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# Persistence during Extinction: Examining the Effects of Continuous and Intermittent Reinforcement on Problem Behavior

**Jacquelyn M. MacDonald**,
The New England Center for Children, Northeastern University

**William H. Ahearn**,
The New England Center for Children, Northeastern University

**Diana Parry-Cruwys**,
The New England Center for Children, Northeastern University

**Stacie Bancroft**, and
The New England Center for Children, Northeastern University

**William V. Dube**
University of Massachusetts Medical School-Shriver Center

## Abstract

This study examined behavioral persistence during extinction following continuous or intermittent reinforcement in the context of an analogue functional analysis of problem behavior. Participants were four children diagnosed with an autism spectrum disorder who engaged in problem behavior; and for whom functional analyses indicated sensitivity to social reinforcers. Experimental sessions included four successive 5-min components: No social interaction, continuous or intermittent reinforcement for problem behavior (alternating across sessions), extinction, no social interaction. All participants' problem behavior was more persistent during extinction following continuous reinforcement suggesting that behavior during extinction was affected by the preceding schedule of reinforcement.

### Keywords

Behavioral momentum; resistance to change; problem behavior; autism

Behavioral momentum theory predicts that reinforcers added to a situation, regardless of their effect on behavior, should increase behavioral persistence (e.g., Nevin & Grace, 2000). Continuous reinforcement (CRF) often produces higher rates of reinforcement than intermittent (INT) schedules. Behavioral momentum theory thus predicts that the higher rate of reinforcement may enhance resistance to change. Confirmations of this prediction have sometimes been demonstrated in the treatment of problem behavior. For example, Lerman et al. (1996) examined extinction (EXT) of problem behavior maintained by access to preferred items or escape from demands following CRF and INT (range, fixed-ratio [FR] 3 to variable-ratio [VR] 10) schedules with three adults with intellectual disabilities. When resistance to extinction was measured by the number of responses emitted during a series of EXT sessions, resistance was greater following CRF for two of the participants.

Address correspondence to: Jacquelyn MacDonald, The New England Center for Children, 33 Turnpike Road, Southborough, MA 01772. jmacdonald@necc.org.

These results may have implications for assessments of problem behavior. The analogue functional analysis (FA; Iwata et al., 1982/1994) is a well-established method for assessing problem behavior. Potential maintaining variables are presented in separate, controlled conditions, and consequences are usually delivered on CRF schedules to enhance the salience of the contingencies. Behavioral momentum theory thus suggests that CRF, as imposed during an FA, could increase resistance to change during treatment if the schedule represents an increase in density of reinforcement relative to the naturally occurring schedule. In other words, providing additional reinforcement prior to treatment may increase behavioral persistence during subsequent treatment, particularly those involving extinction.

Although it is important to examine the effects on behavior in transition from reinforcement to extinction, many problems are inherent in studying behavior during transitions. For example, if extinction continues until responding ceases to occur and reinforcement is reinstated with behavior being exposed to extinction again, the second extinction period may produce a very different pattern of responding than was previously observed. Sidman (1960) discussed this problem at length, noting that initial states of transition from reinforcement to extinction may be unrecoverable. He offered an alternative conceptualization that the lack of recovery of initial transition states may be a byproduct of incomplete experimental control. However, it is possible that observing transitions from reinforcement to brief exposures to extinction (i.e., not extinguishing responding) may be one means of establishing experimental control. The current study sought to retain experimental control through multiple brief exposures to extinction while manipulating rate of reinforcement for socially mediated problem behavior.

More specifically, the purpose of the present study was to extend previous research by comparing CRF and INT reinforcement-to-extinction transitions for problem behavior (a) within an analogue FA context and (b) with multiple, brief exposures to each transition within subject to understand the effects of CRF and INT schedules on behavior.

## Method

### Participants and Setting

Participants were four boys diagnosed with an autism spectrum disorder by a professional not affiliated with their school. They were referred by their service providers as exhibiting problem behavior that interfered with participation in educational activities. An analogue FA (Iwata et al., 1982/1994) was conducted for each student. Results indicated that problem behavior was maintained by escape from demands for Dale and Cody and attention for Jimmy and Brent (data available from first author). Experimental sessions were conducted in a 1.5×3 m room equipped with a wide-angle video camera, microphone, video recording equipment, materials necessary to conduct the procedures, and an appropriately sized table with two chairs.

### Response Measurement and Interobserver Agreement

For Dale and Brent, *aggression* was defined as any instance of grabbing, pinching, hitting, kicking, or biting another person. Aggression was measured using frequency recording. For Jimmy, an episode of *hand biting* began when he put one or more fingers into his mouth and bit down such that the fingers were closed between his upper and lower teeth. For Cody, an episode of *whining* began as his voice rose to a higher pitch than normal conversational level. Hand biting and whining were measured as total duration of episodes; an episode ended when the target behavior was absent for 3 s.

