes (pink, blue, green, purple, orange, yellow, light blue, black) as well as four wooden shapes of all the same color (circle, star, square, heart). 10 pennies were used as reinforcers in this experiment.

Measurement

The primary dependent variable was the cumulative number of touches. A touch was defined as anytime the learner made contact with the tip of the finger on the object and ended

when contact was broken. Touches were divided by each item. If the participant touched multiple objects at once, each item that was touched was counted as one touch. A secondary dependent variable consisted of the order of buttons in which buttons were touched.

For data collection purposes, each session was recorded on a laptop. Sessions were scored by measuring touches to each object every two seconds. If a participant touched an object twice, then two touches were recorded. Data began recording when the experimenter presented the first colored button in front of the learner. The video frame only consisted of the table, objects, and the participant's hands, and the participant's face were not in the frame.

Interobserver Agreement

A second observer was present for 33% of sessions. The observer was told to watch the video and mark how many responses occurred and when. She was given a laptop to watch the videos and for data collection. An Excel document was made that had time listed on the left column and item across the top row. Data were collected on when the participant responded to a particular item and how many times, including the order of responses.

IOA was calculated for 33% of sessions (2 videos). Exact agreement was calculated using the formula: total number of agreements divided by the total number of agreements and disagreements times 100. 97%-100% agreement was obtained for all conditions in each video.

Introduction to Apparatus

At the beginning of the session, the participant reviewed and signed an informed consent form. The consent form stated the general purpose of the study, credit to be given, and potential risks. Once the experimenter received the informed consent form, the experimenter started recording video on the laptop. Then, the experimenter explained the apparatus by reading the PORTL instructions: "Today we are going to play a game with the objects you see on the table.

In a minute, I will spread out the objects in the center of the table. Sometimes, you will have access to all of the objects. Other times, you may have access to just some of the objects. When I say, “you may begin,” you can touch or interact with the objects in any way you wish. Sometimes, when you do certain actions or interact with certain objects, you will hear a click sound (click the clicker), and I will hand you a penny (hand the learner a penny). When you receive a penny, please place it in this cup. Your goal today will be to earn as many pennies as possible.” For more detailed instructions, see Appendix A.

The delivery of the penny was practiced two times before moving on. The experimenter instructed the participant to use only one finger and one hand to interact with the objects and to collect pennies. The experimenter told the participant that his or her other hand can be kept in his or her lap or off to the side. After every 10 pennies, the learner will take a brief break to write down information on the learner data sheet. The participant will fill out one row on the learner data sheet by answering these questions: “What are you doing to earn pennies?” and “How do you feel?” The learner was informed that the experimenter is recording video on a laptop so that further data can be collected, they were also told that only his or her hand and the objects will be recorded, and the participant’s face will not be recorded. No further instructions were given to the learner regarding how he or she should behave with respect to the objects, and what he or she should write on the data sheet (Hunter and Rosales-Ruiz, 2019).

Response Shaping

The purpose of response shaping was to establish the target behavior for the experiment. Response shaping began when the experimenter put an index card with a black dot on it in front of the learner and said “touch.” The experimenter waited until the learner touched the dot with their chosen finger. After the learner touched the dot with their chosen finger, the experimenter

clicked and delivered a penny to the learner. The experimenter said “touch” only during the first presentation of the card. The card was presented a total of six times, in different positions. On the fourth presentation, the experimenter waited until two touches occurred. Then, a click and a penny (reinforcer) were given. A trial was defined as when the learner touched the object twice with the index finger and a click and a penny were delivered. This requirement remained in effect during the pre-training and experimental phases. Next, a coin was placed on the table. After the learner received three reinforcers for double touching the coin, the experimenter replaced the coin with a magnet faced down. After the first presentation of the magnet and a reinforcer was given, the learner was instructed to write information down on the Learner Data Sheet. The magnet was presented two more times. After the learner received three reinforcers, the magnet was removed, and the pennies were removed from the cup for the start of the experimental phase.

During response shaping and experimental phases, if the participants used another finger to touch the object, the experimenter counted those touches, then during the break, the experimenter reminded the participant to use the same finger they originally chose. If the learner touched anything outside of the black dot on the card, the experimenter waited until the learner exclusively touched the black dot twice.

Experimental Design

The experimental design was an A-B-A for three participants and B-A-B for the other three participants. Condition A was the reinforcement and extinction (Sr+ and Ext) phase and Condition B was the reinforcement only (Sr+) phase. The first two conditions for all participants involved the colored buttons. The last condition involved four wooden shapes, regardless if it was condition A or B. If Condition A was the third condition, it was called Sr+ and Ext with

shapes. If Condition B was the third condition, it was called Sr+ with shapes. After all conditions were completed, the interview began.

Reinforcement and Extinction Condition (Sr+ and Ext)

The reinforcement and extinction condition resembled a typical resurgence procedure. A typical resurgence procedure involves reinforcing a target behavior, putting that response on extinction while reinforcing an alternative behavior, then putting both of those responses on extinction.

Phase 1: Pink

The pink button was presented about six inches away from the learner. If the learner double touched the pink button, a click and a penny were delivered. If the learner did not touch the pink button or started interacting with it in a different way, the experimenter waited until a double touch was emitted. The pink button was presented in different positions for eight trials. On the ninth trial, a small period of extinction began. During this period, the learner emitted two double touches, did not receive a click or a penny, then the experimenter removed the button. Then, the blue and pink buttons were presented.

Phase 2: Blue

The blue and pink buttons were presented equidistant from the learner and each button. If the learner touched the pink button first, the experimenter waited until the learner double touched the blue button, then delivered a click and a penny. The buttons were presented in different positions for eight trials. For example, one trial the blue button might be presented closer to the learner and the next trial, the pink button might be presented closer to the learner. Then, on the ninth trial the experimenter did not deliver a click, or a penny and a small extinction period

began. After the learner emitted two double touches on the blue and pink buttons, the buttons were removed. Then, the pink, blue, and green buttons were presented.

Phase 3: Green

The pink, blue, and green buttons were presented about six inches in front of the learner in a horizontal array with green in the middle. If the learner double touched the green button, a click and a penny were delivered. If the learner double touched pink or blue, the experimenter did not provide a click or penny and waited until the learner double touched the green button. After eight reinforcers were delivered, the buttons were presented in a triangle shape with green at the top of the triangle. The green button was presented at the top of the triangle to control for position bias and to make sure that touching the pink or blue button was equal in response effort. During this small extinction period, the learner emitted two double touches to pink, blue, and green; then the buttons were removed. Next, the pink, blue, green, and purple buttons were presented.

Phase 4: Purple

The pink, blue, green, and purple buttons were presented six inches in front of the learner. Buttons were presented in random arrays for eight trials. If the learner double touched the purple button, a click and a penny were delivered. If the learner double touched pink, blue, or green, then the experimenter did not deliver a click nor a penny. After 8 pennies were delivered, the next phase began.

Resurgence Test

The final phase began by presenting all colored buttons in a horizontal line with the blue button on the left, pink next to it, purple next to pink, and green on the right (from the

experimenter's perspective). Once the learner double touched the purple button, the experimenter delivered a click and a reinforcer and the 30 second timer began. If the learner touched any other button, then the timer began. Then, after the learner double touched the purple button once more, the experimenter started the timer for 30 seconds and the buttons remained in front of the learner. After 30 seconds had elapsed, the buttons were removed, and the learner was instructed to write down information on the Learner Data Sheet. The pennies were removed from the cup and placed back in front of the learner.

Reinforcement Only Condition (Sr+)

The reinforcement only condition tested how participants responded in the resurgence condition, when extinction is not used. During this condition, only one button was presented at a time.

The experimenter presented the orange button about six inches away from the learner. The experimenter waited until the learner double touched the orange button. For eight trials, the orange button was presented in different positions. Once the learner received eight reinforcers, the orange button was removed, and the yellow button was presented. If the learner did not double touch or only touched once, the experimenter waited until the learner double touched the orange button. This process is repeated for the yellow, blue, and black buttons.

After the 8^{th} click and reinforcer were delivered for double tapping the black button, all four buttons were presented in a random array with the black button closest to the learner. The orange, yellow, and blue buttons were placed at least three inches away from the black button. This was done to ensure the reinforcement of the black button was in the presence of the other three buttons. If the learner double touched the black button, then a click and a penny were delivered. All four buttons were presented again, in a different array with the black button closest

to the learner with the other buttons about one inch away from the black button. After the learner double touched the black button, a click and a penny were delivered, and buttons were removed.

Resurgence Test

Finally, the buttons were presented once more in a horizontal line with yellow (second trained) on the left, orange (first trained) next to yellow, black (fourth trained) next to orange, and blue (third trained) on the right, so that primacy and recency effects were equal distance from the fourth trained. After the learner double touched the black button, a click and a penny were delivered. Once the learner double tapped the black button, the experimenter started the timer of 30 seconds with her Apple Watch® and the buttons remained in front of the learner. None of the responses were reinforced and the buttons were removed after 30 seconds. Then, the learner was instructed to write down information on the Learner Data Sheet.

Post-Experiment Interview

The experimenter asked a series of questions to debrief the participants: 1. What was I trying to teach you? 2. Was the task the same for all sets of buttons? 3. Did you have a rule for choosing which button to touch? Then, the experimenter stopped recording the video on the laptop and explained the purpose of the study as well as thanking the participants for their time and efforts.

CHAPTER 3

RESULTS

Experimental Results

Figures 1-6 show the cumulative number of responses for each of the items in each condition for each subject. The x-axis shows time in seconds. The y-axis shows the cumulative number of responses.

Figure 1 shows Rachel's results for all conditions. During the Sr+ condition (top graph), Rachel's performance during training was steady at about 25 responses per minute. During the resurgence test, Rachel responded to the first trained stimulus, then the second trained stimulus, then the fourth trained stimulus, and last the third trained stimulus. During the Sr+ and Ext condition (middle graph), Rachel's performance during the training was steady at 15 responses per minute. Each time that an alternative response was trained, and the target stimulus was placed on extinction, Rachel did not respond in the reverse order of training. First, Rachel responded to the third trained stimulus, then the first trained, then the second trained stimulus. During the resurgence test, Rachel first responded to the fourth trained stimulus, then the third trained stimulus, then the first trained stimulus, then the second trained stimulus. During the Sr+ condition with shapes (bottom graph), Rachel's performance during the training was steady at 17 responses per minute. During the resurgence test, Rachel first responded to fourth trained stimulus, then the first trained stimulus, then the second trained stimulus, then the third trained stimulus.

