

*THE ROLE OF NEGATIVE REINFORCEMENT IN INFANT  
CAREGIVING: AN EXPERIMENTAL SIMULATION*

RACHEL H. THOMPSON, JENNIFER L. BRUZEK, AND  
NICOLE M. COTNOIR-BICHELMAN

UNIVERSITY OF KANSAS

We observed 11 undergraduates in an experiment designed to simulate infant caregiving. In negative reinforcement conditions experienced by all participants, a targeted caregiving response (e.g., rocking a baby doll) produced escape from, and avoidance of, a recorded infant cry. Nine participants' caregiving was shown to be controlled by this negative reinforcement contingency. Nine participants experienced an extinction condition that consisted of an inescapable cry, and the previously reinforced caregiving responses of 2 of these participants were resistant to extinction. For both of these participants, the previously reinforced response was eliminated when an alternative form of caregiving was reinforced. These results highlight the role of negative reinforcement in infant caregiving and suggest the need for additional research on the effects of crying on caregivers as well as the development of effective strategies for minimizing infant crying.

*Key words:* caregiving, colic, crying, extinction, infants, negative reinforcement

Frequent crying is a primary concern expressed by infant caregivers (Golton & St. James-Roberts, 1991; McKim, 1987; Ventura, 1987). Despite caregivers' attempts to minimize crying (e.g., holding, feeding, offering a toy or pacifier; Bell & Ainsworth, 1972), it is estimated that infants cry a mean of approximately 2 hr per day during the first 3 months of life (Golton & St. James-Roberts, 1991; Hunziker & Barr, 1986) and that 5% to 40% of infants experience colic (Elliot, Drummond, & Barnard, 1996; Golton & St. James-Roberts, 1991; Hide & Guyer, 1982), which is characterized by excessive crying or fussiness occurring at least 3 hr per day, 3 days per week, for 3 months (Wessel, Cobb, Jackson, Harris, & Detwiler, 1954).

Although infant crying is a universal and developmentally normal form of early communication, a large body of research suggests that persistent crying may negatively affect caregiver interactions with the child. In general, mothers of persistent criers have been described in the research literature as less responsive, sensitive, and affectionate (Shaw, 1977; St. James-Roberts, Conroy, & Wilsher, 1998). Perhaps more worrisome is the apparent relation between crying and physical abuse of infants. Physical abuse is the leading cause of injury-related infant death, and the incidence of inflicted traumatic brain injury for children under 1 year of age has been estimated at 30 per 100,000 (Keenan et al., 2003). Inconsolable crying is frequently cited as the most common precipitant of violent shaking episodes and other forms of serious physical abuse against infants (e.g., Dykes, 1986; Krugman, 1983; Schmitt, 1987). In fact, one recent study reported that 6% of parents in their sample admitted to smothering, slapping, or shaking their infant to stop crying (Reijneveld, van der Wal, Brugman, Sing, & Verloove-Vanhorick, 2004). Unfortunately, due to practical and ethical difficulties associated with the experi-

---

We thank Philip Hinline for his feedback on an earlier version of this article. Rachel Thompson is now at Western New England College, Jennifer Bruzek is now at Vanderbilt University, and Nicole Cotnoir-Bichelman is now a consultant in Memphis, Tennessee.

Address correspondence to Rachel H. Thompson, Western New England College, 1215 Wilbraham Road, Springfield, Massachusetts 01119 (e-mail: rthompson@wnec.edu).

doi: 10.1901/jaba.2011.44-295

mental manipulation of infant crying, there are few experimental studies that help to elucidate the relation between crying and physical abuse of infants.

Donovan and Leavitt present one promising model for the experimental evaluation of the effects of infant crying on caregiver behavior (e.g., Donovan, 1981; Donovan & Leavitt, 1985, 1989; Donovan, Leavitt, & Walsh, 1990). These authors overcame difficulties associated with manipulating the cry of a live infant by presenting recorded cries in an experimental simulation of caregiving. In this series of studies, mothers of young infants were exposed to conditions designed to evaluate the effects of an inescapable infant cry on acquisition of a subsequent caregiving task. For example, in a study by Donovan (1981), mothers were initially exposed to one of three pretreatment conditions during which 35 un-signaled trials of an 80-dB cry were presented. Two pretreatment (escapable and inescapable) groups were presented with a button-pressing task and were told that performance of the task would terminate the cry. For the escapable group, the cry was presented for 10 s, but was terminated contingent on completion of the button-pressing task. For the inescapable group, button pressing had no effect on the presentation of the cry; the duration of cries was yoked to those presented in the escapable group. Participants in a control group also experienced cries yoked to those presented in the escapable condition, but these participants were not presented with the button-pressing task and were told to listen passively to the cry. After pretreatment, all mothers participated in test trials during which performance of a shuttle-box task terminated crying. Mothers who experienced the inescapable pretreatment condition had the most difficulty acquiring the shuttle-box task (i.e., learned helplessness; Seligman, 1972). When considered in light of studies that identify a correlation between persistent crying and decreased maternal re-

sponsiveness, results of Donovan (1981) suggest that persistent crying may result in suboptimal (and possibly neglectful) interaction patterns between infants and their caregivers.

