RESURGENCE OF INFANT CAREGIVING RESPONSES

By

Jennifer L. Bruzek

Ph.D., University of Kansas, 2007

Submitted to the Department of
Applied Behavioral Science and the
Faculty of the Graduate School of the
University of Kansas in Partial
Fulfillment of Requirements for the
Degree of Doctor of Philosophy

_____

Rachel H. Thompson, Chairperson

_____

Gregory P. Hanley, Committee Member

_____

Edward K. Morris, Committee Member

_____

Joseph E. Spradlin, Committee Member

_____

Michael S. Vitevitch, Committee Member

Date defended:

The Dissertation Committee for Jennifer L. Bruzek certifies
that this is the approved version of the following dissertation:

RESURGENCE OF INFANT CAREGIVING RESPONSES

_____
Rachel H. Thompson, Chairperson

_____
Gregory P. Hanley, Committee Member

_____
Edward K. Morris, Committee Member

_____
Joseph E. Spradlin, Committee Member

_____
Michael S. Vitevitch, Committee Member

Date approved:

Abstract

RESURGENCE OF INFANT CAREGIVING RESPONSES

BRUZEK, JENNIFER, L., M.Ed. University of Kansas, 2007. Dissertation directed by Professor Rachel H. Thompson.

Three experiments were conducted to identify the conditions likely to produce resurgence. The preparation was a simulated caregiving context, wherein a recorded infant cry sounded and was terminated contingent upon specified caregiving responses. The general sequence of experimental conditions was modeled after Epstein (1983). In each of three experiments, a reinforcement history was created for one or more responses, and those responses were then extinguished. Each previously reinforced response was measured in a resurgence test condition in which an additional response was reinforced and placed on extinction in the same session; resurgence occurred when previously reinforced responses reemerged during the resurgence test. Experiment 1 was conducted to determine whether resurgence would be obtained with human participants in a negative reinforcement preparation. Experiments 2 and 3 were conducted to determine whether responses with a longer history of reinforcement or a more recent history of reinforcement would show the strongest resurgence effect. Results of all three experiments suggest that resurgence is a phenomenon that can be obtained in preparations involving human subjects with responses that are maintained by negative reinforcement. Additionally, results from Experiments 2 and 3 provide evidence that the response with a longer history of

reinforcement is likely to resurge, regardless of the relative temporal proximity of the history.

Resurgence of Infant Caregiving Responses

Resurgence is defined as the reemergence of a previously reinforced response when a subsequently reinforced response is placed on extinction. Relative to other extinction-related phenomena (e.g., bursts, emotional behavior, spontaneous recovery) resurgence has been understudied in the basic and applied literature (Lerman & Iwata, 1996). Yet, as Lieving and Lattal (2003) suggest, resurgence may play a role in problem solving and creativity and may serve as one experimental model of clinical relapse. In each of these examples, a previously reinforced response reemerges when more recently reinforced responses no longer satisfy the current contingency.

A study by Goh and Iwata (1994) presents one possible clinical example of resurgence. These authors treated the escape-maintained self-injurious behavior of a 40-year old male diagnosed with profound mental retardation. Self-injurious behavior was the primary target of the intervention, but aggressive behavior was also recorded although aggression was blocked and ignored across all conditions. During baseline, instructions were delivered, praise was contingent on compliance, and SIB resulted in a brief escape from demands. During extinction sessions, escape was no longer provided contingent on SIB. Rates of SIB were variable throughout baseline and no aggression was emitted in that condition. However, when SIB was placed on extinction, rates of SIB were high and variable before they eventually decreased to

near zero. Interestingly, aggression was also initially emitted in the extinction condition. It is possible that the emission of aggression when SIB was placed on extinction was an instance of resurgence. That is, aggression, a response with a long extra-experimental history of reinforcement, emerged when SIB was placed on extinction. However, this interpretation is speculative because there was no experimental history of reinforcement for aggression.

Similar results were obtained by Lieving, Hagopian, Long, and O'Connor (2004) who measured several topographies of problem behavior displayed by two children whose problem behavior was sensitive to positive reinforcement in the form of access to preferred items. During baseline, reinforcement was programmed for all topographies of problem behavior. Extinction was applied first to disruptive behavior (reinforcement continued for other responses), the only topography that occurred during baseline, and both participants showed an increase in a topography of problem behavior (aggression and dangerous acts) that had not occurred during baseline. Extinction was then applied to both disruptive behavior and the topography that emerged during extinction of disruptive behavior. With one participant, a third topography of problem behavior (cursing) emerged under this condition, and extinction was then extended to include this topography, at which time a fourth topography (aggression) emerged. A strength of this study is the replication of a possible resurgence effect within and across participants. A limitation is that, although reinforcement was programmed for all topographies of problem behavior during baseline, only one topography of problem behavior occurred during baseline.

Thus, no experimental history of reinforcement was created for responses prior to their emergence. In addition, when a previously unperformed topography of problem behavior emerged, this response was reinforced; thus, it is difficult to separate the evocative effects of extinction from those of direct reinforcement of the behavior.

The Goh and Iwata (1994) and Lieving, Hagopian, Long, and O'Connor (2004) studies serve as clinical examples illustrating resurgence. However, given the clinical nature of these investigations, these studies were not designed to include all controls necessary to draw definitive conclusions regarding the variables controlling increases in problem behavior under extinction. However, basic studies involving non-humans as subjects have expanded our understanding of the conditions that produce resurgence. Experimental studies of resurgence begin by establishing a history of reinforcement for response 1. A history of reinforcement for response 2 is then created, and the test of resurgence occurs when response 2 is placed on extinction; an increase in response 1 during extinction of response 2 is considered resurgence. Beyond this general experimental arrangement, resurgence studies have differed in the manner in which response 1 is extinguished. After establishing a history of reinforcement for response 1, some studies include a traditional extinction condition in which response 1 is extinguished by terminating reinforcer deliveries. In other studies, extinction of response 1 is programmed only during a condition in which response 2 is simultaneously reinforced (see Figure 1 for hypothetical data illustrating these experimental sequences). Typically, response 1 and 2 have been reinforced and subsequently exposed to extinction under similar conditions (e.g.,

same reinforcer, same/similar environments; Lieving, Hagopian, Long, & O'Connor, 2004).

Studies examining resurgence have attempted to identify the conditions most likely to produce this phenomenon. One line of resurgence research has focused on the extent to which resurgence is dependent on the degree of extinction of response 1. For example, Rawson, Leitenberg, Mulick, and Lefebvre (1977) reinforced response 1 (lever-pressing) for all groups in the first phase. Phase 2 consisted of four different conditions evaluated across groups. One group was exposed to a traditional extinction condition in which, response 1 and response 2 were available but not reinforced. This was the only condition that allowed response 1 to undergo extinction. The remaining three conditions prevented extinction of response 1 by (a) combining extinction of response 1 with reinforcement of response 2, (b) physically preventing the response by removing the levers, or (c) removing the subject from the experimental arrangement (i.e., forgetting). In the final phase, no reinforcement was delivered. An increase in response 1 (resurgence) was observed in the final phase for all groups except the traditional extinction group; response 1 resurged only when it was not allowed to undergo extinction.

Similarly, a series of experiments conducted by Leitenberg, Rawson, and Mulick (1975) showed that, when response 2 was reinforced during extinction of response 1, higher rates of reinforcement for response 2 produced a higher degree of resurgence of response 1 when response 2 was placed on extinction. When response 2 was reinforced at high rates during extinction of response 1, there was little

opportunity for response 1 to contact extinction, and resurgence of response 1 was more likely. Conversely, lower rates of reinforcement for response 2 during extinction of response 1, allowed response 1 to undergo extinction, and resurgence of response 1 was not observed under these conditions. These results are consistent with those obtained by Rawson, Leitenberg, Mulick, and Lefebvre (1977), suggesting that a response is less likely to resurge when it has been allowed to undergo extinction.

These results provide evidence to support the Response Prevention Hypothesis (Estes, 1944; Skinner, 1938), which suggests that the degree of resurgence of a response is a function of the degree of extinction of that response. Essentially, simultaneous reinforcement of a second response interferes with the extinction of the first response. That is, response 1 "remerges" during extinction of response 2 simply because it has not undergone extinction. Cleland, Foster, and Temple (2000) tested the predictions of the Response Prevention Hypothesis by manipulating the number of sessions during which response 1 was exposed to traditional extinction (i.e., those in which response 2 is not reinforced), using repeated within-subject exposures. These researchers found that the degree of resurgence was inversely related to the amount of exposure to extinction for response 1. These data lend additional support to the Response Prevention Hypothesis; when response 1 was weakened through extinction prior to reinforcement of response 2, response 1 was less likely to emerge during extinction of response 2.