Figure 2 shows Phoebe's results for all conditions. During the Sr+ condition (top graph), Phoebe's performance during training was steady at about 25 responses per minute. During the resurgence test, Phoebe responded to the fourth trained stimulus, then the first trained stimulus,

then the second trained stimulus, then the third trained stimulus last. During the Sr+ and Ext condition (middle graph), Phoebe's performance during the training was steady at 30 responses per minute. Each time that an alternative response was trained, and the target stimulus was placed on extinction, Phoebe responded in the reverse order of training. During the resurgence test, Phoebe first responded to the fourth trained stimulus, the first trained stimulus, the second trained stimulus, then the third trained stimulus last. During the Sr+ condition with shapes (bottom graph), Phoebe's performance during the training was steady at about 31 responses per minute. During the resurgence test, Phoebe first responded to the fourth trained stimulus, then the first trained stimulus, then the second trained stimulus, and last the third trained stimulus. Phoebe touched the buttons in the same pattern during all resurgence tests.

Figure 3 shows Emily's results for all conditions. During the Sr+ condition (top graph), Emily's performance during training was steady at about 22 responses per minute. During the resurgence test, Phoebe responded to second trained stimulus, then the fourth trained stimulus, then the first trained stimulus, and last the third trained stimulus. During the Sr+ and Ext condition (middle graph), Emily's performance during the training was steady at about 25 responses per minute. Each time that an alternative response was trained, and the target stimulus was placed on extinction, Emily responded in the reverse order of training. During the resurgence test, Emily first responded to the fourth trained stimulus, then the third trained stimulus, then the first trained stimulus, last the second trained stimulus. During the Sr+ with shapes condition (bottom graph), Emily's performance during training was steady at 23 responses per minute. During the resurgence test, Emily first responded to the fourth trained stimulus, the first trained stimulus, the second trained stimulus, and last the third trained stimulus.

Figure 4 shows Monica's results for all conditions. During the Sr+ and Ext condition (top graph), Monica's performance during training was steady at about 21 responses per minute. Each time that an alternative response was trained, and the target stimulus was placed on extinction, Monica responded in the reverse order of training. During the resurgence test, Monica responded to the fourth trained stimulus, then the third trained stimulus, then the first trained stimulus, and then the second trained stimulus last. During the Sr+ condition (middle graph), Monica's performance during training was steady at about 19 responses per minute. During the resurgence test, Monica responded to the fourth trained stimulus, then the first trained stimulus, then the second trained stimulus, then the third trained stimulus. During the Sr+ and Ext with shapes condition (bottom graph), Monica's performance during training was steady at about 14 responses per minute. Each time that an alternative response was trained, and the target stimulus was placed on extinction, Monica responded in the reverse order of training. During the resurgence test, Monica responded to the third trained stimulus, then the fourth trained stimulus, then the first trained stimulus, then the second trained stimulus last.

Figure 5 shows Charlie's results for all conditions. During the Sr+ and Ext condition (top graph), Charlie's performance during training was steady at about 22 responses per minute. Each time that an alternative response was trained, and the target stimulus was placed on extinction, Charlie responded in the reverse order of training. During the resurgence test, Charlie responded to the fourth trained stimulus, then the third trained stimulus, then the second trained stimulus, and touched the first trained stimulus last. During the Sr+ condition (middle graph), Charlie's performance during training was steady at about 24 responses per minute. During the resurgence test, Charlie responded to the fourth trained stimulus, then the third trained stimulus, then the second trained stimulus, and the first trained stimulus last. During the Sr+ and Ext with shapes

condition (bottom graph), Charlie's performance during training was steady at about 27 responses per minute. Each time that an alternative response was trained, and the target stimulus was placed on extinction, Charlie did not respond in the reverse order of training. First, Charlie responded to the third trained stimulus, then the first trained, and last the second trained stimulus. During the resurgence test, Charlie responded to the fourth trained stimulus, then the first trained stimulus, the second trained stimulus, and the third trained stimulus last.

Figure 6 shows Elizabeth's results for all conditions. During the Sr+ and Ext condition (top graph), Elizabeth's performance during training was steady at about 15 responses per minute. Each time that an alternative response was trained, and the target stimulus was placed on extinction, Elizabeth responded in the reverse order of training. During the resurgence test, Elizabeth responded to the fourth trained stimulus, then the third trained stimulus, then the second trained stimulus, and the first trained stimulus last. During the Sr+ condition (middle graph), Elizabeth's performance during training was steady at about 17 responses per minute. During the resurgence test, Elizabeth first responded to the second trained stimulus, then the first trained stimulus, the fourth trained stimulus, and responded to the third trained stimulus last. During the Sr+ and Ext with shapes condition (bottom graph), Elizabeth's performance during training was steady at about 19 responses per minute. Each time that an alternative response was trained, and the target stimulus was placed on extinction, Elizabeth responded in the reverse order of training. During the resurgence test, Elizabeth responded to the second trained stimulus, the first trained stimulus, the fourth trained stimulus, and the third trained stimulus last. During the resurgence test of the last two conditions, Elizabeth touched the items in a line from right to left.

Figures 7-12 show the total percentage of responding during the resurgence test of all conditions. The x-axis shows each condition. The y-axis shows the percentage of responses during the resurgence test.

Figure 7 shows the percentage of Rachel's responses during the resurgence tests in all conditions. During the resurgence test of the Sr+ condition (first column), Rachel responded to the first trained stimulus one time, the second trained stimulus four times, then the third trained stimulus three times, and the fourth trained stimulus 12 times. During the resurgence test of the Sr+ and Ext condition (second column), Rachel responded to the first trained stimulus two times, second trained stimulus three times, the third trained stimulus three times, then the fourth trained stimulus 10 times. During the resurgence test of the Sr+ with shapes condition, Rachel responded to the first trained stimulus four times, the second trained stimulus two times, the third trained stimulus three times, and the fourth trained stimulus 11 times.

Figure 8 shows the percentage of Phoebe's responses during the resurgence tests in all condition. During the resurgence test of the Sr+ condition (first column), Phoebe responded to the first trained stimulus eight times, the second trained stimulus seven times, the third trained stimulus 13 times, and the fourth trained stimulus 10 times. During the resurgence test of the Sr+ and Ext condition (second column), Phoebe responded to the first trained stimulus 13 times, the second trained stimulus nine times, third trained stimulus 12 times, and the fourth trained stimulus 11 times. During the resurgence test of the Sr+ with shapes condition (third column), Phoebe responded to the first trained stimulus nine times, the second trained stimulus 10 times, the third trained stimulus 10 times, and the fourth trained stimulus 13 times.

Figure 9 shows the percentage of Emily's responses during the resurgence tests in each condition. During the resurgence test of the Sr+ condition (first column), Emily responded to the

first trained stimulus six times, the second trained stimulus three times, the third trained stimulus five times, and the fourth trained stimulus 10 times. During the resurgence test of the Sr+ and Ext condition (second column), Emily responded to the first trained stimulus six times, the second trained stimulus four times, the third trained stimulus six times, and the fourth trained stimulus eight times. During the resurgence test of the Sr+ with shapes condition (third column), Emily responded to the first trained stimulus five times, the second trained stimulus five times, the third trained stimulus eight times, and the fourth trained stimulus six times.

Figure 10 shows the percentage of Monica's responses during the resurgence tests in each condition. During the resurgence test of the Sr+ and Ext condition (first column), Monica responded to the first trained stimulus two times, the second trained stimulus two times, the third trained stimulus two times, and the fourth trained stimulus nine times. During the Sr+ condition (second column), Monica responded to all trained stimuli two times each. During the Sr+ and Ext with shapes condition (third column), Monica responded to the first trained stimulus three times, the second trained stimulus one time, the third trained stimulus three times, and the fourth trained stimulus four times.

Figure 11 shows the percentage of Charlie's responses during the resurgence tests in each condition. During the resurgence test of the Sr+ and Ext condition (first column), Charlie responded to the first trained stimulus eight times, the second trained stimulus eight times, the third trained stimulus eight times, and the fourth trained stimulus 20 times. During the resurgence test of the Sr+ condition (second column), Charlie responded to the first trained stimulus nine times, the second trained stimulus nine times, the third trained stimulus nine times, and the fourth trained stimulus 10 times. During the resurgence test of the Sr+ and Ext with shapes condition (third column), Charlie responded to the first trained stimulus eight times. The

second trained stimulus 10 times, the third trained stimulus eight times, and the fourth trained stimulus 16 times.

Figure 12 shows the percentage of Elizabeth's responses during the resurgence tests in each condition. During the resurgence test of the Sr+ and Ext condition (first column), Elizabeth responded to the first trained stimulus two times, the second trained stimulus two times, the third trained stimulus two times, and the fourth trained stimulus four times. During the resurgence test of the Sr+ condition (second column), Elizabeth responded to the first trained stimulus six times, the second trained stimulus six times, the third trained stimulus six times, and the fourth trained stimulus 10 times. During the resurgence test of the Sr+ and Ext with shapes condition (third column), Elizabeth responded to the first trained stimulus four times, the second trained stimulus seven times, the third trained stimulus six times, and the fourth trained stimulus 11 times.

Figures 13-18 show the temporal order of responses during the resurgence tests for all subjects. The order of trained stimuli is on the left side of the figure and time in seconds is at the bottom of the figure.

Figure 13 shows the temporal order of Rachel's responses during the resurgence tests. During the resurgence test of the Sr+ condition (top), Rachel's temporal order of responses was 1,2,4,3. Then she responded in the following order, 4,1,2,3,4. During the resurgence test of the Sr+ and Ext condition (middle), Rachel's temporal order of responses was 4,3,1,2. Then she responded in the following order, 4,3,2. During the resurgence test of the Sr+ with shapes (bottom) condition, Rachel's temporal order of responses was 4,1,2,1. Then, she responded in the following order, 4,3,4,3, followed by 1,2,3,4.

Figure 14 shows the temporal order of Emily's responses during the resurgence tests in each condition. During the resurgence test of the Sr+ condition (top), Emily's temporal order of

responses was 2,4,1,3. Then she responded in the following order, 4,1,4,3, followed by, 4,1,4,1,2. During the resurgence test of the Sr+ and Ext condition (middle), Emily's temporal order of responses was 4,3,1,2. She repeated this order once more, then responded 4,3,1,4. During the resurgence test of the Sr+ with shapes (bottom) condition, Emily's temporal order of responses was 4,1,2,3. Then she responded in the following order 1,2,4,3, followed by 4,1,2,3,4,3,4,3.

Figure 15 shows the temporal order of Phoebe's responses during the resurgence tests in each condition. During the resurgence test of the Sr+ condition (top), Phoebe's temporal order of responses was 4,1,2,3. Then, she responded in the following order, 4,3,2,1, followed by 4,3,1,3,4,2,1. During the resurgence test of the Sr+ and Ext condition (middle), Phoebe's temporal order of responses was 4,1,2,3. Then, she responded in the following order, 4,1,4,2,1,3,4 followed by 1,2,3,4. During the resurgence test of the Sr+ with shapes (bottom) condition, Phoebe's temporal order of responses was 4,1,2,3. Then, she responded in the following order, 4,3,4,1,2,1,4,3,4. Then, she responded in the following order, 1,2,3.