Similar to the procedures used by Donovan and colleagues (e.g., Donovan, 1981; Donovan & Leavitt, 1985, 1989; Donovan, Leavitt, & Walsh, 1990), we sought to develop an experiment aimed at understanding the effects of crying on caregiver behavior. As in the earlier studies, we exposed participants to a recorded infant cry. The current study extends previous research by targeting responses that more closely simulate interactions with an infant. We created an experimental simulation of infant caregiving that allowed us to observe undergraduate students interacting with a baby doll under conditions in which common caregiving responses (e.g., rocking, playing, feeding; Bell & Ainsworth, 1972) resulted in termination of the recorded infant cry. Ultimately, an understanding of the effects of infant crying on caregiver behavior may assist in the development of programs for the prevention of negative outcomes (e.g., abuse and neglect) associated with exposure to persistent crying. Our goal for this initial study was to demonstrate the viability of a laboratory simulation and to evaluate sensitivity of caregiving to experimentally arranged negative reinforcement and extinction conditions.

## METHOD

### *Participants, Setting, and Materials*

Eight female and three male undergraduates received extra credit in a university course for their participation. After completion of the study, eight of the 11 participants completed a questionnaire regarding previous caregiving experience (we were unable to make contact with the remaining three participants). All eight of these participants reported some experience with caring for infants. Three of the participants were parents (P-4, P-8, P-9), and one of these participants (P-4) reported that she had raised

“two colicky babies.” Other caregiving experiences included employment in an infant care setting, babysitting, caring for a younger sibling, and infant care on a mission trip. The experiment was conducted in a session room (1.77 m by 2.45 m) with an adjoining observation room equipped with a one-way mirror. For all participants, the session room was equipped with a crib, blanket, baby doll, and tape recorder that produced a recorded infant cry (80 dB). For some participants (P-2, P-3, P-7, P-8, P-9, and P-11), infant toys and a bottle were also available. Experimenters operated a tape player by depressing a microswitch in the adjoining observation room. With parental consent, we recorded the cry of an infant enrolled in a university-run child development program. It was typical for this infant to cry as he was held and rocked in a rocking chair before naps. The recording consisted of a crying episode (i.e., approximately 15 min) that was repeated continuously to accommodate the maximum duration of the session (i.e., longer than 30 min).

#### *Data Collection and Interobserver Agreement*

From behind a one-way observation window, trained observers recorded a variety of participant responses using a handheld computer. Observers recorded the duration of *horizontal* and *vertical rocking* (holding baby in arms in a horizontal or vertical position and moving the upper body, creating visible movement of the baby's head), *feeding* (holding the bottle to the mouth of the baby), and *playing* (holding a toy within the baby's visual field). Interobserver agreement was assessed during a mean of 62% of sessions across all participants (range, 30% to 100%). We calculated agreement percentages by partitioning the session into 10-s intervals and comparing observers' records on an interval-by-interval basis. The smaller duration of the response in each interval was divided by the larger duration; these fractions were then averaged across intervals and converted to a percentage agreement score. Mean agreement

scores for horizontal rocking, vertical rocking, feeding, and playing were 94% (range, 77% to 99%), 97% (range, 94% to 99%), 98% (range, 97% to 99%), and 97% (range, 96% to 99%), respectively. Ranges reflect agreement scores for individual sessions rather than for individual participants.

#### *Procedure*

Prior to beginning the experiment, an experimenter informed each participant that the purpose of the study was to determine how adults would respond in a simulated caregiving situation and instructed the participant to “do what comes naturally.” One session was conducted per day, one to three times per week. Sessions were a maximum of 30 min in duration, but were terminated after 5 continuous minutes of the target behavior (negative reinforcement conditions), or 5 continuous minutes without the target behavior that was most recently reinforced (extinction and no-cry conditions). We used the same criteria to determine when to terminate an experimental condition. That is, when behavior conformed to the current experimental conditions for 5 continuous minutes in one session, the session was terminated and a new experimental condition was implemented in the next session.