Although results of the three empirical studies described above offer support for the Response Prevention Hypothesis (Rawson, Leitenberg, Mulick, & Lefebvre,

1977; Leitenberg, Rawson, & Mulick, 1975; Cleland, Foster, & Temple, 2000), data from other studies (Epstein, 1983; Lieving & Lattal, 2003) demonstrate that resurgence does, in fact, occur when response 1 has been extinguished before reinforcement of a second response is initiated. In a study conducted by Epstein, six pigeons' key-pecking was shaped and subsequently maintained on a variable-interval (VI) schedule of reinforcement. In phase 2, key-pecking was extinguished for one or more 1-hr sessions (i.e., up to twelve sessions). The number of extinction sessions for each subject was randomly assigned. Phase 3 consisted of an initial period of extinction for key-pecking (i.e., 30 min and until no key pecks were emitted for 10 min), and then an incompatible response (e.g., wing-raising) was reinforced 20 times. Finally, all responses were placed on extinction. Key-pecking responses resurged for all pigeons when the incompatible response was placed on extinction. Further, for all six pigeons combined, only two pecks were recorded on a control key, which was available in the chamber but not associated with a programmed reinforcement contingency. Beyond the simple demonstration of resurgence, the methods employed in this study allow for two interesting conclusions regarding variables controlling resurgence. First, because key-pecking underwent a period of traditional extinction before the incompatible response was reinforced, resurgence was not the sole function of the prevention of extinction for response 1. In addition, because the control response did not increase when the incompatible response was extinguished, the resurgence of response 1 can be more confidently attributed to the history of

reinforcement for that response and not a general increase in variability of responding (see Epstein).

In a recent study, Lieving and Lattal (2003) examined the extent to which within-subject repeated exposure to extinction would weaken the magnitude of resurgence. Response 1 was reinforced, response 1 was subsequently extinguished while response 2 was simultaneously reinforced, and finally, response 2 was extinguished (resurgence test condition). That sequence was repeated twice with all subjects. Repeated exposure to extinction did not attenuate the resurgence effect; thus, the results obtained in this experiment did not support the Response Prevention Hypothesis. The mixed findings evident in this line of research suggest the need for additional research to identify variables that contribute to resurgence.

Despite the fact that resurgence may contribute to a host of socially important behavioral phenomena, controlled studies of resurgence have included primarily nonhuman subjects. Therefore, a purpose of the current study was to examine resurgence with human participants. Although resurgence has been observed both when response 1 has been exposed to extinction simultaneous with reinforcement of response 2 and when response 1 has been exposed to traditional extinction (in the absence of reinforcement for response 1), we chose the latter approach. Our procedures were developed based on those described by Epstein (1983) who exposed response 1 to traditional extinction and measured a control response. Among the resurgence studies reviewed, Epstein's procedures allowed for the clearest

interpretation of the data by ruling out response prevention and mere increases in variability as variables responsible for resurgence.

Although a substantial portion of naturally occurring human behavior appears to be under aversive control, relatively little research has been devoted to exploring the role of negative reinforcement in socially important human behavior (Iwata, 1987). In addition, in experimental studies of resurgence positive reinforcement has been programmed exclusively (e.g., Cleland, Foster, & Temple, 2000; Epstein, 1983; Leitenberg, Rawson, & Mulick, 1975; Lieving & Lattal, 2003; Rawson, Leitenberg, Mulick, & Lefebvre, 1977). Therefore, a second purpose of this study was to describe the resurgence phenomenon when negative reinforcement is programmed for response 1 and response 2 with human participants.

In the current study, negative reinforcement for participant responses was programmed within a simulated infant caregiving context. Infant caregiving is one naturally occurring interaction that appears to involve negative reinforcement. Crying affects caregivers physiologically in ways similar to other noxious stimuli (e.g., increased heart rate; Frodi & Lamb, 1980; see Herd, 1991 for a comprehensive review), and in a series of studies by Donovan and colleagues (e.g., Donovan, 1981; Donovan & Leavitt, 1985) participants performed simple tasks that resulted in termination of a recorded infant cry. Thus, it seems likely that some forms of caregiving are shaped and maintained by negative reinforcement in the form of escape from and avoidance of infant crying. We simulated these contingencies by arranging for several caregiving responses directed toward a baby doll to result in

termination of a recorded cry. Extinction conditions were designed to simulate a period of inconsolable crying.

General Method

Participants, Setting, and Materials

Participants were undergraduate students at the University of Kansas who received extra credit for their participation. All sessions were conducted in a small therapy room (1.77 m x 2.45 m) equipped with a one-way mirror and an adjacent observation booth. Each session included materials designed to occasion target caregiving responses including a baby doll, a blanket, a bottle (Experiment 1 only), infant toys, a crib, a chair, and a cassette recorder that was located under the crib. The cassette recorder played a recorded infant cry (80 db) and was activated from the observation booth. The infant cry was recorded in a university-run daycare with consent from the infant's parents. A small cassette recorder was available in the classroom and the cry was recorded during a routine care activity (i.e., napping), which typically evoked crying from the infant.

Response Measurement and Interobserver Agreement

Data were collected on the duration of infant caregiving responses using handheld computers. For each response, scoring began when the participant performed the response for 3 consecutive s and stopped when that response ceased for 3 consecutive s.

Vertical rocking was defined as the participant holding the doll in her arms in a vertical position (baby's head between the neck and the middle of upper arm) with

the baby's face/body facing the participant and moving the baby in a side-to-side or up-and-down motion (baby's head moving). Feeding (Experiment 1 only) was defined as the participant placing the bottle to the doll's mouth with at least one of the participant's hands on the bottle. Playing was defined as the participant placing a toy in the doll's visual field (i.e., in front of baby, above baby's waist) with at least one of the participants' hands on the toy.

Agreement was determined by partitioning each session into 10-s intervals and comparing data collectors' records on an interval-by-interval basis. Within each interval, the smaller duration was divided by the larger duration. These quotients were then averaged across intervals and multiplied by 100. Interobserver agreement percentages are reported for each experiment below.

Procedure

The participant entered the room approximately 2 min prior to the start of each session. Instructions delivered to all participants before each session were:

> "We are conducting this study to learn how adults will respond in a simulated caregiving situation. Do what comes naturally. Please do not touch the lights or the sound receiver. We will knock on the window to indicate when the session begins and ends."

The maximum session length was 30 min in Experiment 1 and 15 min in Experiments 2 and 3. However, during reinforcement conditions, sessions were terminated after 5 consecutive min of engagement in the target response (acquisition criterion), and during extinction conditions, sessions were terminated when the participant did not

engage in the target response for 5 consecutive min (extinction criterion). Target responses were randomly assigned to the first experimental condition prior to the start of the study. To increase the likelihood that target responses would contact the reinforcement contingency, target responses assigned in subsequent conditions were randomly selected from those that were exhibited at some level in previous conditions. One participant (i.e., P-W) did not engage in the response that was initially targeted for reinforcement during phase 1 for two sessions (i.e., vertical rocking, data not shown), therefore, the reinforcement contingency was reassigned to a target response (i.e., playing) that occurred at low levels when reinforcement was programmed for vertical rocking.

Data Interpretation

Data are depicted in 60-s bins as cumulative seconds of caregiving. Breaks between data paths along the x-axis indicate the start of a new session. In the resurgence test condition, the final experimental phase, there is an initial period of reinforcement for the target response, followed by a period during which all previously reinforced responses were on extinction. The transition from reinforcement to extinction is depicted on the graph with a dashed line.

For each participant, a response never reinforced during the experiment was also measured and served as a control against which to compare the duration of previously reinforced responses in the resurgence test conditions. An increase in a previously reinforced response above levels of the control response is considered resurgence. If previously reinforced responses and the control response increase, this

pattern cannot be attributed to a previous history of reinforcement and is thus not considered an example of resurgence in this experimental preparation (Epstein, 1983).

Experiment 1

Experiment 1 was conducted to identify whether resurgence would occur with human participants in a negative reinforcement arrangement. The preparation was a simulated caregiving context in which escape from a recorded infant cry was programmed for participant responses.

Method

Participants

Participants were seven undergraduate students (five females and two males) between the ages of 20- and 22-years old who reported varying levels of caregiving experience (i.e., experience ranged from none to over 100 hours; see Table 1).

Interobserver Agreement

A second observer simultaneously, but independently recorded data during a mean of 94% of sessions for each participant (range, 74% to 100%). Mean agreement across participants for all target responses was 97% (range, 87% to 100%).

Procedure

Experimental Conditions

Negative Reinforcement (SR^-) response 1. The cry was terminated only after the participant engaged in the target response (response 1) for 3 s. The cry resumed if the participant ceased to engage in the target response for 3 s. This experimental

condition was repeated until the participant met the acquisition criterion in one session.