Figure 16 shows the temporal order of Monica's responses during the resurgence tests in each condition. During the resurgence test of the Sr+ and Ext condition (top), Monica's temporal order of responses was 4,3,1,2. Then, repeated the same pattern, 4,3,1,2. During the resurgence test of the Sr+ condition (middle), Monica's temporal order of responses was 4,1,2,3,4. During the resurgence test of the Sr+ and Ext with shapes (bottom) condition, Monica's temporal order of responses was 3,4,1,2. Then, she responded in the following order 1,4,3.

Figure 17 shows the temporal order of Elizabeth's responses during the resurgence tests in each condition. During the resurgence test of the Sr+ and Ext condition (top), Elizabeth's temporal order of responses was 4,3,4,2,1. During the resurgence test of the Sr+ condition (middle), Elizabeth's temporal order of responses was 4,2,1,4,3. Then, she responded in the

following order, 2,1,4,3. During the resurgence test of the Sr+ and Ext with shapes (bottom) condition, Elizabeth's temporal order of responses was 2,1,4,3. Then, she responded in the following way, 3,2,1,4, followed by 1,2,3,4.

Figure 18 shows the temporal order of Charlie's responses during the resurgence tests in each condition. During the resurgence test of the Sr+ and Ext condition (top), Charlie's temporal order of responses was 4,3,2,1. This pattern was repeated twice more, followed by repeated responding to 4. During the resurgence test of the Sr+ condition (middle), Charlie's temporal order of responses was 4,3,2,1. This pattern was repeated twice more, followed by 1,2,3,4. During the resurgence test of the Sr+ and Ext with shapes condition (bottom), Charlie's temporal order of responses was 4,1,2,3,4. Then, she responded in the following way, 1,2,3,4,3,2,1,4.

Table 2 shows primacy and recency effects during the resurgence tests in all conditions for all participants. Recency was defined as touching the third trained stimulus first during the resurgence test. Primacy was defined as touching the first trained stimulus first during the resurgence test. Primacy (P2) was defined as touching the second trained stimulus first during the resurgence test. The bolded letters indicate a discrepancy compared to other participants. During the first exposure, two out of three participants showed a primacy effect in the Sr+ condition, and the other showed a P2 effect. Three out of three participants showed a recency effect during the first Sr+ and Ext condition. During the second exposure, two out of three participants showed a recency effect during the Sr+ and Ext condition. The other participant showed a primacy effect. In the Sr+ condition, one participant showed a primacy effect, another showed a P2 effect, and the third participant showed a recency effect. During the third exposure to the Sr+ with shapes condition, three out of three participants showed a primacy effect. In the

Sr+ and Ext with shapes condition, one participant showed a recency effect, another showed a P2 effect, and the third participant showed a primacy effect.

Table 3 compares the primacy and recency effects derived from either the frequency or the order of responses during the resurgence test for all participants. Overall, there were six out of 18 instances in which the frequency of responding and the order of responses both were categorized as primacy effects. There were ten out of 18 instances in which the frequency of responding was not differentiated between recency and primacy. There were two out of 18 instances in which the order of responding was categorized as primacy, and frequency of responding was categorized as recency.

Table 4 shows a summary of responses from the Learner Data Sheets from all participants. The first row identifies the condition. The second row shows the participant's responses to "what are you doing to earn pennies?", during training. The responses were categorized by "touch twice" or "color/shape order." The lower part of the table identifies the participant's responses to "how do you feel?" during the resurgence test. The participant's responded with "confused", "good", "OK", or "time?". During the training of Sr+ condition, all of the participants wrote that they were learning to touch the item twice, except for one who wrote about color order. During the training of Sr+ and Ext condition, all participants identified that they were learning to respond to color order. During the training of Sr+ with shapes condition, two participants wrote that they were learning to touch the item twice and the other wrote about shape order. During the training of Sr+ and Ext with shapes condition, two participants wrote that they were learning to touch the items twice, and the other participant wrote about shape order. During the resurgence test of the Sr+ condition, three participants wrote they were "confused", and the other three wrote they were "good". During the resurgence test for

the Sr+ and Ext condition, five participants wrote “confused” and the other participant wrote “OK”. During the resurgence test for the Sr+ with shapes condition, two participants wrote they were “confused”, and the other participant wrote “there might be a time component?”. During the resurgence test for the Sr+ and Ext with shapes condition, two participants wrote they were “confused”, and the other participant wrote “OK”.

Post-Experiment Interview

After the experimental phase, participants were asked three questions. Table 5 shows a summary of the participant’s responses. The first question was, “what was I trying to teach you?”. All of the participants wrote that they were learning to touch the objects twice, except for two participants who wrote they were learning to touch the new item. The second question was, “were all the tasks the same?”. Four out of the six subjects wrote that all tasks were the same. The other two wrote that all three tasks were different. The third question was, “did you have a rule for which button to touch?”. Four participants wrote that they were learning to touch the newest object. The other two wrote that they were learning to touch the item that was previously reinforced. One participant also wrote that she was supposed to touch the items in the way they were taught.

CHAPTER 4

DISCUSSION

The results show that subjects that began with the Sr+ condition responded in a way consistent with primacy effects during the resurgence test. Subjects that began with Sr+ and Ext condition responded in a way consistent with recency effects during the resurgence test. When the conditions were reversed from Sr+ to Sr+ and Ext or from Sr+ and Ext to Sr+ only, four out of six subjects switched from primacy to recency or from recency to primacy, respectively. The other two subjects did not switch their responses. One subject continued responding in a way consistent with primacy and the other subject continued responding in a way consistent with recency. When the initial condition was replicated with shapes, three subjects that began with Sr+ responded in a way consistent with primacy, which corresponded to their initial performances. Of the other three subjects that began with Sr+ and Ext, only one subject responded in a way consistent with recency, which corresponded to her initial performance. The second subject continued to respond in a way consistent with primacy, which is how she responded in the previous condition. The third subject's response changed from recency to primacy. According to the Learner Data Sheets, the two procedures used in this study produced two types of rules. Participants noted that the Sr+ procedure was about learning to touch the items twice. The Sr+ and Ext procedure was about learning to touch the items in color order.

Part of these results replicate existing resurgence research. Typically, in the resurgence literature, responses resurged in a way that is consistent with recency effects. That is, the most recently extinguished behavior resurged first during extinction of the current behavior (Epstein, 1984; Leitenberg, 1975; Lambert, 2015; Lattal et al., 2017). In the present study, the recency effect was clearly seen during the training phase of Sr+ and Ext and the final resurgence tests.

Each time the target behavior was placed on extinction, alternative responses resurged in the reverse order of training for most participants. For example, when behavior three was placed on extinction, behavior three occurred first, then behavior two, then behavior one.

The recency and primacy effects that were described above are robust and were reversed and replicated in four out of six subjects. The other two subjects responded to other dimensions outside of the experiment (e.g. ordinal positioning). One subject touched the items in a line from the right side to the left side of the table. This order of responses was not trained, but it is likely that this order will come up when confronted with objects lined up. The other subject responded to the items in the reverse order of training for the first two conditions, then switched to the order of training for the last condition. Both of these patterns of responding were not trained in this experiment. Objects lined up might have produced the stimulus conditions necessary to evoke them (see Lattal et al., 2017).

In conclusion, these results show that the type of training has differential effects on the order of responses that come up during resurgence. When reinforcement and extinction are used in training, it is more likely that responses trained last come up first during the resurgence test. In contrast, when only reinforcement is used in training, it is more likely that responses trained first come up first in the resurgence test. The difference in results partially answers Lattal et al., (2017) question, “is it necessary that the target response be extinguished before it can be resurged?” (p.88). The present results suggest that the terms resurgence and reappearance should be used to distinguish both procedures and their effects. Resurgence should be reserved for instances in which the behavior is extinguished. And the term reappearance should be used when behavior is reinforced, but not extinguished (Mechner & Jones, 2015).

Previous research has analyzed resurgence in terms of how many responses or how much time is allocated towards a response during the resurgence test (Epstein, 1984; Reed and Morgan, 2006; Lambert et al., 2015; 2017). The current study analyzed resurgence in terms of both the order and the frequency of responses that occurred during the resurgence tests. These two ways to analyze resurgence were not equivalent. In the current study, the order and frequency measure were in agreement six out of 18 instances. The low correspondence between the frequency measure and the temporal order measure underscores the need to specify exactly how resurgence should be measured (see Lattal et al., 2017).

These results have implications for applied research. Sometimes applied researchers teach alternative responses in order for a particular behavior to be the last resort. For example, if aggression is maintained by attention, many alternative responses can be reinforced so that aggression occurs last during extinction. This is usually done in functional communication training (Wacker et al., 2011; Lambert et al., 2017; Sullivan et al., 2020).

Alternatively, applied researchers teach a behavior that they would like to come up first during extinction. This is usually done when therapists are reinforcing an alternative behavior to the problem behavior using the procedure of differential reinforcement of alternative behaviors (DRA) (Lambert et al., 2017; Brown et al., 2020). One strategy could be, before the problem behavior is put on extinction, to heavily reinforce an alternative behavior before the DRA is in place. Another example is when responses are trained to come up in a particular sequence to solve a problem. For example, Epstein (1984) used extinction during part of the training to teach a pigeon to peck bananas by pushing and climbing on top of a box. First, directional pushing was trained with the box in the presence of the green spot then extinguished without the green spot. Next, the green spot was removed and climbing on top of the box and pecking the bananas was

reinforced. Then, the box was removed, and all other behaviors such as flying or jumping in the presence of the bananas were extinguished. Last, a resurgence test was conducted by placing all behaviors on extinction and the box was placed back in the chamber. The results show that the pigeon tried to peck the bananas first, then pushed the box towards the bananas, which made it possible for the pigeon to climb and peck the bananas. In order for the pigeon to successfully solve the problem of using a box to peck bananas, behaviors needed to resurge in a specific order.

In closing, this research shows that training with and without extinction is relevant to the order in which behaviors occur during resurgence. More research is needed to create a technology of resurgence, that is in order to control the effects that are consistent with either recency or primacy depending upon the needs in the applied setting.