*Negative reinforcement (Sr-)*. At the start of each session, the experimenter presented a recorded infant cry until the participant performed the target response (e.g., vertical rocking, feeding) for 3 consecutive seconds. The cry was re-presented only if the target response ceased for 3 consecutive seconds. The target response varied across sessions and across participants and was determined prior to the start of each phase. Across participants we sought to target a variety of responses in various sequences. Aside from this consideration, target responses were assigned unsystematically across participants and phases. In some cases, newly targeted responses had been performed, but not reinforced, in previous conditions, and, in some cases, newly targeted responses had never been

performed in sessions with that participant. However, pilot data suggested that the set of responses targeted in this study were probable in this procedure. This condition simulated a naturally occurring caregiving situation in which crying occurs unless the infant's needs are being met.

*Extinction.* The experimenter presented a recorded infant cry for the duration of the session, independent of participant responding. That is, no response was effective in terminating the cry. This condition simulated a naturally occurring period of inconsolable crying, which is typical of infants with colic. This condition also served as a control; if caregiving was sensitive to the negative reinforcement contingency, one would expect previously targeted caregiving responses to decrease under extinction.

*No cry.* The recorded infant cry was not presented during the session (P-11 only). This condition simulated a caregiving condition in which the infant's needs have been met, and the infant is content. This condition served as an additional experimental control with one participant whose caregiving responses persisted under extinction; if experimental caregiving was primarily evoked by infant crying (e.g., rather than the potential demand characteristics of the experimental arrangement), one would expect a reduction in caregiving when the cry was eliminated.

### *Design*

Experimental control was demonstrated via reversal designs. Participants' behavior was shown to be under control of the negative reinforcement contingency (i.e., escape from and avoidance of the cry) through (a) the assignment of this contingency to various topographies of caregiving (e.g., horizontal rocking, feeding, playing) or (b) a comparison of negative reinforcement and extinction conditions. Our minimum criterion for demonstration of experimental control was implementation of an ABA design (or its experimental

equivalent). That is, we determined that caregiving was under control of negative reinforcement if participants' behavior conformed to the experimental conditions in a minimum of three conditions (Kazdin, 1982, p. 119).

## RESULTS

Simulated caregiving responses performed by nine participants (see Figures 1, 2, and 3) were shown to be controlled by negative reinforcement in the form of escape from and avoidance of the recorded infant cry. The figures present within-session cumulative caregiving responses, and the data paths reset at the start of each new session. Figure 1 shows data for two participants for whom experimental control was demonstrated using a contingency reversal strategy whereby the negative reinforcement contingency was assigned to two or more different topographies of caregiving. P-1 engaged in a high level of horizontal rocking in Phases 1 and 3 during which this response was targeted with the negative reinforcement contingency. Vertical rocking occurred at high levels when this response was targeted in Phase 2. Similarly, P-2 performed a high level of horizontal rocking, feeding, and playing when these responses were targeted in the first three phases. When vertical rocking was targeted in the final phase, P-2 performed a high level of vertical rocking and, to a lesser extent, the other two previously reinforced responses (feeding and playing) before allocating responding toward vertical rocking. Overall, these two participants reliably performed the response targeted for negative reinforcement. With both participants, the session termination criterion (i.e., 5 consecutive minutes of the target response) was met within one session each time the contingency was assigned to a different topography. Each time the reinforcement contingency was reassigned to a new target response, the previously reinforced response did contact extinction briefly. However, these short