Extinction response 1. The cry was presented for the duration of the session, independent of participant responding. This experimental condition was repeated until the participant met the extinction criterion in one session (P-BB and P-CC) or two consecutive sessions (P-S, P-T, P-U, P-Y, and P-W). The number of extinction sessions at criterion was reduced to one session for P-BB and P-CC in an attempt to identify whether similar patterns of responding would occur with a more efficient experimental preparation. However, P-CC did not meet the extinction criterion in the first extinction session and was therefore exposed to two sessions of extinction.

SR^- response 2/Extinction response 2 (resurgence test). After the participant engaged in 5 continuous min of the target response, the target response (response 2) was placed on extinction; the cry was presented for the remaining duration of the session, independent of participant responding.

The transition from reinforcement of response 1 to extinction was programmed to occur within a session rather than at the start of a new session to avoid confounding the resurgence test with other behavior changes that may occur at the start of the session (e.g., spontaneous recovery; Sidman, 1960, p. 310).

Results and Discussion

All participants acquired response 1 within one session (see Figures 2-4). Participants who were required to meet the extinction criterion in two consecutive sessions (P-S, P-T, P-U, P-Y, and P-W) completed the extinction phase in a

maximum of four sessions (Figures 2 and 4). Participants who were required to meet the extinction criterion in only one session (P-BB and P-CC) completed the extinction phase in one (P-BB) or two (P-CC) sessions (Figure 3).

In the resurgence test condition, all participants acquired the second response within one session and, within that same session, the reemergence of the previously reinforced response (response 1) under extinction of response 2 was observed in five (those shown in Figures 2 and 3) of seven participants. That is, after a period of reinforcement and the onset of extinction for response 2, the resurgence of response 1 (the response with an experimental history of reinforcement) was observed relative to the control response (a response with no experimental history of reinforcement). One participant (P-W) did not perform the previously reinforced response when exposed to extinction of response 2 (see Figure 4). One participant (P-Y) showed an increase in the previously reinforced response and an increase in the control response (see Figure 4).

These findings are consistent with those obtained by Epstein (1983) and Lieving and Lattal (2003) who found that resurgence was obtained when response 1 was exposed to traditional extinction (i.e., no simultaneous reinforcement of a second response) prior to the resurgence test. Results from Epstein and Lieving and Lattal suggest that the degree of exposure to extinction does not affect the magnitude of resurgence and results of Experiment 1 also are consistent with those findings. For example, P-BB was exposed to only one session of extinction of response 1. Yet, the magnitude of the resurgence of this response was similar to (P-S) or less than (P-T, P-

U) the magnitude of resurgence observed with participants who experienced more exposure to extinction.

Additionally, these results serve as an experimental demonstration of resurgence of negatively reinforced human behavior. These data illustrate a common context, infant caregiving, in which negatively reinforced behavior comes into contact with extinction. In infant caregiving situations, caregivers often contact periods of extinction (i.e., inconsolable crying) for responses that had been previously reinforced in similar situations but are not effective in the current situation. These data suggest that, when this occurs, caregivers are likely to revert to responses that have been successful in terminating the cry in the past.

A limitation of Experiment 1 is illustrated in the response pattern of P-Y, who displayed increases in response 1 (vertical rocking, the previously reinforced response) and the control response (feeding) during the resurgence test. According to Epstein (1983), this pattern might be considered an increase in variability rather than resurgence because a response with a programmed experimental history of reinforcement and a response with no experimental history of reinforcement increased similarly when response 2 was placed on extinction. However, P-Y reported over 100 hours of caregiving experience during which she was responsible for feeding babies (see Table 1); thus there was an extra-experimental history of reinforcement for the control response. Therefore, an increase in the control response (i.e., feeding) during the resurgence test may have been an instance of resurgence of a response with a lengthier, but more temporally distant history of reinforcement.

Despite the fact that response 1 was randomly assigned prior to the start of the experiment, it is possible that resurgence effects observed with some participants were a result of differential extra-experimental histories of reinforcement associated with various responses. Given that a goal of our preparation was to simulate naturally occurring caregiving conditions, it would have been difficult to select responses with no extra-experimental history of reinforcement. Therefore, in Experiment 2, we attempted to select responses that were likely to be associated with equal extra-experimental histories of reinforcement.

Experiment 2

The results for one participant (P-Y) in Experiment 1 suggested that a response with a lengthier but more temporally distant (and extra-experimental) history of reinforcement showed the same pattern of resurgence as a response with a recent experimental history of reinforcement. Thus, the purpose of Experiment 2 was to evaluate the effects of length and recency of reinforcement history on responding during the resurgence condition. In order to minimize the intrusion of extra-experimental reinforcement history, target and control responses consisted of four distinct yet topographically similar responses that each involved toy play directed toward the baby doll.

Method

Participant and Materials

Participants were eight undergraduate students between the ages of 20- and 23-years old (see Table 2). Materials were a baby doll, a blanket, four infant toys (puppet, rattle, mirror, and block), a crib, a chair, and a sound receiver.

Response Measurement and Interobserver Agreement.

The duration of playing (defined in general method) with each of the four infant toys was measured separately. A second observer simultaneously, but independently recorded data during a mean of 62% of sessions for each participant (range, 36% to 100%). Mean agreement across participants for all target responses was 97% (range, 85% to 100%).

Procedures

Experimental Conditions

SR^- toy 1 (lengthier history). Response 1 was reinforced using procedures identical to those used in the negative reinforcement condition in Experiment 1. However, to establish a relatively lengthier history, this experimental condition continued until the participant engaged in the target response for 5 continuous min during 3 consecutive sessions.

SR^- toy 2 (more recent history). Response 2 was reinforced using procedures identical to those used in the negative reinforcement condition in Experiment 1. This experimental condition was conducted until the participant engaged in the target response for 5 continuous min for only one session, creating a relatively shorter, but more recent, history of reinforcement compared to that associated with response 1.

Extinction toys 1 and 2. A recorded infant cry was played for the duration of the session, independent of participant responding. This condition continued until the extinction criterion was met for both response 1 and response 2 in one session.

SR^- toy 3/Extinction toy 3 (resurgence test). A third response was reinforced and then placed on extinction using the procedures described in the resurgence test in Experiment 1.

Results and Discussion

The lengthier history of reinforcement for response 1 (three consecutive sessions with 5 continuous min of engagement in the target response) was established within five sessions (see Figures 5-7). The shorter but more recent history of reinforcement was established within one session (see Figures 5-7). When extinction was applied to responses 1 and 2, all participants met the extinction criterion (one session with 5 min of continuous non-engagement in the responses targeted for extinction) within three sessions (see Figures 5-7). In the resurgence test condition, participants acquired the third response in between one and three sessions. When response 3 was placed on extinction during the resurgence test, five of eight participants displayed the highest levels of response 1 (lengthier, but more temporally distant history) relative to response 2 (more recent history) and the control response. One participant (P-LL) performed responses 1 and 2 (both responses with some experimental history of reinforcement) at approximately equal durations (see Figure 7), but did not engage in the control response. Two participants (P-KK and P-QQ) showed an increase in both responses with a history of reinforcement (i.e., responses

1 and 2) and an increase in the control response (see Figure 7). No participants displayed a higher level of the most recently reinforced response during the resurgence test.

These results are consistent with the findings of Lieving and Lattal (2003). These authors examined the effects of the recency of the reinforcement contingency for response 1 by manipulating the amount of time that response 2 was reinforced (i.e., 5 vs. 30 days), and found that reinforcement recency had no effect on the magnitude of resurgence. That is, response 1 resurged with a similar magnitude regardless of the duration of exposure to reinforcement of response 2. Together, the results of the Lieving and Lattal study and the current study suggest that recency of reinforcement for a particular response has little or no effect on the magnitude of resurgence.

By contrast, results of the current study suggest that the length of reinforcement history may affect resurgence. Responses with a longer (but more temporally distant) history of reinforcement were, overall, more likely to resurge than responses that were more recently reinforced. However, a limitation of Experiment 2 is that the lengthier history was always arranged for response 1. Therefore, length of history is confounded with primacy. Reed and Morgan (2006) trained rats to emit a series of three-response sequences (consisting of different patterns of lever-pressing responses) and found that, after response sequences that were more recently reinforced resurged, the response sequences trained first were most likely to resurge.

Given these findings, it is possible that a primacy effect accounts for the findings observed in Experiment 2.

Experiment 3

To address the main limitation of Experiment 2, Experiment 3 was designed to disentangle the length of history and primacy variables. In this experiment, a relatively shorter history of reinforcement was programmed for the first response trained and a lengthier history of reinforcement was programmed for response 2.