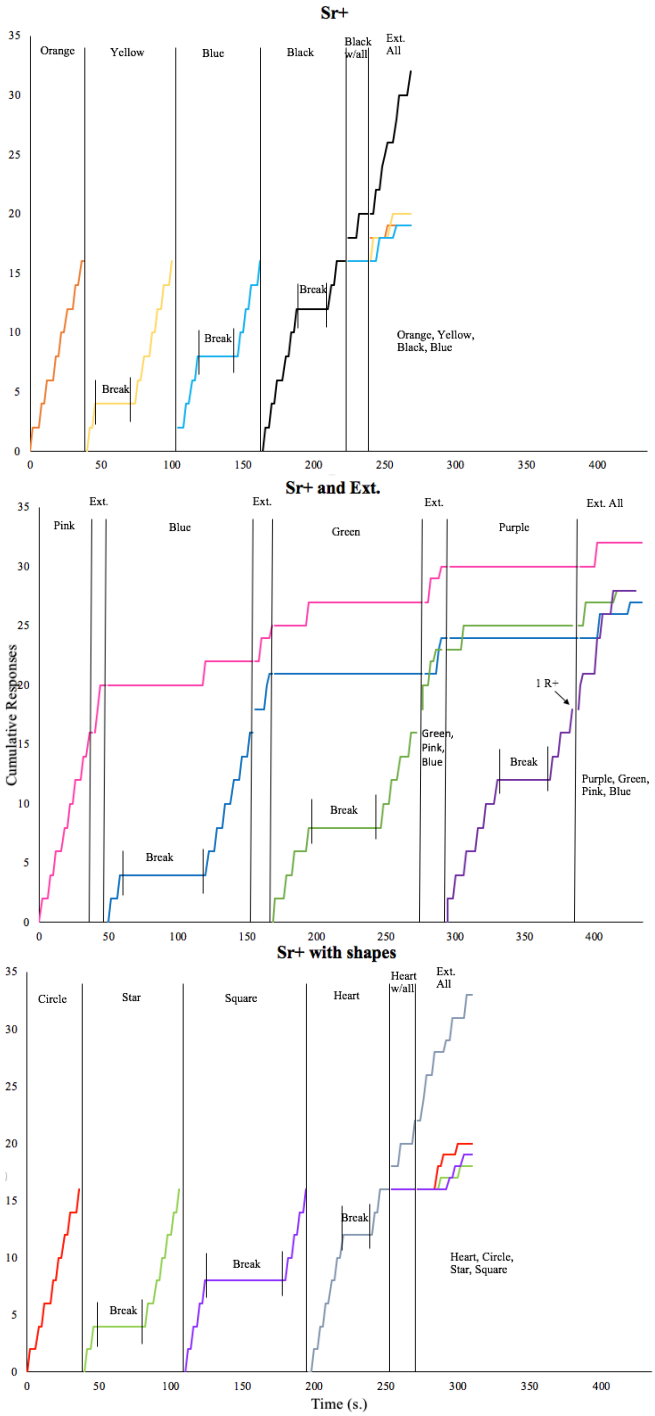

Figure 1. Rachel. Cumulative responses during Sr+ condition (top graph), Sr+ and Ext condition (middle graph), Sr+ with shapes condition (bottom graph). The y-axis shows the cumulative number of responses and the x-axis shows time in seconds. Each line represents a colored button or wooden shape.

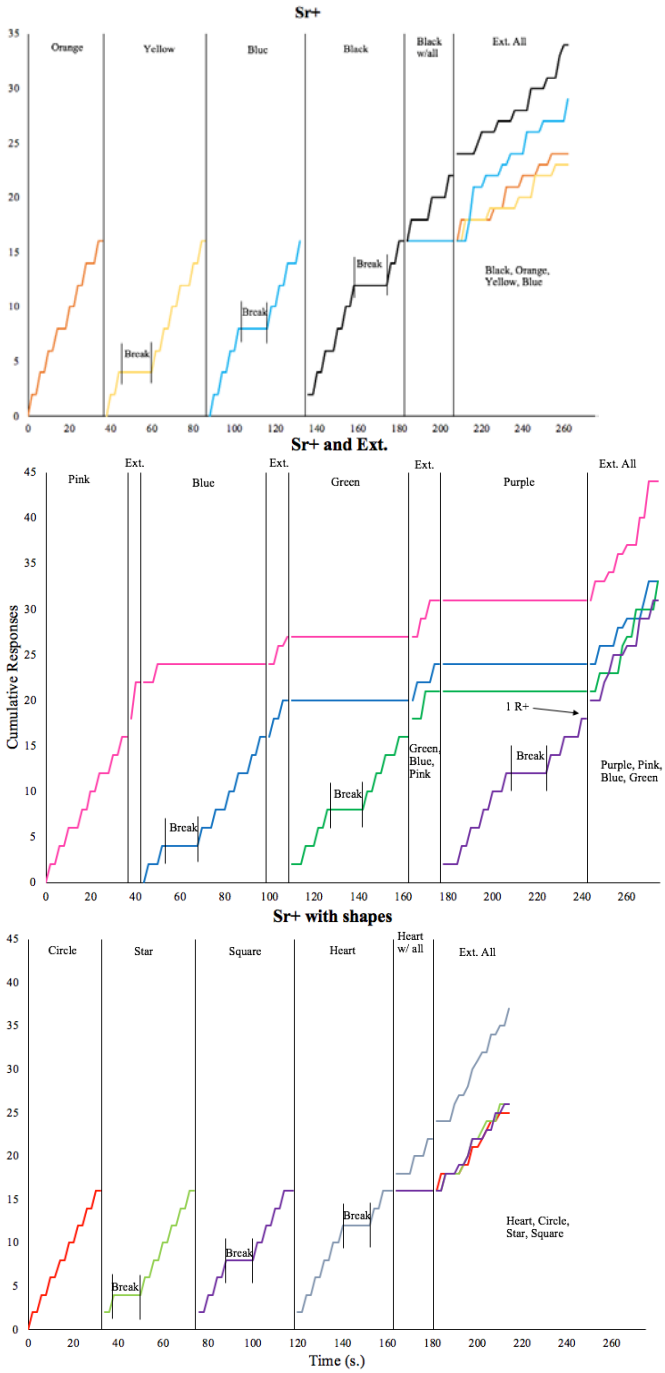

Figure 2. Phoebe. Cumulative responses during Sr+ condition (top graph), Sr+ and Ext condition (middle graph), Sr+ with shapes condition (bottom graph). The y-axis shows the cumulative number of responses and the x-axis shows time in seconds. Each line represents a colored button or wooden shape.

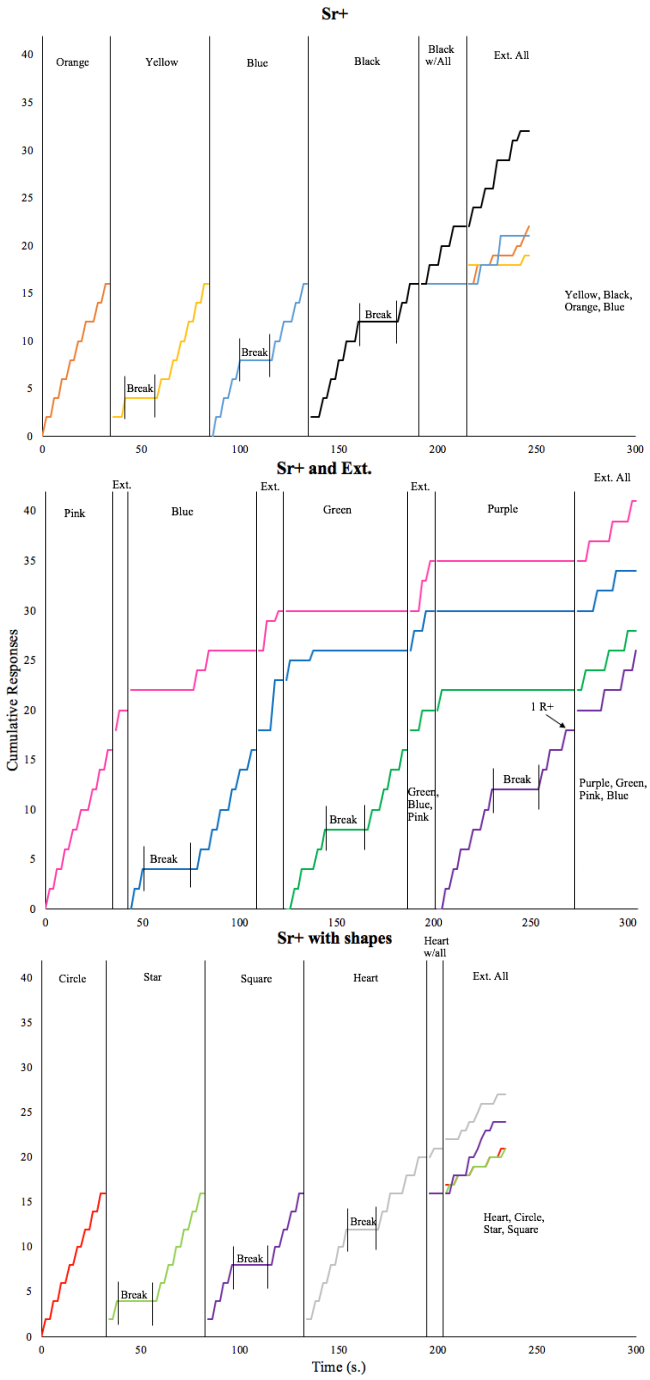

Figure 3. Emily. Cumulative responses during Sr+ condition (top graph), Sr+ and Ext condition (middle graph), Sr+ with shapes condition (bottom graph). The y-axis shows the cumulative number of responses and the x-axis shows time in seconds. Each line represents a colored button or wooden shape.

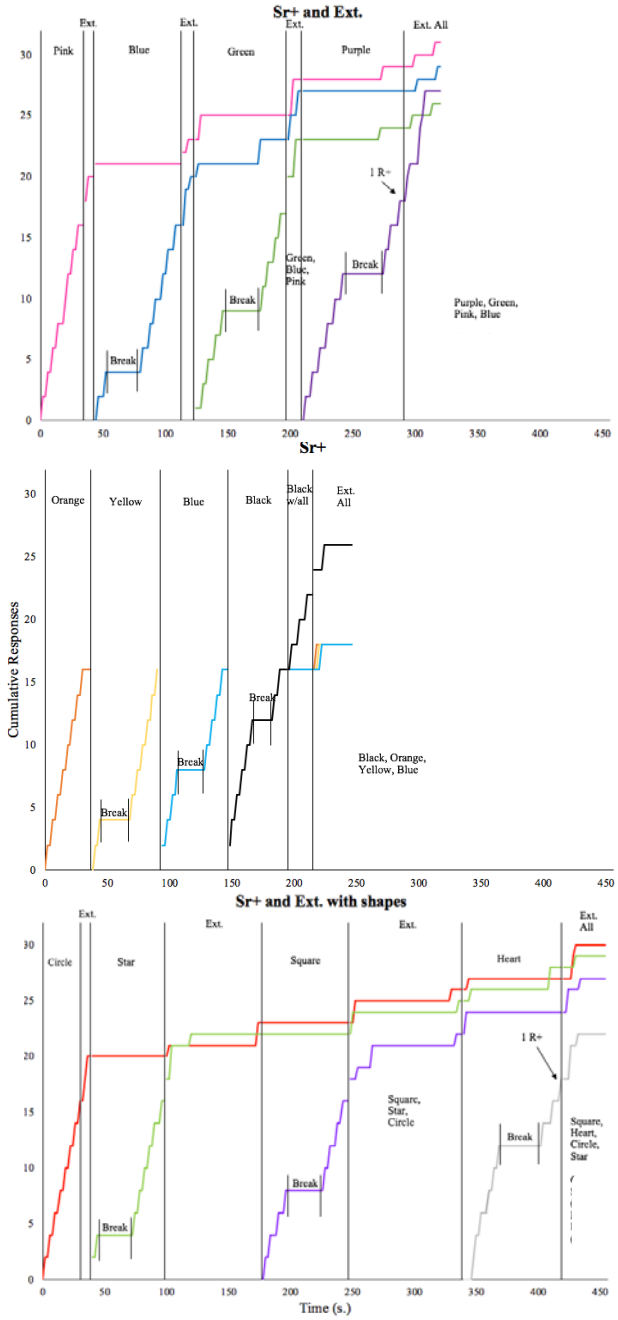

Figure 4. Monica. Cumulative responses during Sr+ and Ext. condition (top graph), Sr+ condition (middle graph), Sr+ and Ext. with shapes condition (bottom graph). The y-axis shows the cumulative number of responses and the x-axis shows time in seconds. Each line represents a colored button or wooden shape.