All sessions were videotaped and later scored using hand held computers. Interobserver agreement (IOA) for frequency measures was calculated for total responses per component (see below), and for duration measures for 1-s intervals. Each 1-s interval was scored for presence versus absence of the target behavior by each observer. IOA results are expressed as the sum of agreements divided by the sum of agreements plus disagreements, multiplied by 100. IOA was calculated for at least one-third of sessions for each participant. Mean IOA was 96% (range, 93–100%) for Dale; 96% (range, 91–100%) for Brent; 94% (range, 85–100%) for Jimmy; and 92% (range, 87–100%) for Cody.

### Procedure

Procedures were similar to those described in Ahearn, Clark, Gardenier, Chung, and Dube (2003). Sessions consisted of four successive components in the following order: (1) no social interaction, (2) CRF or INT for problem behavior, (3) EXT for problem behavior, and (4) no social interaction. The first, third, and fourth components were the same in all sessions; CRF and INT were quasi-randomly alternated in the second component.

In the *no-interaction* component, participants had free access to two toys that were identified as moderately preferred in a previous preference assessment (data available from the first author); an experimenter was present but did not attend to the participant. The CRF and INT components for Brent and Jimmy were similar to the attention condition of the FA. When the target behavior occurred, the therapist said, “Don’t do that, you’ll hurt yourself/someone” and made physical contact with the participant for 5 s. No toys were present during this condition. The CRF and INT components for Dale and Cody were similar to the demand condition of the FA. The experimenter presented a series of academic tasks familiar to the participant. If the participant did not begin a task within 5 s, the experimenter first modeled correct responding and then manually guided the correct response if necessary. Verbal praise was delivered for correct independent or modeled responses. If the target behavior occurred, the experimenter said, "OK, you don't have to do this," turned away from the participant, and withdrew demands for 15 s. These consequences followed every occurrence of the target behavior during CRF and every third occurrence or episode on average (VR-3 schedule) during INT. The CRF and INT schedules were associated with identical ambient stimulus conditions. The EXT component was similar to the CRF and INT components, except the consequences were not delivered for problem behavior.

Components were 5 min with the exception of the CRF and INT components for Cody and Dale. For these participants, the component was increased by 15 s for each demand removal to equate the opportunity for reinforcement during the reinforcement components. Participants left the experimental room for approximately 1 min between components. Sessions continued until each participant completed three sessions with CRF and INT.

## Results and Discussion

Figure 1 shows response frequencies (Dale and Brent) and durations (Jimmy and Cody) during each reinforcement and extinction component. Levels of responding in the CRF and corresponding extinction condition were compared to those in the INT and its corresponding extinction condition occurring on the same day (with one condition conducted immediately after the preceding condition). Participants played with the preferred toys and never emitted the target behavior during the no- interaction components, so these components are not depicted on the figures. When examining reinforcement components, response rates were slightly higher or equal in INT for Dale, lower in INT than CRF for two of three comparisons for Brent, higher in INT for two of three comparisons for Jimmy, and higher in all INT comparisons for Cody When examining extinction conditions, higher levels of responding occurred in all extinction components following CRF for Dale and Brent, in only

one comparison following CRF for Jimmy, and higher in two of three comparisons following CRF for Cody. Rates of obtained reinforcement (not depicted) were, on average, higher during CRF than INT for each participant (3.33 and 1.45 during CRF and INT respectively for Dale, 13 and 9.2 for Brent, 63.67 and 38.4 for Jimmy, and 18 and 10 for Cody).

Figure 2 shows responding in EXT components expressed as a proportion of responding during reinforcement. Proportional change was calculated by dividing the response rate during EXT by the response rate during the immediately preceding reinforcement component. The left portion of each panel shows the data for individual CRF/EXT or INT/EXT transitions. Proportional responding was higher in all three CRF/EXT sessions than in any INT/EXT session for Brent, while two of the three highest proportions were obtained during CRF/EXT for each of the other three participants. The rightmost portion of each panel illustrates the mean for all three replications; the mean proportional rates of the target behavior were higher following CRF for all participants.

The data demonstrated that extinction onset within typical FA conditions was sensitive to the reinforcement schedule of the preceding component. This result was obtained for problem behavior maintained by both positive (Brent and Jimmy) and negative (Dale and Cody) social reinforcement, and with both frequency (Dale and Brent) and duration (Jimmy and Cody) response measures. In addition, the present data extend the results of Lerman et al. (1996) by demonstrating similar outcomes with frequent alternation between reinforcement and extinction. Lerman et al. also found that CRF increased the likelihood of extinction bursts, compared to INT. In the current study, in six of the eight instances, responding was higher in extinction than during the preceding reinforcement component following CRF. The findings in the present study conflict with the partial-reinforcement extinction effect (see Mackintosh, 1974).

These findings suggest that placing problem behavior on an INT schedule prior to treatment may reduce the likelihood of extinction bursts during treatment conditions as well as minimize resistance to change. However, we still recommend using CRF schedules when conducting FAs to increase the saliency of the tested contingencies. Studying transition states using multiple, brief exposures to extinction may be a productive way of analyzing behavior in extinction and the resistance of behavior to extinction (see Sidman, 1960). In the context of treatment evaluations, using multiple, brief exposures to extinction may be a beneficial way of examining the effects of extinction on behavior, as behavior is rarely extinguished in natural contexts.