Method

Participants and Materials

Participants were four undergraduate students (one male and three females) between the ages of 18 and 45 years old (see Table 3). Materials were those used in Experiment 2.

Response Measurement and Interobserver Agreement

The dependent variables were defined and scored the same as in Experiment 2. A second observer simultaneously, but independently, recorded data during 100% of sessions for each participant. Mean agreement across participants for all target responses was 97.5% (range, 97% to 98%).

Procedures

Experimental Conditions

SR^- toy 1 (primary history). Response 1 was reinforced using procedures identical to those used in the negative reinforcement conditions described previously. This condition continued until the acquisition criterion was met in one session.

SR- toy 2 (lengthier history). Response 2 was reinforced using procedures identical to those used in the negative reinforcement condition in Experiment 1. To ensure a longer history of reinforcement for response 2, this condition continued until the acquisition criterion was met in three consecutive sessions and until response 2 had occurred (and was necessarily reinforced) for at least 10 min longer than response 1.

Extinction toys 1 and 2. This condition was identical to the extinction condition described in Experiment 2.

SR- toy 3/Extinction toy 3 (resurgence test). This condition was identical to the resurgence test described in Experiment 2.

Results and Discussion

All participants acquired response 1 within two sessions (see Figure 8). Next, the lengthier reinforcement history was established for response 2 with all participants within six sessions. Participants met the extinction criterion in between one and five sessions. In the resurgence test condition, all participants acquired the third response within one session. When response 3 was placed on extinction, the greatest magnitude of resurgence was observed with response 2 (longer history) in three of four participants (Figure 8). That is, after a period of reinforcement and subsequent extinction for response 3, the resurgence of response 2 (the response with a longer experimental history of reinforcement and the one most recently reinforced) was observed relative to the response that was reinforced first (i.e., response 1) and the control response (a response with no experimental history of reinforcement). One

participant (P-DDD) did not show an increase in any responses during extinction of response 3 (see Figure 8).

Among the three participants for whom resurgence was observed, the response with a longer history of reinforcement showed the largest magnitude of resurgence. Together with the results of Experiment 2, these results indicate that the response with the longest history is likely to resurge to the largest extent, independent of the sequence according to which that history was established. However, the resurgence effects obtained in Experiment 3 were less robust than those obtained in Experiment 2, suggesting that the order in which responses are reinforced may also affect the magnitude of resurgence as in Reed and Morgan (2006).

General Discussion

The results of these and other studies on resurgence suggest that it is a phenomenon that has generality across subject populations and classes of reinforcement (i.e., positive and negative) and occurs with some regularity. Basic studies investigating resurgence have focused almost exclusively on the extent to which extinction of response 1 interferes with its resurgence. Existing literature provides support for two opposing hypotheses, the Response Prevention Hypothesis and the Extinction-Induced Resurgence Hypothesis. The Response Prevention Hypothesis suggests that the extent to which response 1 resurges is dependent on the amount of exposure to extinction for that response. Thus, resurgence of response 1 occurs when extinction of response 1 is programmed simultaneous with reinforcement of an alternative response. Evidence supporting the Response

Prevention Hypothesis was obtained in at least three studies (Rawson, Leitenberg, Mulick, & Lefebvre, 1977; Leitenberg, Rawson, & Mulick, 1975; Cleland, 2000).

Data from other studies (Epstein, 1983; Lieving & Lattal, 2003), however, support the Extinction-Induced Resurgence Hypothesis (Epstein, 1983; Cleland, Foster & Temple, 2003), which suggests that resurgence is simply the result of extinction of an alternative response. Results from Epstein (1983) and Lieving and Lattal (2003) support the Extinction-Induced Resurgence Hypothesis by demonstrating that resurgence occurs when response 1 is exposed to traditional extinction (i.e., extinction without simulatanous reinforcement of response 2) before an alternative response is reinforced. The data from our experiments also demonstrate that resurgence was observed even when response 1 had been previously exposed to traditional extinction. However, due to practical considerations, human participants in the current study were exposed to relatively brief periods of extinction, and this exposure may have been insufficient to weaken previously reinforced responses to the extent necessary. For example, there was a period of spontaneous recovery at the start of each new extinction session for several participants, suggesting that previously reinforced responses were not fully extinguished. This relatively brief exposure to extinction limits the conclusions that can be drawn regarding the role of extinction of response 1 in the resurgence observed in the current study.

Results of Experiments 1 and 2 indicated that responses with lengthier reinforcement histories were more likely to resurge, and length of history was a more accurate predictor of the magnitude of resurgence than primacy or recency. However,

a comparison of results across Experiments 2 and 3 suggests that the largest magnitude of resurgence was observed with response 1 (the first response trained) when that response was also associated with the lengthier history of reinforcement. This account is somewhat speculative given that this study was not designed to identify the separate and interactive effects of primacy and length of reinforcement history. Nevertheless, these results may provide some insight into why relapse is so common.

A common intervention for severe problem behavior, such as self-injurious behavior and aggression displayed by individuals with developmental disabilities is to extinguish problem behavior while simultaneously reinforcing a more appropriate behavior, like picture exchange communication (e.g., Hagopian, Fisher, Acquisto, Sullivan, & LeBlanc, 1998). The data on resurgence suggests that this sequence of experiences is likely to evoke problem behavior when reinforcement for response 2, functional communication, is less available or unavailable. In fact, this phenomenon has been observed in a number of studies when an appropriate alternative response initially reinforced on a continuous schedule is exposed to leaner schedules of reinforcement (i.e., schedule thinning; see Fisher, Thompson, Hagopian, Bowman, & Krug, 2000; Hagopian et al.; Hanley, Iwata, & Thompson, 2001). As in the current study, a response with a temporally distant but lengthy history of reinforcement resurges under extinction or extinction-like conditions.

Results of the current study suggest that the parameters of the interaction between recency and longer history should be investigated further. For example, in

Experiment 2, the response with the longer history of reinforcement was reinforced for 10 min longer than the more recently reinforced response. It is unlikely that this criterion for establishing a longer history is representative of clinical contexts in which responses have been emitted and reinforced for more extensive periods of time (e.g., years) before an intervention is initiated. Thus, future research should manipulate the length of reinforcement history to further identify its contribution to resurgence. This line of research may be valuable in identifying variables that override length of history, and this information would be valuable in the development of interventions to prevent relapse.

Results obtained in series of experiments conducted by Lieving and Lattal (2003) have some implications for the prevention of undesirable forms of resurgence. For example, Lieving and Lattal (2003) found that response-independent food delivery did not result in resurgence and that the magnitude of resurgence was diminished when intermittent reinforcement was presented during the resurgence test, compared to when traditional extinction was arranged. These data are promising and suggest that interventions involving noncontingent reinforcement may be a way to prevent the resurgence of undesirable responses. Moreover, these data suggest that clinical interventions should avoid using procedures similar to extinction alone. However, the results are limited to one study that investigated the effects of positive reinforcement on a very dense schedule (VT 30-, 120-s, and VI 360-s) with non-humans. Thus, future research on resurgence should evaluate the extent to which

similar effects are obtained with humans under conditions analogous to those present during clinical intervention.

Existing research on resurgence has programmed identical reinforcers for all responses targeted in the experiment. However, some forms of clinical relapse may involve the reemergence of responses previously maintained by reinforcer A, when a response maintained by reinforcer B is placed on extinction. For example, when a significant other fails to respond to a client's social initiations, one might observe a relapse in alcohol abuse. Therefore, it may be important to identify whether similar resurgence effects are obtained when different reinforcers are delivered for responses within the experimental preparation.

The delineation of variables that influence resurgence may guide both intervention and prevention. As noted above, one strategy for preventing negative forms of resurgence is to eliminate extinction conditions (e.g., through NCR or lean schedules). Alternatively, one might increase the likelihood that more desirable responses would emerge during extinction by arranging the appropriate reinforcement histories for those responses. The current study illustrated resurgence of previously effective caregiving responses when more recently reinforced responses no longer terminated the cry. Under naturally occurring caregiving conditions, resurgence may be beneficial if caregivers revert to previously effective and socially desirable forms of caregiving (e.g., singing) when one form of caregiving becomes ineffective (e.g., feeding). Resurgence would be detrimental with parents who have a history of successfully terminating crying episodes with rough handling (e.g., shaking,

aggressive pacifier placement). For example, in some cases of fatal infant shaking, perpetrators report that they had shaken the baby previously (Hoffman, 2005). If responses with a history of reinforcement are more likely to emerge during periods of inconsolable crying, it may be beneficial to develop a method of programming a history of reinforcement for a variety of appropriate responses, increasing the likelihood that caregivers will engage in appropriate responses. This approach may decrease the likelihood that abusive responses would emerge when prolonged crying occurs.