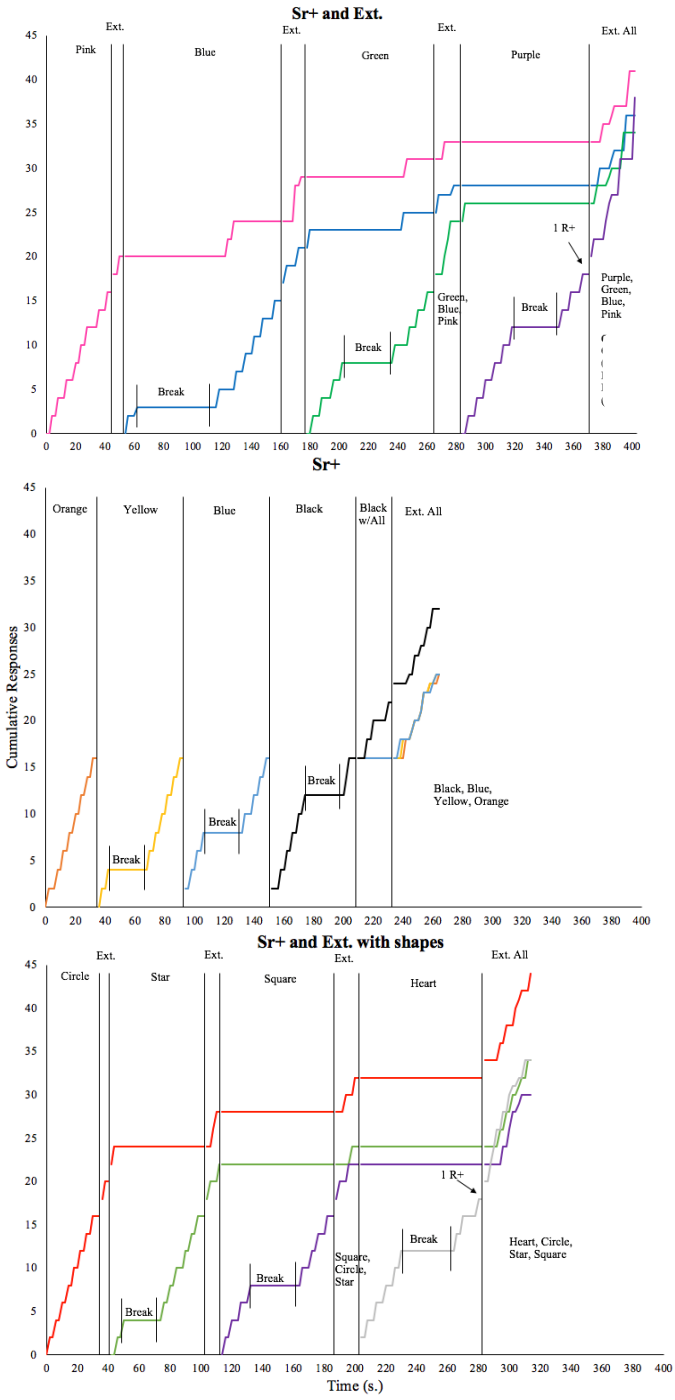

Figure 5. Charlie. Cumulative responses during reinforcement only condition. The top graph is the Sr+ and Ext condition, middle graph is Sr+ condition, bottom graph is the Sr+ and Ext with shapes condition. The y-axis is the cumulative number of responses, while the x-axis depicts time during the session. Each line depicts a colored button or wooden shape.

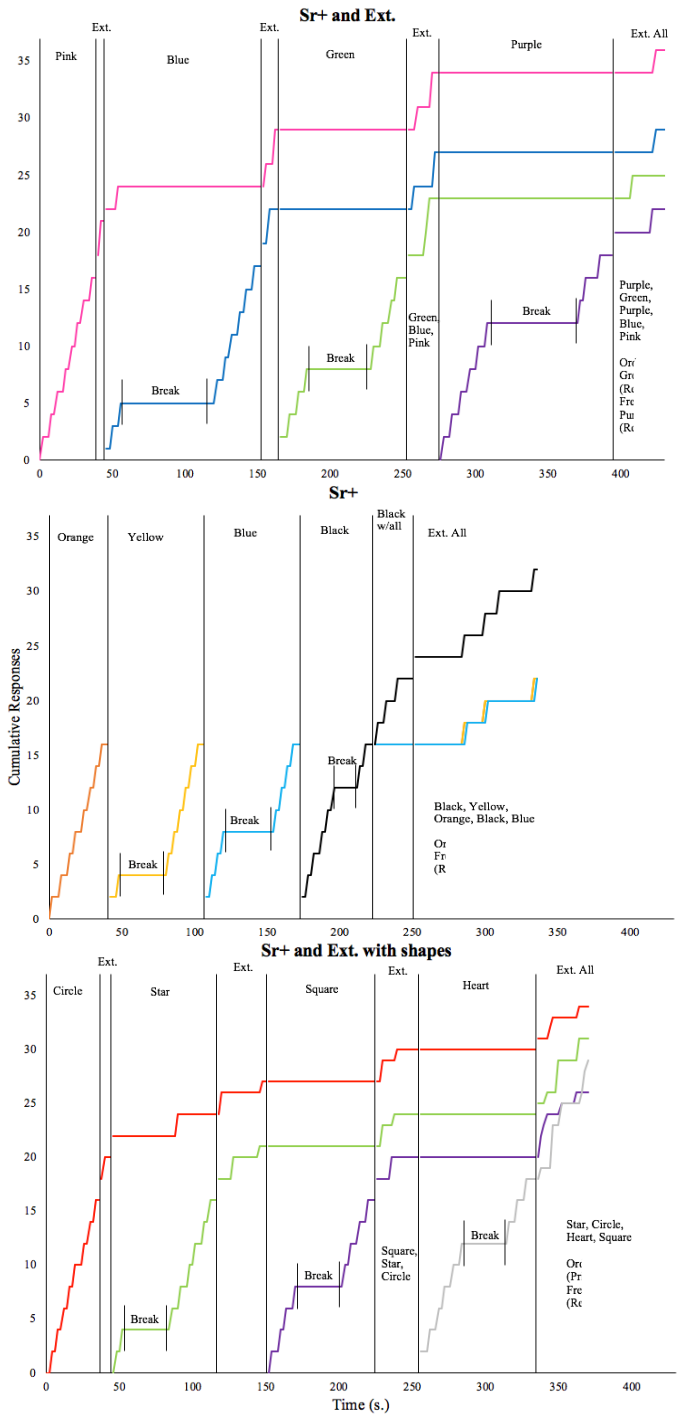

Figure 6. Elizabeth. Cumulative responses during reinforcement only condition. The top graph is the Sr+ and Ext condition, middle graph is Sr+ condition, bottom graph is the Sr+ and Ext with shapes condition. The y-axis is the cumulative number of responses, while the x-axis depicts time during the session. Each line depicts a colored button or wooden shape.

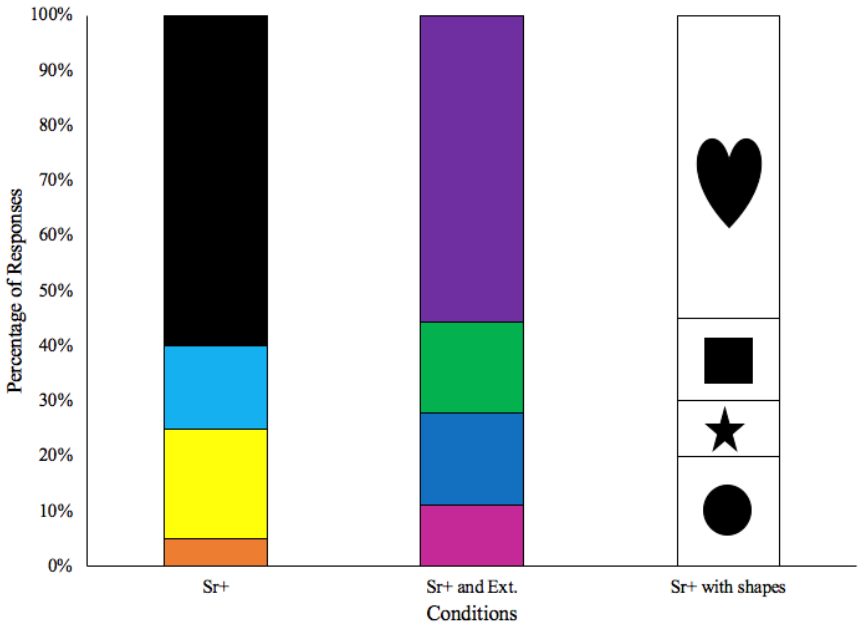

Figure 7. Rachel: Percentage of responses during resurgence test of each condition. Rachel's responses are graphed by percentage of responses during the resurgence test for all conditions. Percentages are stacked in the order that training occurred.