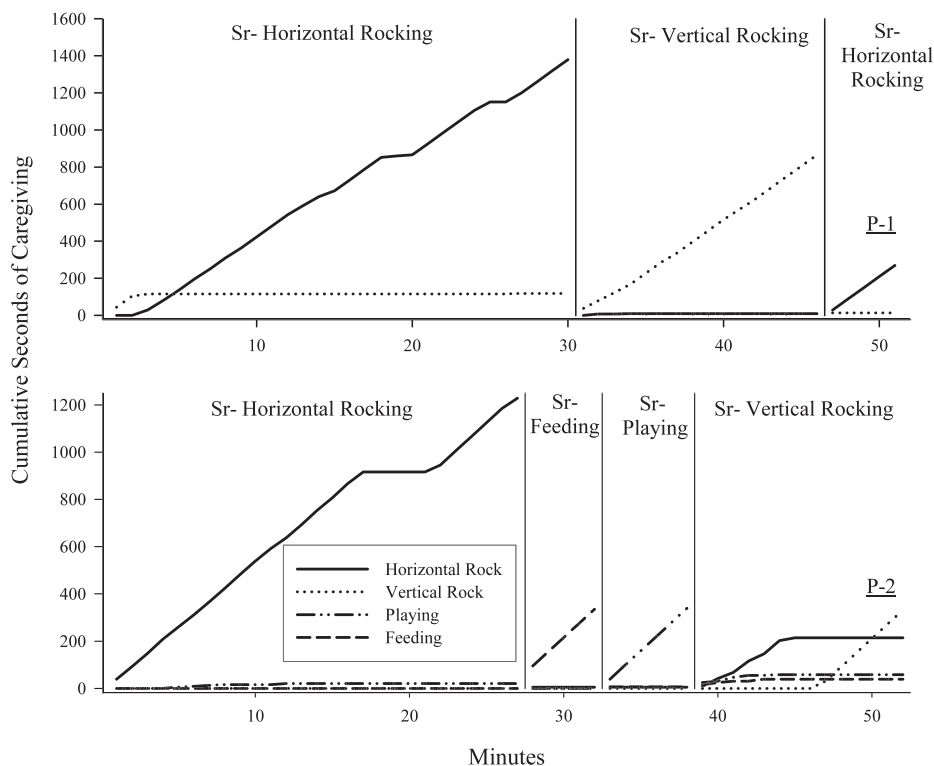


Figure 1. The cumulative duration of caregiving in seconds (*y* axis) for P-1 and P-2. Data are depicted in 1-min bins along the *x* axis, and breaks in the data paths indicate the start of a new session.

durations of responding are difficult to detect given the manner of data depiction. Short pauses in responding are also difficult to detect. P-1, for example, did not meet the criteria for session termination until the 16th minute of the Sr– vertical rocking condition because of brief (5 s or less) pauses in responding earlier in the session.

Figure 2 depicts data for four participants for whom a simulated caregiving response was initially reinforced and then subsequently extinguished. Three participants (P-3, P-4, and P-5) required two sessions to meet the criterion during the initial negative reinforcement condition, and two (P-4 and P-6) required two extinction sessions to meet the criterion. Figure 3 shows results from three participants who were exposed both to contingency reversal and to extinction conditions.

Criteria for reinforcement or extinction were met in one session for every participant and phase. Note that the extinction criterion required 5 continuous minutes without the most recently reinforced target response; therefore, P-8 met the extinction criterion during the fourth session, although playing occurred throughout this session. In two conditions, participants reallocated responding to a new target response although the previously reinforced response did not contact extinction. In Phase 3 (Sr– feeding), P-7 exclusively fed the baby, although playing had been reinforced in the previous condition. Similarly, P-8 exclusively played with the baby in Phase 2 (Sr– playing), although feeding had been reinforced in the previous condition. In both cases, the current target behavior was one that occurred in the first minute of every session in each