References

Cleland, B. S., Foster, T. M., & Temple, W. (2000). Resurgence: the role of extinction. *Behavioural Processes, 52*, 117-129.

Donovan, W. L. (1981). Maternal learned helplessness and physiologic response to infant crying. *Journal of Personality and Social Psychology, 40(5),* 919-926.

Donovan, W. L., & Leavitt, L. A. (1985). Simulating conditions of learned helplessness: The effects of interventions and attributions. *Child Development, 56,* 594-603.

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

Estes, W. K. (1944). An experimental study of punishment. *Psychological Monographs, 57(263)*, 1-40.

Fisher, W. W., Thompson, R. H., Hagopian, L. P., Bowman, L. G., & Krug, A. (2000). Facilitating tolerance of delayed reinforcement during functional communication training. *Behavior Modification, 24*, 3-29.

Frodi, A. M., & Lamb, M. E. (1980). Child abusers' responses to infant smiles and cries. *Child Development, 51,* 238-241.

Goh, H. L., & Iwata, B. A. (1994). Behavioral persistence and variability during extinction of self-injury maintained by escape. *Journal of Applied Behavior Analysis, 27*, 173-174.

Hagopian, L. P., Fisher, W. W., Sullivan, M. T., Acquisto, J., & Leblanc, L. A.

(1998). Effectiveness of functional communication training with and without extinction and punishment: A summary of 21 inpatient cases. *Journal of Applied Behavior Analysis, 31*, 211-235.

Hanley, G. P., Iwata, B. A., & Thompson, R. H. (1999). Reinforcement schedule thinning following treatment with functional communication training. *Journal of Applied Behavior Analysis, 34*, 17-38.

Herd, J. A. (1991). Cardiovascular response to stress. *Physiological Reviews, 71(1),* 305-330.

Iwata, B. A. (1987). Negative reinforcement in applied behavior analysis: An emerging technology. *Journal of Applied Behavior Analysis, 20*, 361-378.

Hoffman, J. M. (2005). A case of shaken baby syndrome after discharge from the newborn intensive care unit. *Advances in Neonatal Care, 5(3)*, 135-146.

Iwata, B. A., Pace, G. M., Cowdery, G. E., & Miltenberger, R. G. (1994). What makes extinction work: An analysis of procedural form and function. *Journal of Applied Behavior Analysis, 27*, 131-144.

Iwata, B. A., Pace, G. M., Kalsher, M. J., Cowdery, G. E., & Cataldo, M. F. (1990). Experimental analysis and extinction of self-injurious escape response. *Journal of Applied Behavior Analysis, 23(1)*, 11-27.

Leitenberg, H., Rawson, R. A., & Mulick, J. A. (1975). Extinction and reinforcement of alternative behavior. *Journal of Comparative and Physiological Psychology, 88*, 640-652.

Lerman, D. C., & Iwata, B. A. (1996). Developing a technology for the use of operant

extinction in clinical settings: An examination of basic and applied research. *Journal of Applied Behavior Analysis, 29*, 345-382.

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

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*, 217-233.

Rawson, R.A., Leitenberg, H., Mulick, J.A., and Lefebvre, M.F. (1977). Recovery of extinction responding in rats following discontinuation of reinforcement of alternative behavior: A test of two explanations. *Animal Learning & Behavior, 5 (4)*, 415-420.

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*, 307-315.

Sidman, M. (1960). *Tactics of scientific research: Evaluating experimental data in psychology*. New York: Basic Books, Inc.

Skinner, B. F. (1938). *The Behavior of organisms: An experimental analysis*. New York: Appleton-Century-Crofts.

Table 1

Participant Profile and Caregiving Experience

Participant	Age (years)	Gender	Type of Experience	Approximate no. hrs.	Responsibilities
S	21	Female	Babysitting, Nursery	< 20	Play, feed, comfort, diaper
T	21	Female	Babysitting, cared for younger sibling	> 100	Play, feed, nap, comfort, diaper
U	20	Female	Babysitting, cared for younger sibling	> 100	Play, feed, nap, comfort, diaper
Y	22	Female	Babysitting, Nannying	> 100	Play, feed, nap, comfort, diaper
W	20	Female	Babysitting, employment in infant care setting	10	Play, feed, nap, comfort, diaper

Table 1 (continued).

Participant Profile and Caregiving Experience

Participant	Age (years)	Gender	Type of Experience	Approximate no. hrs.	Responsibilities
BB	20	Male	No experience		
CC	21	Male	No experience		

Table 2

Participant Profile and Caregiving Experience

Participant	Age (years)	Gender	Type of experience	Approximate No. hrs.	Responsibilities
GG	Not reported	Female	Not reported		
PP	20	Female	Babysitting Employment in infant care setting	~ 100	Play, feed, nap, comfort, diaper
WW	21	Female	Spent time with cousins		Comfort, play
VV	23	Female	Employment in infant care setting	~ 100	Feed, play, comfort, diaper
OO	21	Female	Babysitting	30	Play, feed, nap, Comfort, diaper
QQ	22	Female	Babysitting	> 100	Play, feed, nap, Comfort, diaper

Table 2 (continued).

Participant Profile and Caregiving Experience

Participant	Age (years)	Gender	Type of experience	Approximate No. hrs.	Responsibilities
KK	21	Female	Babysitting	~ 100	Feed, play, Comfort, diaper
LL	20	Female	Babysitting	> 100	Play, feed, nap, Comfort, diaper

Table 3

Participant Profile and Caregiving Experience

Participant	Age (years)	Gender	Type of Experience	Approximate no. hrs.	Responsibilities
ZZ	18	Female	Babysitting	12	Play, feed, nap, comfort, diaper
BBB	45	Male	Parent		Feed, nap, play, comfort, diaper
CCC	21	Female	Exposure to Infants	< 10	Play
DDD	21	Female	Babysitting Younger Sibling	Not reported	Feed, nap, play, comfort, diaper

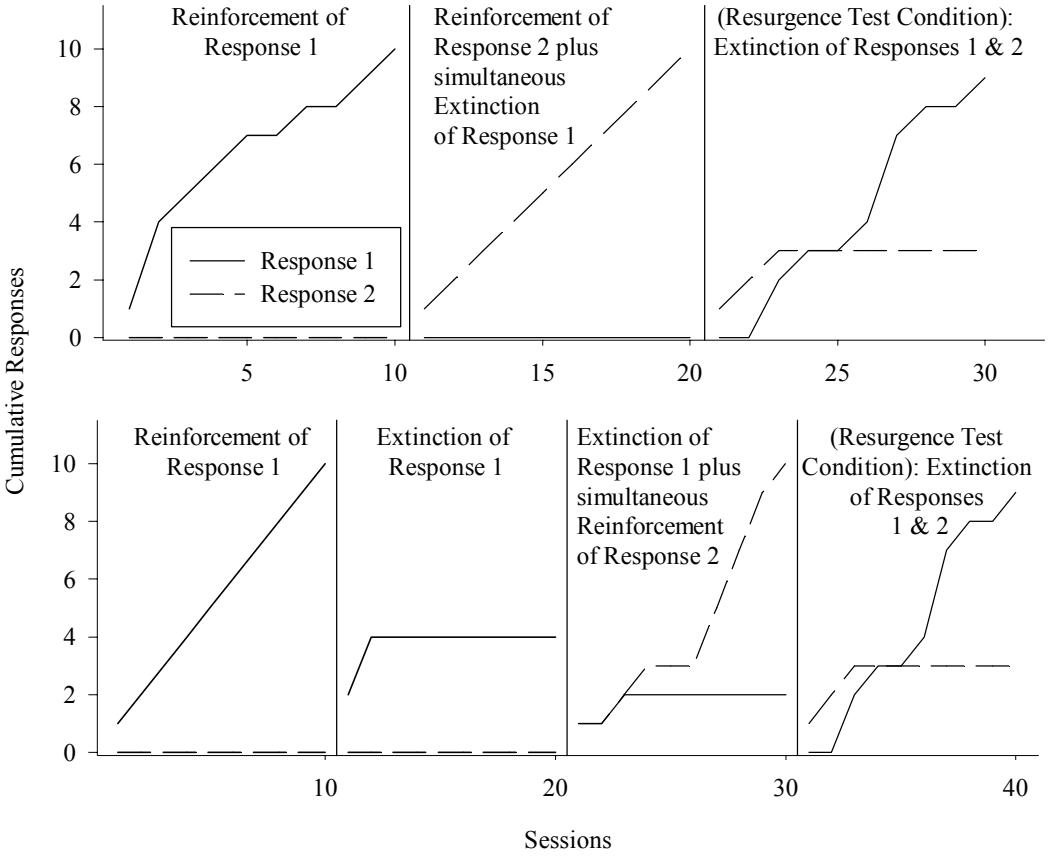

Figure 1. These hypothetical data illustrate two different procedural approaches to extinction of response 1. The top panel is an example of extinction of response 1 simultaneous with reinforcement of response 2. The bottom panel is an example of traditional extinction of response 1 before response 2 is reinforced.