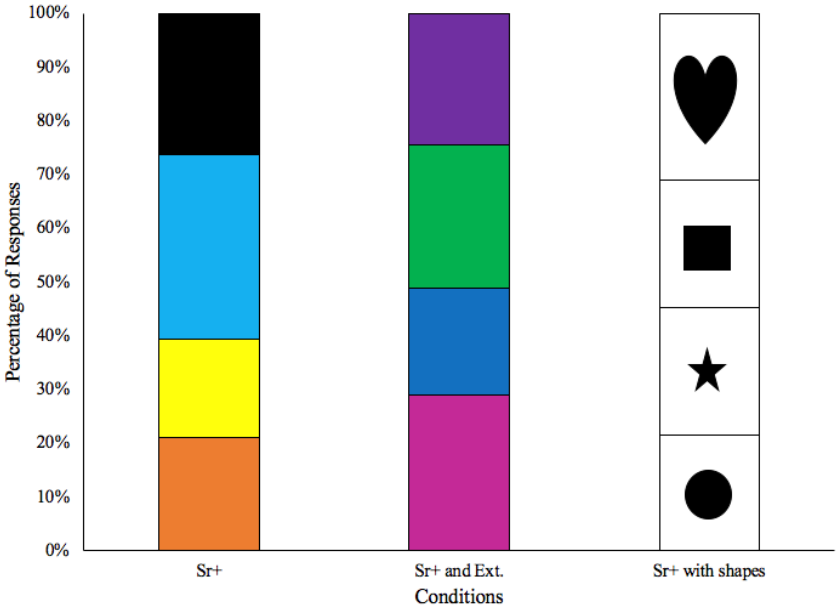

Figure 8. Phoebe: Percentage of responses. Phoebe's responses are graphed by percentage of responses during the resurgence test for all conditions. Percentages are stacked in the order that training occurred.

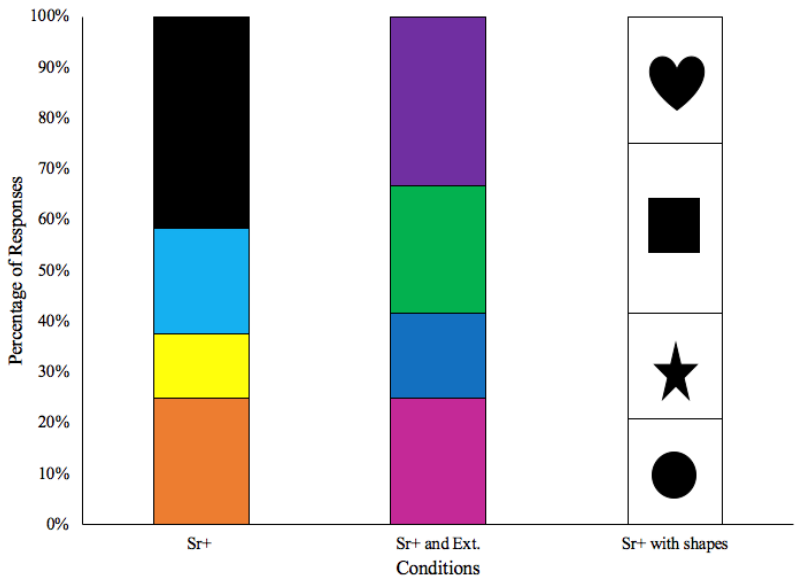

Figure 9. Emily: Percentage of responses. Emily's responses are graphed by percentage of responses during the resurgence test for all conditions. Percentages are stacked in the order that training occurred.

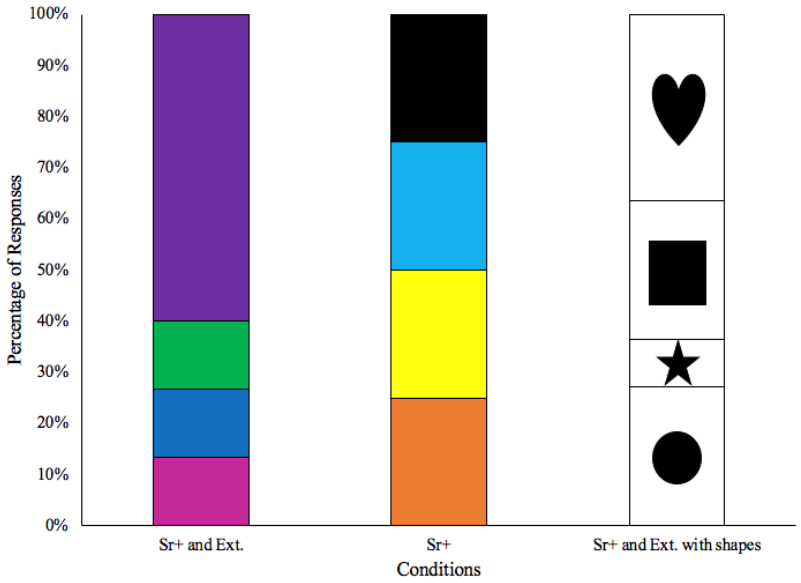

Figure 10. Monica: Percentage of responses. Monica's responses are graphed by percentage of responses during the resurgence test for all conditions. Percentages are stacked in the order that training occurred.

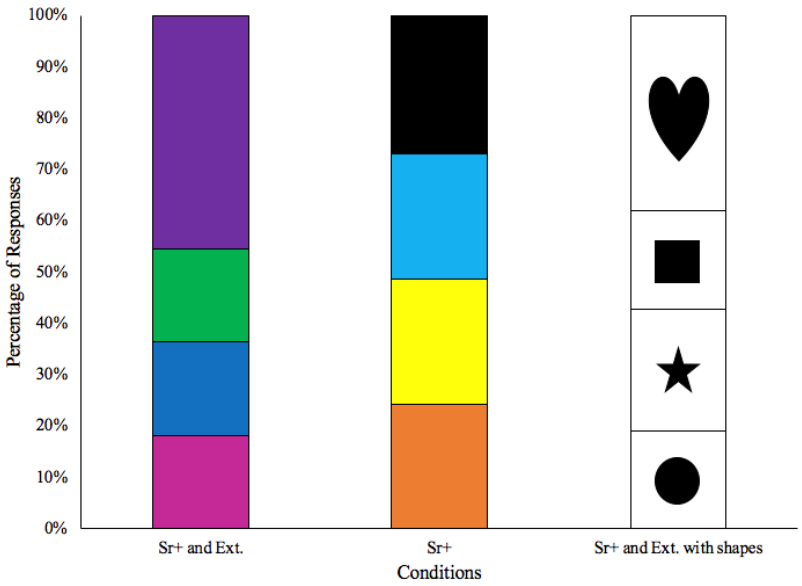

Figure 11. Charlie: Percentage of responses. Charlie's responses are graphed by percentage of responses during the resurgence test for all conditions. Percentages are stacked in the order that training occurred.

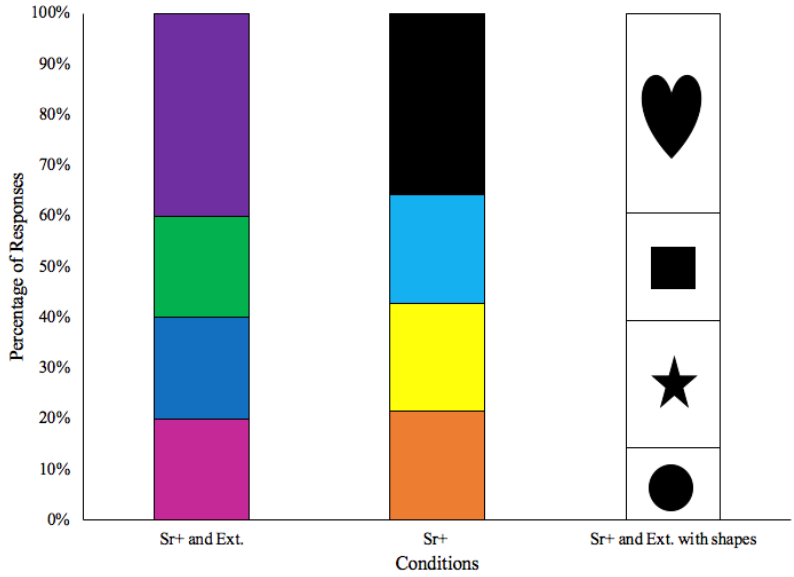

Figure 12. Elizabeth: Percentage of responses. Elizabeth's responses are graphed by percentage of responses during the resurgence test for all conditions. Percentages are stacked in the order that training occurred.

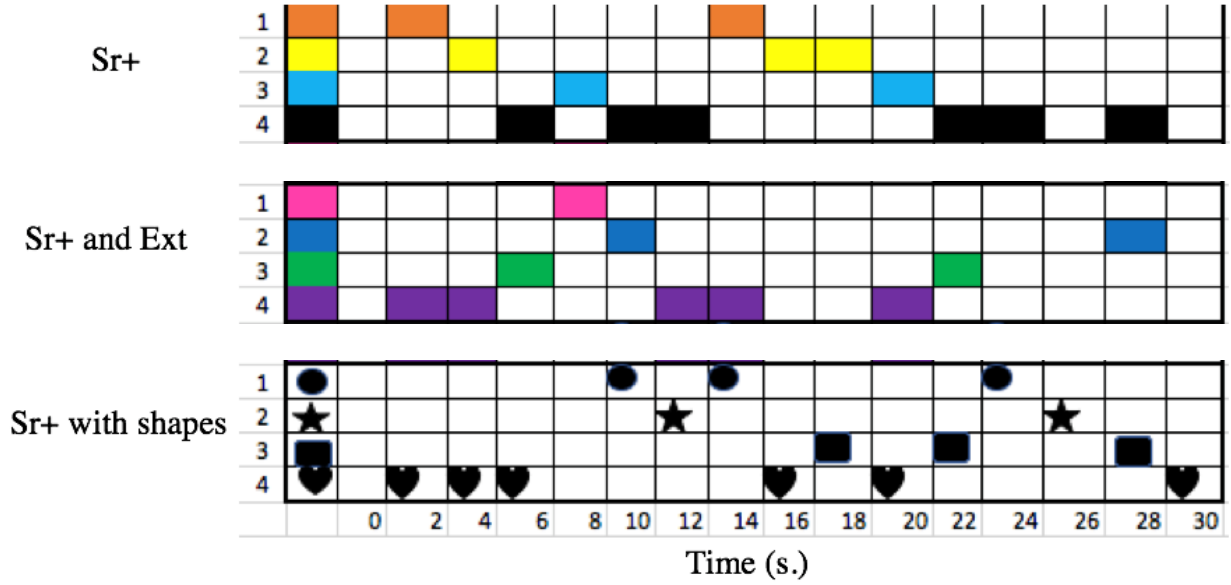

Figure 13. Rachel: Order of responses during each resurgence test. Rachel's responses are graphed by temporal order of responses during each resurgence test condition.