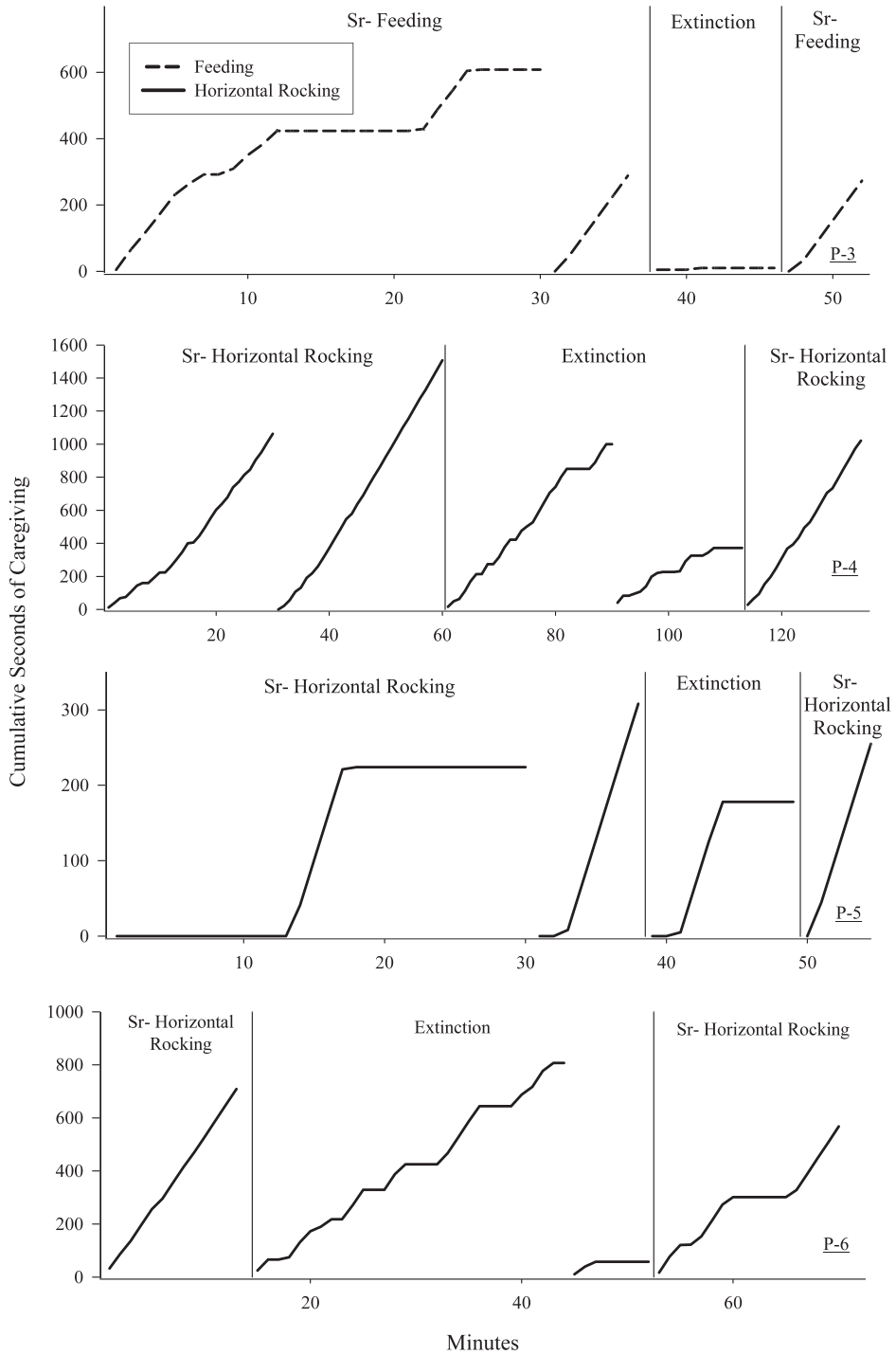


Figure 2. The cumulative duration of caregiving in seconds (*y* axis) for P-3, P-4, P-5, and P-6. Data are depicted in 1-min bins along the *x* axis, and breaks in the data paths indicate the start of a new session.