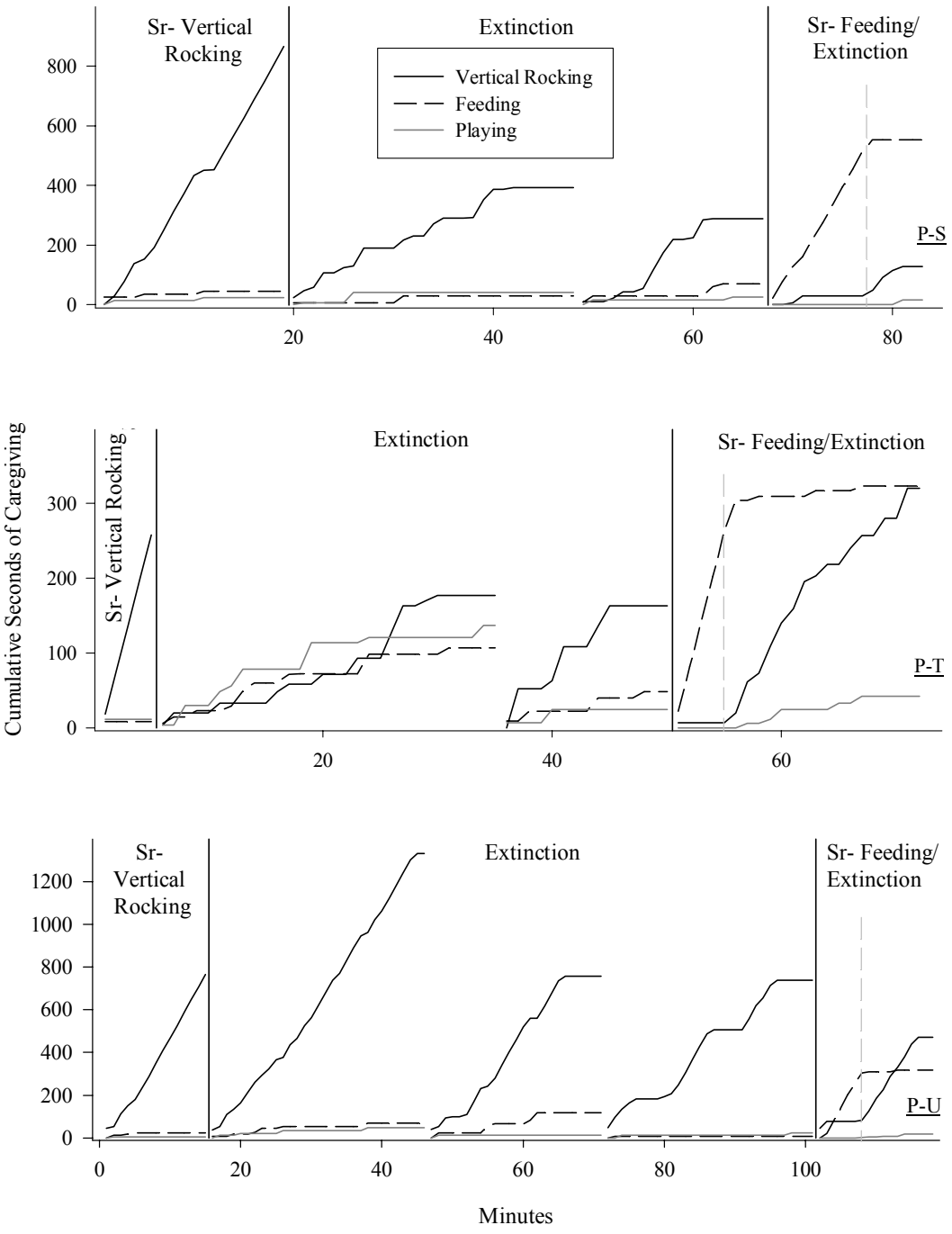

Figure 2. The cumulative duration of caregiving in seconds during Experiment 1. Breaks in the data paths indicate the start of a new session. Vertical dashed lines indicate the transition from reinforcement of a response to extinction.

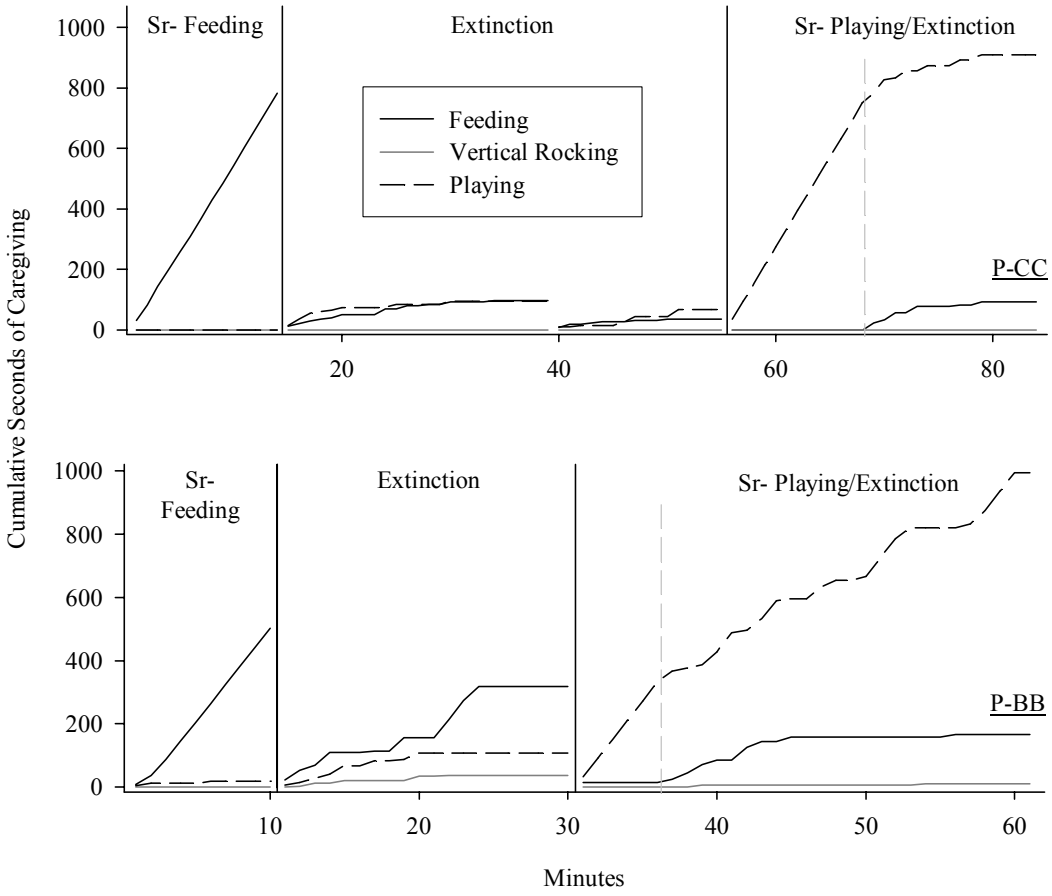

Figure 3. The cumulative duration of caregiving in seconds during Experiment 1. Breaks in the data paths indicate the start of a new session. Vertical dashed lines indicate the transition from reinforcement of a response to extinction.