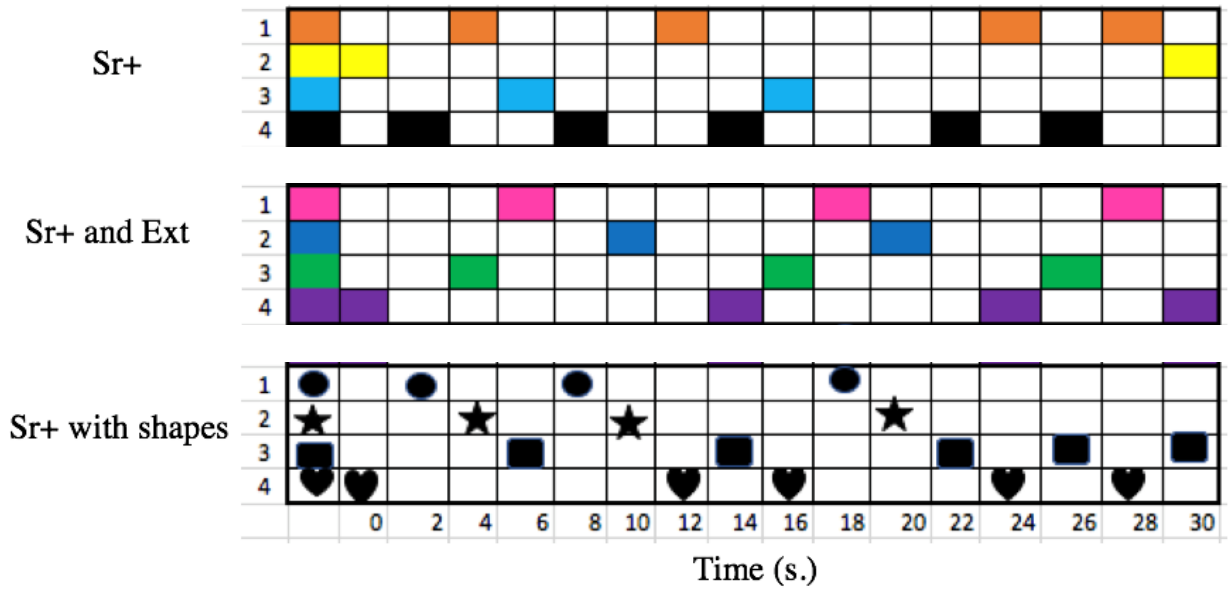

Figure 14. Emily: Order of responses during each resurgence test. Emily's responses are graphed by temporal order of responses during each resurgence test condition.

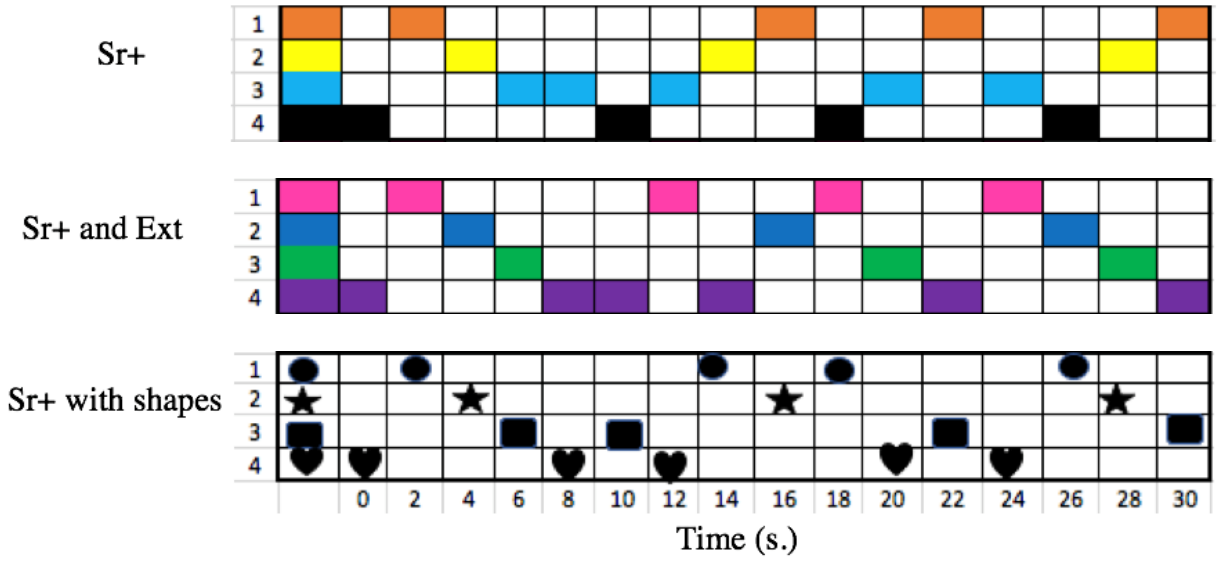

Figure 15. Phoebe: Order of responses during each resurgence test. Phoebe's responses are graphed by temporal order of responses during each resurgence test condition.

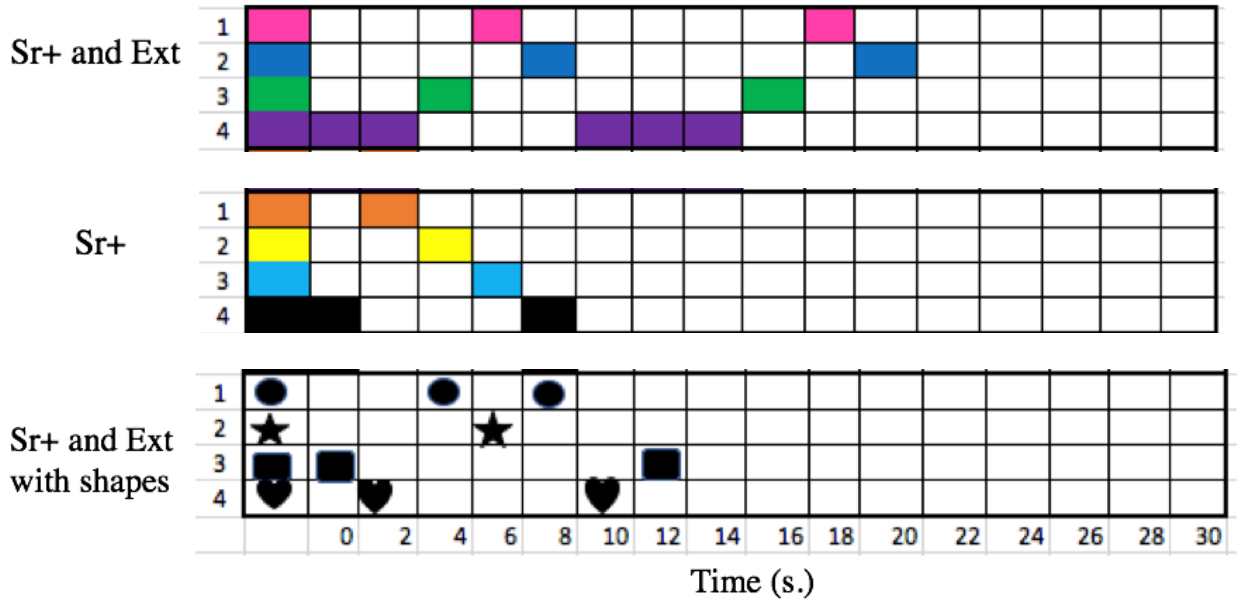

Figure 16. Monica: Order of responses during each resurgence test. Monica's responses are graphed by temporal order of responses during each resurgence test condition.

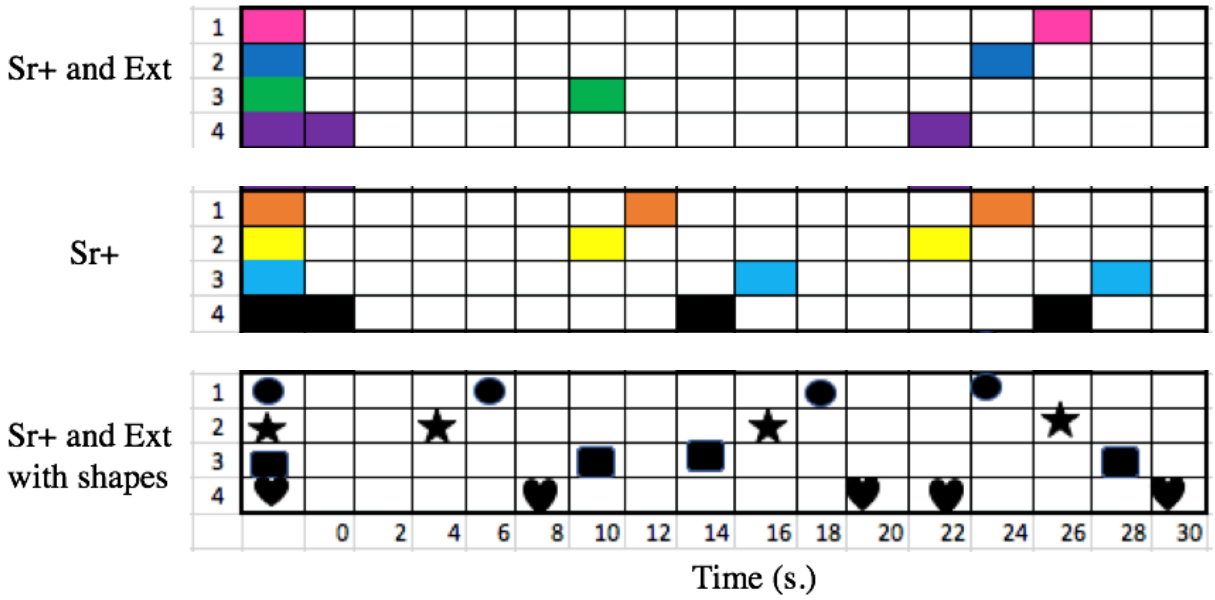

Figure 17. Elizabeth: Order of responses during each resurgence test. Elizabeth's responses are graphed by temporal order of responses during each resurgence test condition.

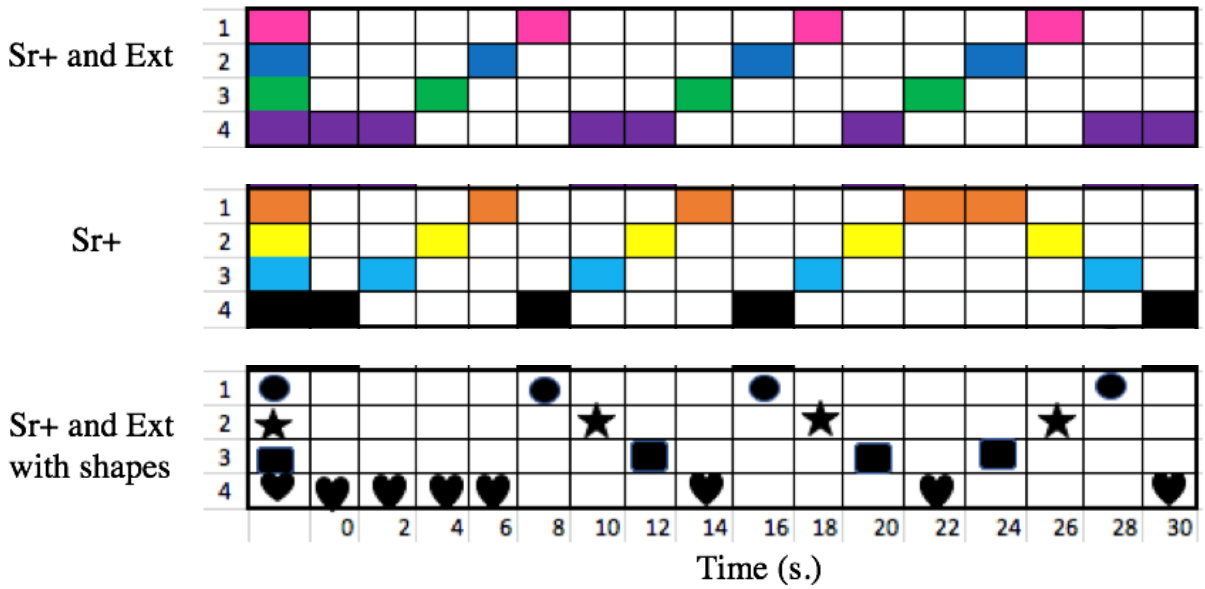

Figure 18. Charlie: Order of responses during each resurgence test. Charlie's responses are graphed by temporal order of responses during each resurgence test condition.