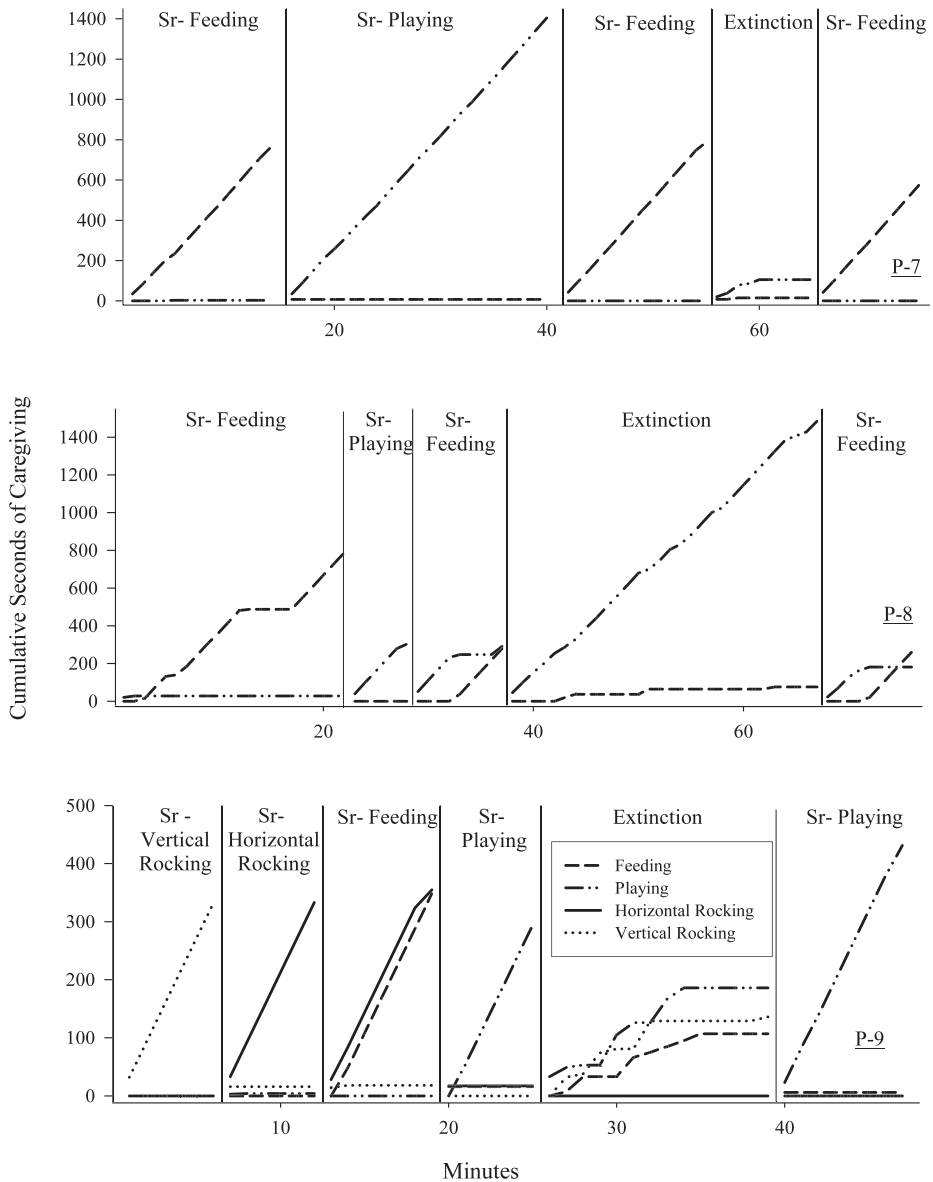


Figure 3. The cumulative duration of caregiving in seconds (*y* axis) for P-7, P-8, and P-9. Data are depicted in 1-min bins along the *x* axis, and breaks in the data paths indicate the start of a new session.

condition. Therefore, contact with reinforcement for the new target occurred without extinction of the previously reinforced response.

Data for two participants (Figure 4) suggested that the simulated caregiving responses were highly resistant to extinction. Our criteria for demonstrating experimental control were not achieved with these two participants. In both

cases, a previously reinforced response that persisted under extinction was reduced rapidly when the reinforcement contingency was re-assigned to a different topography of caregiving. P-10 continued to rock the baby doll for five 30-min sessions in the presence of a continuous cry. Horizontal rocking, the previously reinforced response, was eliminated in the last phase

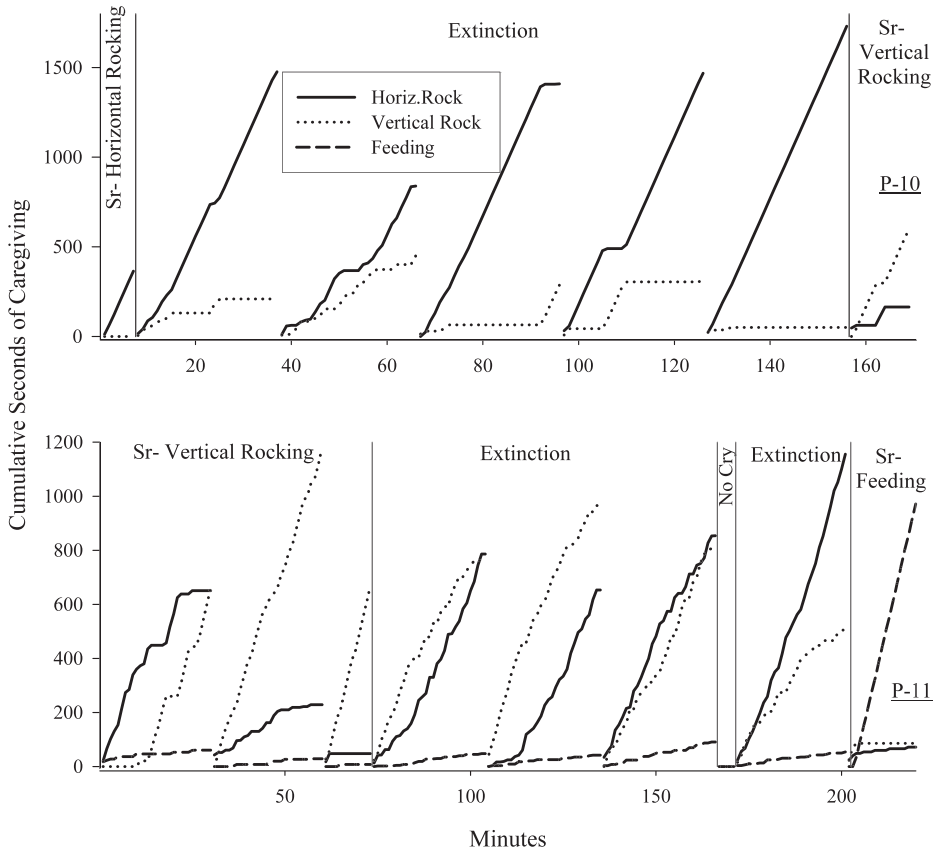


Figure 4. The cumulative duration of caregiving in seconds (*y* axis) for P-10 and P-11. Data are depicted in 1-min bins along the *x* axis, and breaks in the data paths indicate the start of a new session.

when the negative reinforcement contingency was applied to vertical rocking. P-11 required three sessions before meeting the reinforcement criterion in the initial negative reinforcement phase. This participant then continued to rock the baby doll during three 30-min sessions in the extinction condition. The cry was then eliminated in one session (no cry) to demonstrate that simulating caregiving was, in fact, under control of the cry; no caregiving was observed in this session. Rocking occurred again in the subsequent phase (extinction) when the cry was reintroduced. Vertical rocking was eliminated in the final phase in which the negative reinforcement contingency was reassigned to feeding.