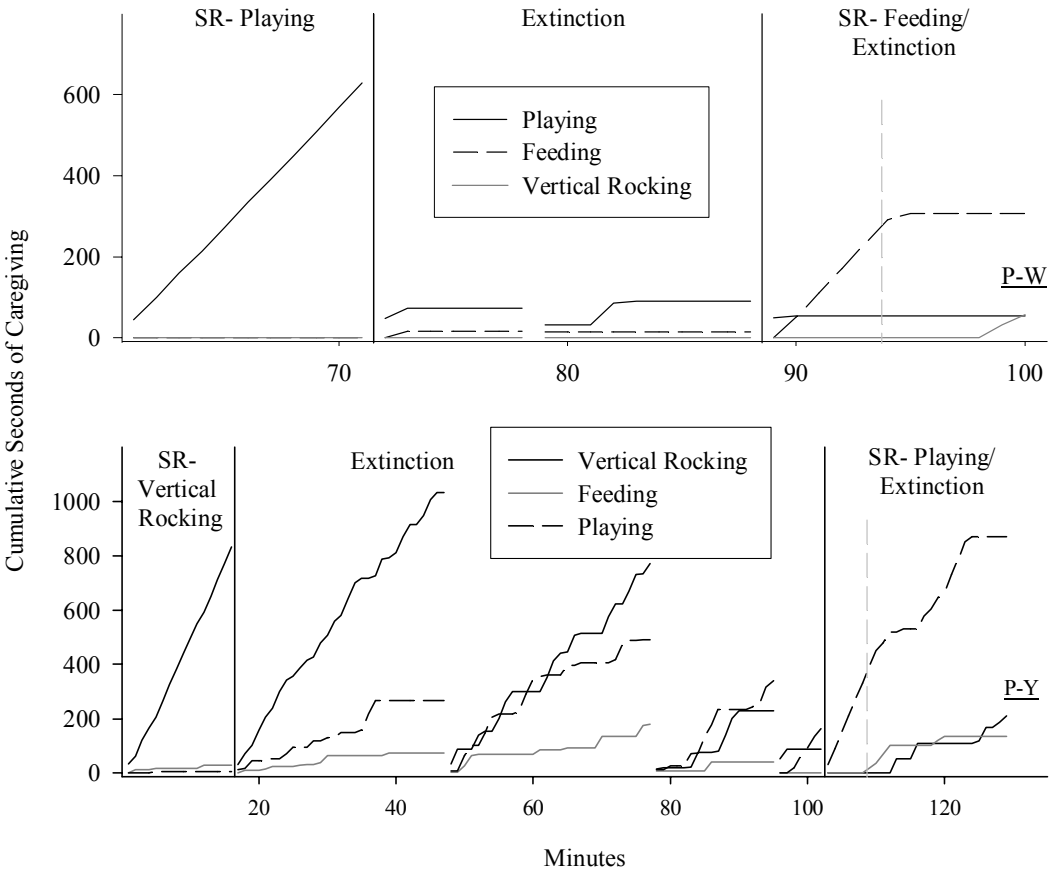

Figure 4. The cumulative duration of caregiving in seconds during Experiment 1. Breaks in the data paths indicate the start of a new session. Vertical dashed lines indicate the transition from reinforcement of a response to extinction.

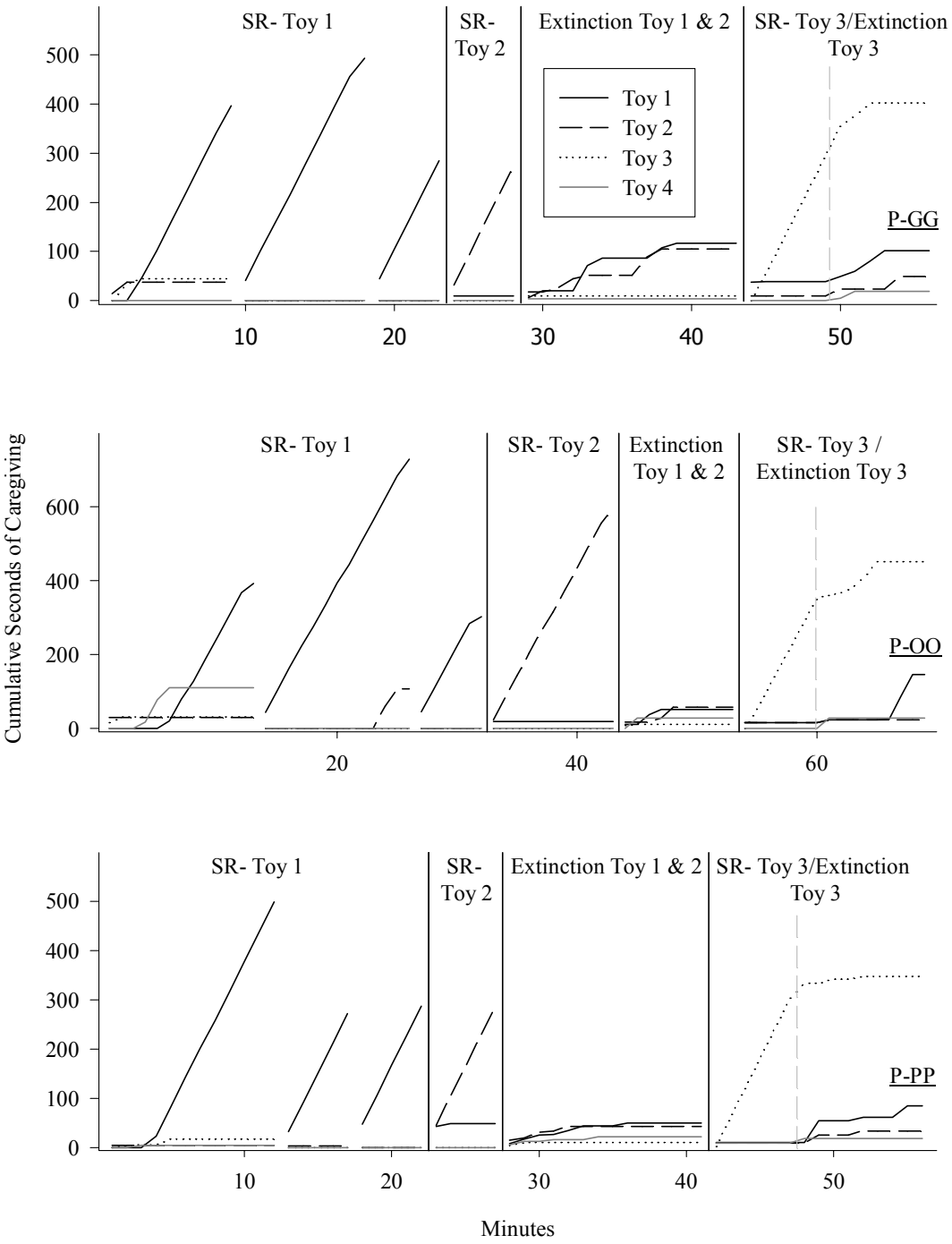

Figure 5. The cumulative duration of caregiving in seconds during Experiment 2. Breaks in the data paths indicate the start of a new session. Vertical dashed lines indicate the transition from reinforcement of a response to extinction the same response.

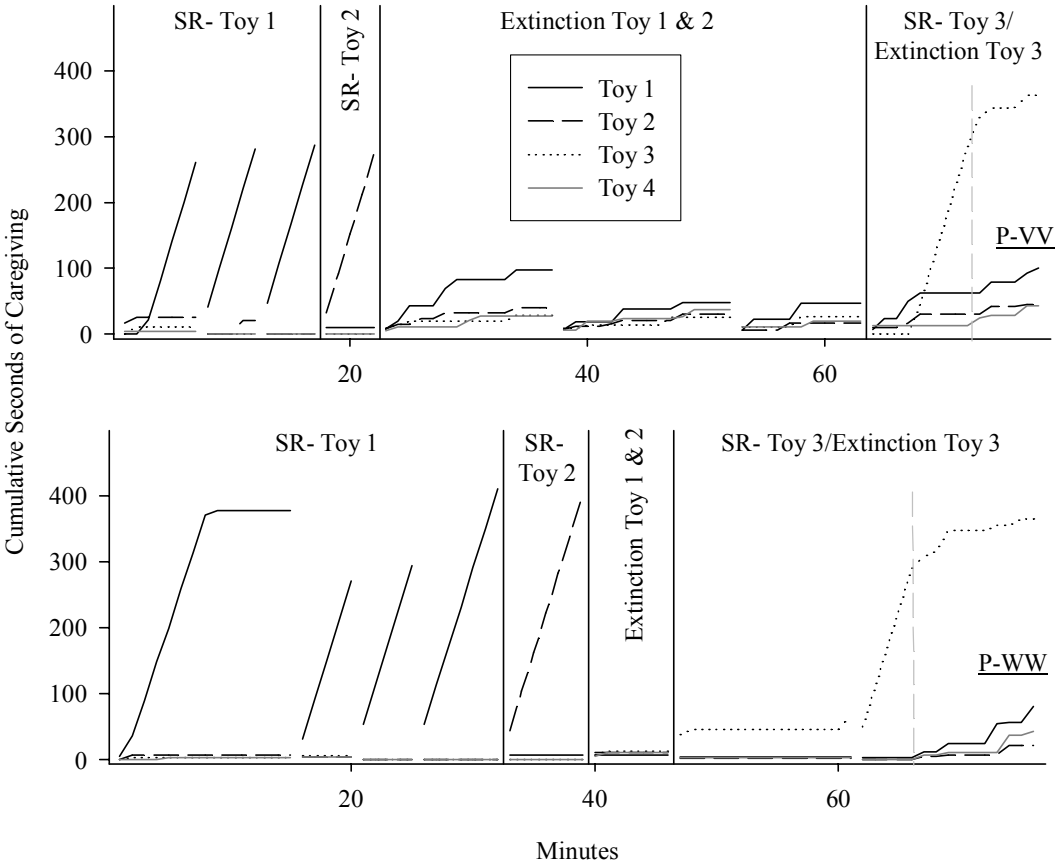

Figure 6. The cumulative duration of caregiving in seconds during Experiment 2. Breaks in the data paths indicate the start of a new session. Vertical dashed lines indicate the transition from reinforcement of a response to extinction.