Table 1

Sequence of Conditions

Participant	1st Condition	2nd Condition	3rd Condition
Rachel	Sr+	Sr+ and Ext	Sr+ with shapes
Phoebe	Sr+	Sr+ and Ext	Sr+ with shapes
Emily	Sr+	Sr+ and Ext	Sr+ with shapes
Monica	Sr+ and Ext	Sr+	Sr+ and Ext with shapes
Elizabeth	Sr+ and Ext	Sr+	Sr+ and Ext with shapes
Charlie	Sr+ and Ext	Sr+	Sr+ and Ext with shapes

Table 2

Primacy or Recency Effects of Order during Resurgence Test

Participant	Sr+	Sr+ and Ext	Sr+ with shapes	Sr+ and Ext	Sr+	Sr+ and Ext with shapes
Rachel	P	R	P			
Emily	P2	R	P			
Phoebe	P	**P**	P			
Monica				R	P	R
Elizabeth				R	Line	Line
Charlie				R	**R**	**P**

Note. P=Primacy. R=Recency. Bolded letters indicate discrepancies.

Table 3

Primacy or Recency Effects of Frequency and Order during Resurgence Test

Participant	Sr+		Sr+ and Ext		Sr+ with shapes		Sr+ and Ext		Sr+		Sr+ and Ext with shapes	
	Freq.	Order	Freq.	Order	Freq.	Order	Freq.	Order	Freq.	Order	Freq.	Order
Rachel	**P2**	**P**	2nd and 3rd	R	**P**	**P**						
Emily	**P**	**P2**	1st and 3rd	R	R	P						
Phoebe	R	P	**P**	**P**	2nd and 3rd	P						
Monica							Same	R	Same	P	1st and 3rd	R
Elizabeth							Same	R	Same	P2	**P2**	**P2**
Charlie							Same	R	Same	R	**P2**	**P**

Note. P=Primacy. R=Recency. P2=Primacy 2. Same=frequency is equal across first three stimuli. Bolded letters indicate similarities between frequency and order.

Table 4

Learner Data Sheet Responses during Training

Sr+		Sr+ and Ext		Sr+ with shapes		Sr+ and Ext with shapes	
Response to "What were you doing to earn pennies?"							
Touch twice	Color order	Touch twice	Color order	Touch twice	Shape Order	Touch twice	Shape order
Rachel	Charlie		Rachel	Rachel	Emily	Elizabeth	Monica
Phoebe			Phoebe	Phoebe		Charlie	
Emily			Emily				
Monica			Monica				
Elizabeth			Charlie				
			Elizabeth				
Response to "How did you feel about it?"							
Confused	Good	Confused	Ok	Confused	Time?	Confused	Ok
Rachel	Monica	Rachel	Monica	Phoebe	Rachel	Charlie	Monica
Phoebe	Charlie	Phoebe		Emily		Elizabeth	
Elizabeth	Emily	Emily					
		Charlie					
		Elizabeth					

Table 5

Post-Experiment Interview

Did you have a rule to know which button to touch?

Touch newest object	Touch previous, then new one	Touch in the way they were taught
Rachel	Emily	Charlie
Phoebe	Elizabeth	
Monica		

Note. Summary of participants' responses to "did you have a rule to know which button to touch?", after experimental conditions were conducted.

APPENDIX

PORTL INSTRUCTIONS, LEARNER DATA SHEET, STIMULI, AND POST-INTERVIEW QUESTIONNAIRE

Instructions for research participants

Initial instructions: Today we are going to play a game with the objects you see on the table. In a minute, I will spread out the objects in the center of the table. Sometimes, you will have access to all of the objects. Other times, you may have access to just some of the objects. When I say 'you may begin', you can touch or interact with the objects in any way you wish. Sometimes, when you do certain actions or interact with certain objects, you will hear a click sound (click the clicker), and I will hand you a penny. (Hand the learner a penny) When you receive a penny, please place it in this cup. Your goal today will be to earn as many pennies as possible.

Demonstrate reinforcement delivery: Experimenter- click the clicker, hand the participant a penny, and wait for the participant to put the penny in the cup. Repeat this two more times. Ask the participant if he or she has any questions.

One hand: Instruct the participant to use only one finger and one hand to interact with the objects and to collect pennies. Experimenter will tell the participant that his or her other hand can be kept in his or her lap or off to the side. Ask the participant which hand he or she plans to use to interact with the objects.

Data sheet: Experimenter explained that the learner will take a brief break after every 10 blocks. Show the participant a copy of the Learner Data Sheet. Tell the participant that, during the break, the participant should fill out one row on the Learner Data Sheet by answering questions "What are you doing to earn pennies?" and "How do you feel?"

Recording: Learner is informed that experimenter is taking video so that further data can be collected. Tell the participant that only his or her hand and the objects will be recorded and that the participant's face will not be recorded.

No further instructions were given to the learner regarding how he or she should behave with respect to the objects and what he or she should write on the data sheet.

Learner Data Sheet

What are you doing to earn pennies?	How do you feel?

Response shaping materials: 

Experimental procedure materials. 

Post-Interview Questionnaire

1. What was I trying to teach you?
2. Were all tasks the same?
3. Did you have a rule to choosing which button to touch?

REFERENCES

Bouton, M. E., & Trask, S. (2016). Role of the discriminative properties of the reinforcer in resurgence. *Learning & Behavior*, *44*(2), 137–150. https://doi.org/10.3758/s13420-0150197-7 .

Catania, A.C. (1991). Glossary. In: Iverson, I., Lattal, K.A. (Eds.), Experimental Analysis of Behavior: Part 2. Elsevier, Amsterdam, p. G1–G44.

Craig, A. R., & Shahan, T. A. (2016). Behavioral momentum theory fails to account for the effects of reinforcement rate on resurgence. *Journal of the Experimental Analysis of Behavior*, *105*(3), 375-392.

Doughty, A. H., Cash, J.D., Finch, E.A., Holloway, C., & Wallington, L. K. (2010). Effects of training history on resurgence in humans. *Behavioural Processes, 83*(3), 340-343.

Epstein, R. (1983). Resurgence of previously reinforced behavior during extinction. *Behaviour Analysis Letters*. 3(6), 391-397.

Epstein, R., Kirshnit, C. E., Lanza, R. P., & Rubin, L. C. (1984). 'Insight' in the pigeon: antecedents and determinants of an intelligent performance. *Nature*, *308*(5959), 560-560.

Hunter, M., & Rosales-Ruiz, J., (2019) The power of one reinforcer: The effect of a single reinforcer in the context of shaping. *Journal of Experimental Behavior Analysis.* 111(3), 449-64.

Keller, F. S., & Schoenfeld, W. N. (1950). Century psychology series. Principles of psychology: A systematic text in the science of behavior. Appleton-Century-Crofts.

Lambert, J. M., Bloom, S. E., Samaha, A. L., Dayton, E., & Rodewald, A. M. (2015). Serial alternative response training as intervention for target response resurgence. *Journal of Applied Behavior Analysis*. 48(4), 765-780.

Lambert, J. M., Bloom, S. E., Samaha, A. L., & Dayton, E. (2017). Serial functional communication training: Extending serial DRA to mands and problem behavior. *Behavioral Interventions*. 32(4), 311-325.

Lattal, K. A., Cançado, C. R., Cook, J. E., Kincaid, S. L., Nighbor, T. D., & Oliver, A. C. (2017). On defining resurgence. *Behavioural Processes*, *141*, 85-91.

Lokko, H. N., & Stern, T. A. (2015). Regression: Diagnosis, Evaluation, and Management. The primary care companion for CNS disorders, 17(3). https://doi.org/10.4088/PCC.14f0176

Leitenberg, H., Rawson, R. A., & Bath, K. (1970). Reinforcement of competing behavior during extinction. *Science*, *169*(3942), 301-303.

Lieving, G. A., & Lattal, K. A. (2003). Recency, repeatability, and reinforcer retrenchment: An experimental analysis of resurgence. *Journal of the Experimental Analysis of Behavior*, *80*(2), 217-233.

Podlesnik, C. A., & Kelley, M. E. (2014). Resurgence: Response competition, stimulus control, and reinforcer control. *Journal of the Experimental Analysis of Behavior*, *102*(2), 231-240.

Podlesnik, C. A., & Shahan, T. A. (2009). Behavioral momentum and relapse of extinguished operant responding. *Learning & Behavior*, *37*(4), 357-364.

Reed, P., & Morgan, T. A. (2006). Resurgence of response sequences during extinction in rats shows a primacy effect. *Journal of the Experimental Analysis of Behavior*. 86(3), 307-315.

Silva, S. P. D., Maxwell, M. E., & Lattal, K. A. (2008). Concurrent resurgence and behavioral history. *Journal of the Experimental Analysis of Behavior*, *90*(3), 313-331.

Sullivan, W.E., Saini, V., DeRosa, N.M., Craig, A.R., Ringdahl, J.E. and Roane, H.S. (2020), Measurement of nontargeted problem behavior during investigations of resurgence. *Journal of Applied Behavior Analysis*, *53*, 249-264. doi:10.1002/jaba.589

Trump, C. E., Ayres, K. M., Quinland, K. K., & Zabala, K. A. (2020). Differential reinforcement without extinction: A review of the literature. *Behavior Analysis: Research and Practice*, *20*(2), 94.

Wacker, D. P., Harding, J. W., Berg, W. K., Lee, J. F., Schieltz, K. M., Padilla, Y. C., Nevin, J.A., and Shahan, T. A. (2011). An evaluation of persistence of treatment effects during long-term treatment of destructive behavior. *Journal of the Experimental Analysis of Behavior*, *96*, 261-282. https://doi.org/10.1901/jeab.2011.96-261