## DISCUSSION

The current study demonstrates the viability of a laboratory model that permits evaluation of variables influencing the behavior of adults under simulated caregiving conditions. Overall, our participants engaged in a wide variety of simulated caregiving responses and showed behavioral sensitivity to the arranged contingencies. Given these preliminary results, it seems reasonable to adapt this laboratory procedure to approximate typical caregiving conditions more closely. First, it would be important to include more relevant participants, such as young women at risk for teen pregnancy or adults seeking to adopt, provide foster care



for, or regain custody of infants. Second, the conditions could be modified to simulate typical caregiving conditions more closely. For example, caregivers most likely experience competing reinforcement schedules and intermittent reinforcement for various caregiving responses. Finally, it may be necessary to reduce observer reactivity to capture abusive and neglectful interactions experimentally. Thus, this area of research would be enhanced through the use of commercially available portable baby simulators that were originally designed for use in teen pregnancy prevention programs. These simulators require a variety of caregiving responses (e.g., feeding, diaper changes) in response to a recorded cry and are equipped with automatic data collection of a variety of caregiver responses including shaking the infant. Portable baby simulators would minimize observer reactivity and would also permit the programming of more long-term caregiving histories, which would better approximate the experience of actual caregivers. These adapted simulations could then be used to investigate further the variables that contribute to neglectful or abusive caregiving and ultimately to evaluate caregiver training.

These findings suggest that caregiver behavior is, at least in part, under the control of negative reinforcement. Of course, one can assume that positive social reinforcement provided by infants and others in the social community also exerts influence over caregiver behavior under natural conditions, but this source of control was not the focus of this study. Identification of the negative reinforcement relation allows us to consider caregiving in the context of a large body of literature (see Hineline, 1977; Hutchinson, 1977) on the effects of negative reinforcement, which may contribute to an understanding of desirable and problematic patterns of caregiver behavior.

In optimal caregiving situations, it seems likely that infant crying is an aversive event that motivates responsive caregiving, as with P-2

who performed four different topographies of caregiving according to the prescribed contingency. At the same time, our findings serve as an important reminder that parents who experience long periods of inconsolable crying (as in colic) are subjected to prolonged exposure to aversive stimulation, as when P-10 experienced a total of 2.5 hr of crying in the extinction condition. The basic literature identifies a number of detrimental effects of inescapable aversive stimulation, including learned helplessness (e.g., Donovan, 1981; Miller & Seligman, 1975) and aggression (Azrin, Hutchinson, & Hake, 1967); these phenomena may contribute to neglectful or abuse patterns of caregiving observed in some families.

The identification of the role of negative reinforcement in infant caregiving emphasizes the ubiquity of negative reinforcement and the need for continued research on the many effects of aversive stimulation experienced by humans. The procedure used in this experiment may be useful for further investigating the role of negative reinforcement in the control of human behavior and for describing the course of extinction and extinction-related phenomena in human subjects following exposure to negative reinforcement contingencies. For example, Bruzek, Thompson, and Peters (2009) demonstrated the reemergence of previously reinforced infant caregiving responses (i.e., resurgence) using a similar method and identified length of history of reinforcement as a variable that may play a role in resurgence.

In the current study, previously reinforced responses persisted during prolonged exposure to extinction in two (P-10 and P-11) of nine participants exposed to extinction. In both cases, the response targeted for extinction was eliminated when an alternative response was negatively reinforced. With respect to infant caregiving, these data suggest equipping caregivers with a variety of responses to infant crying (e.g., rocking, singing, playing) to

increase the likelihood that caregivers will perform some response that terminates the cry.

However, despite the aversive properties of the infant cry, surprisingly little research has evaluated variables that minimize crying. Two factors may contribute to this paucity of research. First, prolonged crying typically occurs for only a few months in infancy (Golton & St. James-Roberts, 1991; Hunziker & Barr, 1986); thus, it may seem unnecessary to address a problem that families will shortly “outgrow” (Stifter & Braungart, 1992). Second, infant crying and the corresponding caregiver responses are considered developmentally normal phenomena, the natural course of which, some would argue, should not be disrupted. Nevertheless, parents frequently express concerns about persistent crying (Golton & St. James-Roberts, 1991; McKim, 1987; Ventura, 1987), and the aversive nature of infant crying suggests that additional research is needed to identify developmentally appropriate strategies for minimizing crying.