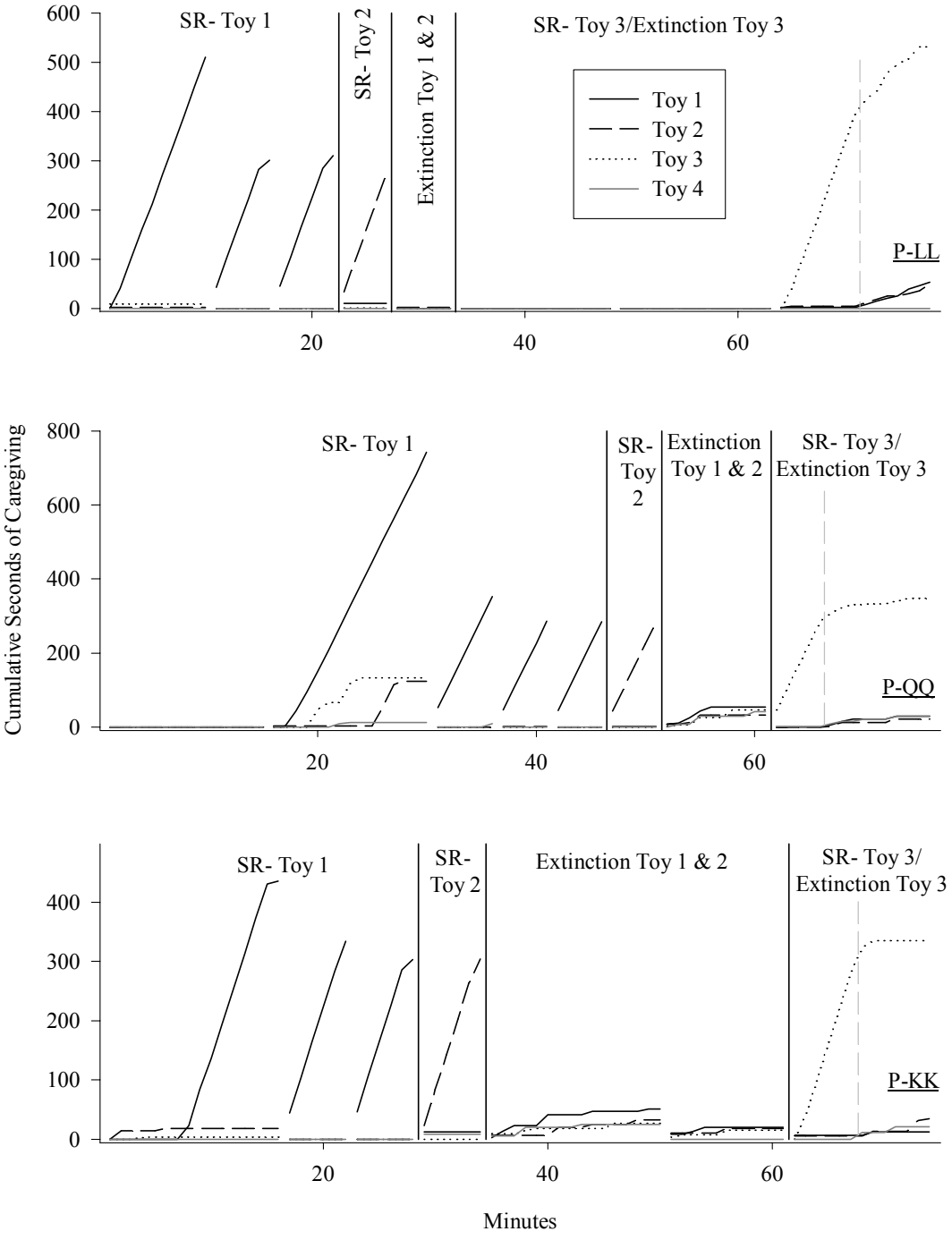

Figure 7. The cumulative duration of caregiving in seconds during Experiment 2. Breaks in the data paths indicate the start of a new session. Vertical dashed lines indicate the transition from reinforcement of a response to extinction.

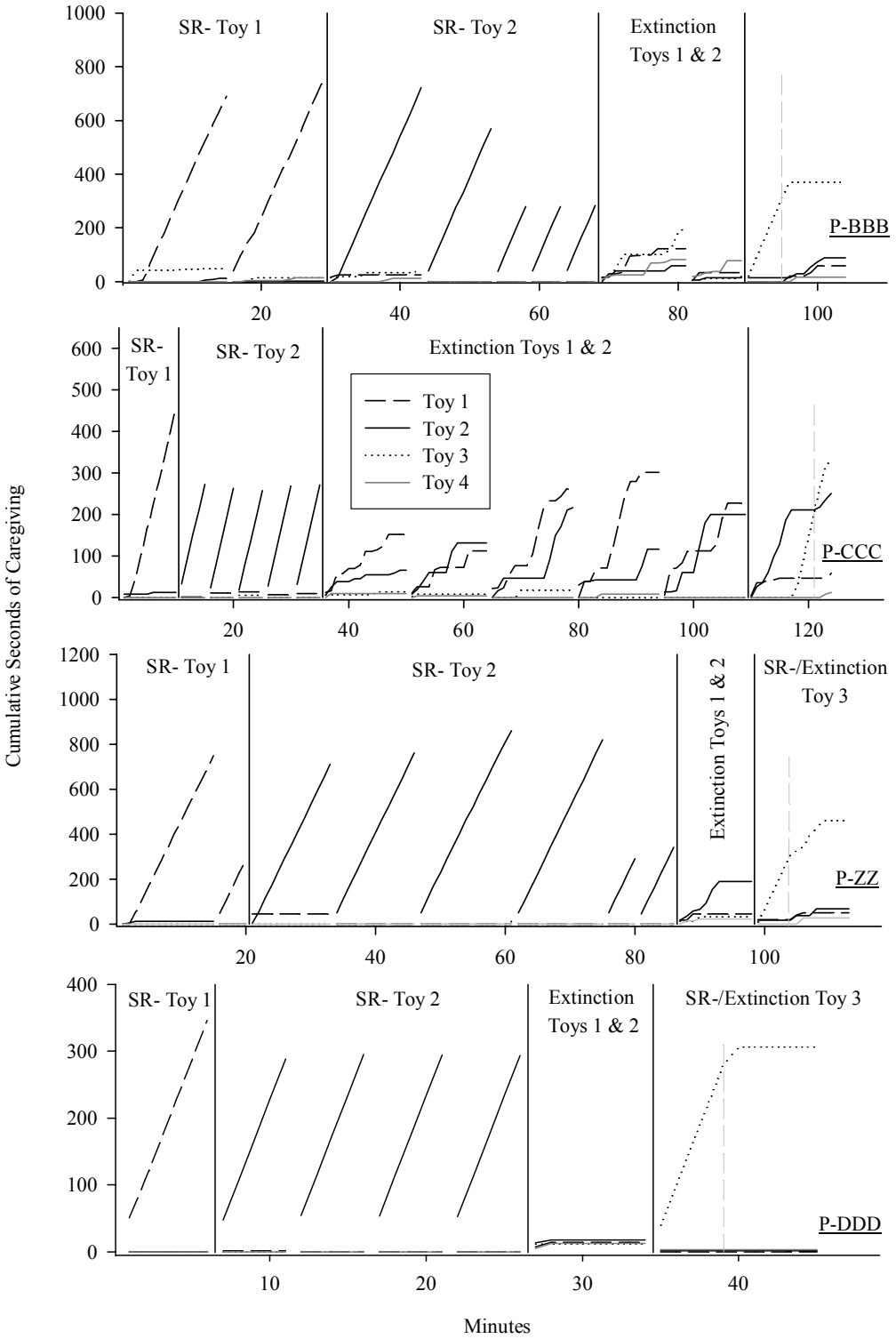

Figure 8. The cumulative duration of caregiving in seconds during Experiment 3. Breaks in the data paths indicate the start of a new session. Vertical dashed lines indicate the transition from reinforcement of a response to extinction.