## REFERENCES

- Azrin, N. H., Hutchinson, R. R., & Hake, D. F. (1967). Attack, avoidance, and escape reactions to aversive shock. *Journal of the Experimental Analysis of Behavior*, *10*, 131–148.
- Bell, S. M., & Ainsworth, M. D. S. (1972). Infant crying and maternal responsiveness. *Child Development*, *43*, 1171–1190.
- Bruzek, J. L., Thompson, R. H., & Peters, L. C. (2009). Resurgence of infant caregiving responses. *Journal of the Experimental Analysis of Behavior*, *92*, 327–343.
- Donovan, W. L. (1981). Maternal learned helplessness and physiologic response to infant crying. *Journal of Personality and Social Psychology*, *40*, 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.
- Donovan, W. L., & Leavitt, L. A. (1989). Maternal self-efficacy and infant attachment: Integrating physiology, perceptions and behavior. *Child Development*, *60*, 460–472.
- Donovan, W. L., Leavitt, L. A., & Walsh, R. O. (1990). Maternal self-efficacy: Illusory control and its effect on susceptibility to learned helplessness. *Child Development*, *61*, 1638–1647.
- Dykes, L. J. (1986). The whiplash shaken infant syndrome: What has been learned? *Child Abuse and Neglect*, *10*, 211–221.
- Elliot, M. R., Drummond, J., & Barnard, K. E. (1996). Subjective appraisal of infant crying. *Clinical Nursing Research*, *5*, 237–250.
- Golton, F., & St. James-Roberts, I. (1991). Crying rates in infancy. *Health Visitor*, *64*, 188–190.
- Hide, D. W., & Guyer, B. M. (1982). Prevalence of infant colic. *Archives of Childhood Disease*, *57*, 559–560.
- Hineline, P. N. (1977). Negative reinforcement and avoidance. In W. K. Honig & J. E. R. Staddon (Eds.), *Handbook of operant behavior* (pp. 364–414). Englewood Cliffs, NJ: Prentice Hall.
- Hunziker, U. A., & Barr, R. G. (1986). Increased carrying reduces infant crying: A randomized controlled trial. *Pediatrics*, *77*, 641–648.
- Hutchinson, R. R. (1977). By-products of aversive control. In W. K. Honig & J. E. R. Staddon (Eds.), *Handbook of operant behavior* (pp. 415–431). Englewood Cliffs, NJ: Prentice Hall.
- Kazdin, A. E. (1982). *Single-case research designs: Methods for clinical and applied settings*. New York: Oxford University Press.
- Keenan, H. T., Runyan, D. K., Marshall, S. W., Nocera, M. A., Merten, D. F., & Sinal, S. H. (2003). A population-based study of inflicted traumatic brain injury in infants. *Journal of the American Medical Association*, *290*, 621–626.
- Krugman, R. D. (1983). Fatal child abuse: Analysis of 24 cases. *Pediatrics*, *12*, 68–72.
- McKim, M. K. (1987). Transition to what? New parents' problems in the first year. *Family Relations*, *36*, 22–25.
- Miller, W. R., & Seligman, M. E. P. (1975). Depression and learned helplessness in man. *Journal of Abnormal Psychology*, *84*, 228–238.
- Reijnveld, S. A., van der Wal, M. F., Brugman, E., Sing, R. A. H., & Verloove-Vanhorick, S. P. (2004). Infant crying and abuse. *The Lancet*, *364*, 1340–1342.
- Schmitt, B. D. (1987). Seven deadly sins of childhood: Advising parents about difficult developmental phases. *Child Abuse and Neglect*, *11*, 421–432.
- Seligman, M. E. P. (1972). Learned helplessness. *Annual Review of Medicine*, *23*, 407–412.
- Shaw, C. (1977). A comparison of the patterns of mother-baby interaction for a group of crying, irritable babies and a group of more amenable babies. *Child: Care, Health, and Development*, *3*, 1–12.
- St. James-Roberts, I., Conroy, S., & Wilsher, K. (1998). Links between maternal care and persistent infant crying in the early months. *Child: Care, Health, and Development*, *24*, 353–376.
- Stifter, C. A., & Braungart, J. (1992). Infant colic: A transient condition with no apparent effect. *Journal of Applied Developmental Psychology*, *13*, 447–462.
- Ventura, J. N. (1987). The stresses of parenthood reexamined. *Family Relations*, *36*, 26–29.
- Wessel, M. A., Cobb, J. C., Jackson, E. B., Harris, G. S., & Detwiler, A. C. (1954). Paroxysmal fussing in infancy sometimes called “colic.” *Pediatrics*, *14*, 421–434.

Received July 31, 2009

Final acceptance May 26, 2010

Action Editor, Dorothea Lerman