One limitation of the present study was the relatively brief duration of transitions. The data describe the onset of extinction, but not the entire course of extinction (i.e., until responding ceased). The results seem most informative for contexts similar to FA sessions where responding has not ceased during extinction conditions.

Despite this limitation, the present study contributes to the application of behavioral momentum theory to applied research by showing relatively consistent effects in the problem behavior of children with autism. Results show that behavior may be more persistent in CRF-to-EXT transitions than INT-to-EXT transitions. These findings suggest that, following an FA or assessment in the ecological setting, changing schedules of reinforcement from CRF-to INT before implementing treatment may decrease resistance to change. Further, when treating problem behavior in natural contexts such as out-patient settings or short term care, it may be beneficial to examine the schedules currently in place before implementing treatment and adjust if feasible. The present results complement recent research showing reinforcement-based interventions for problem behavior (e.g., DRA) may

decrease response frequency but increase resistance to extinction (Mace et al., 2010), and that persistence may diminish over an extended course of treatment, as measured by repeated extinction probes (Wacker et al., 2011).

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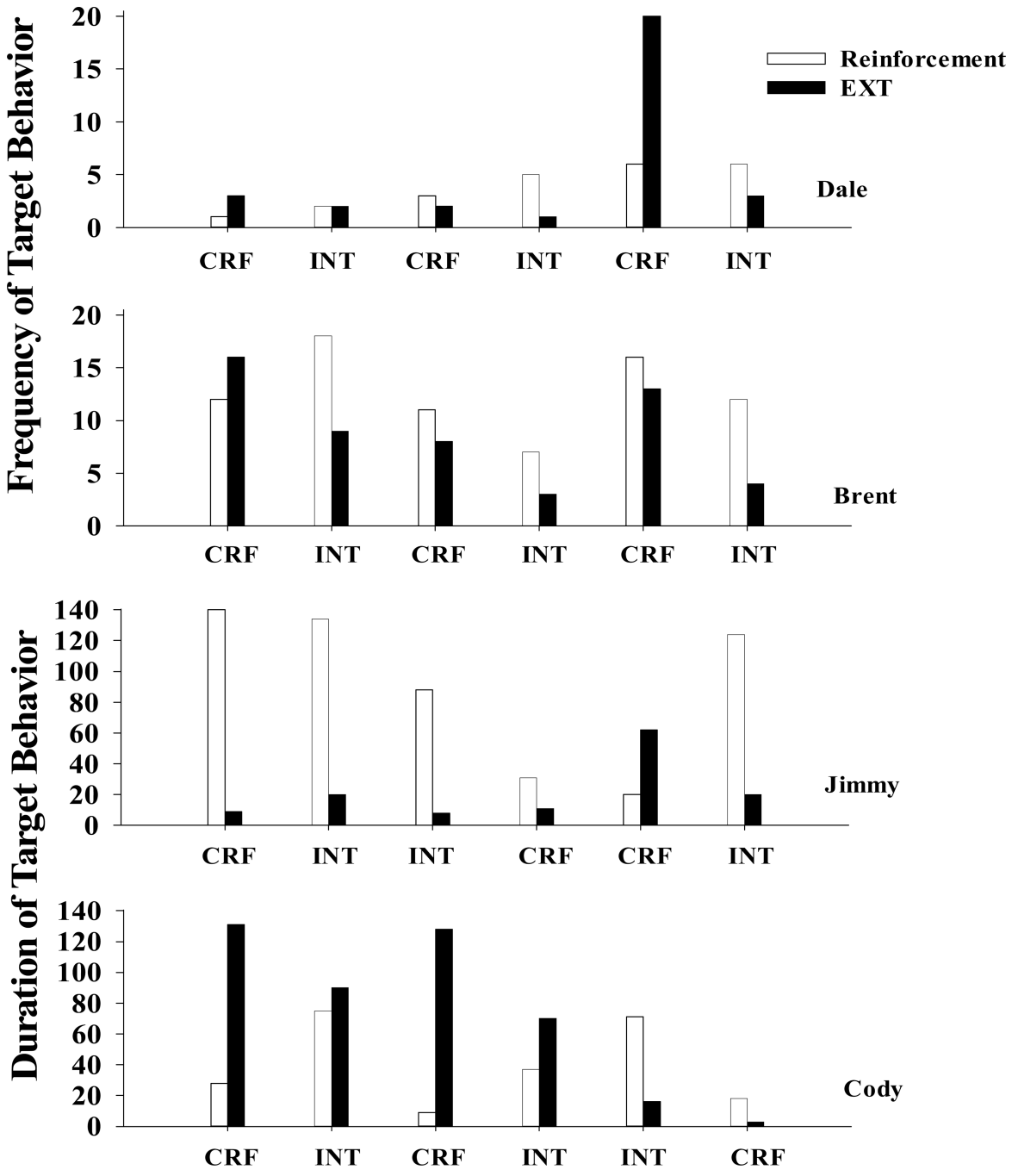


**Figure 1.**
Total responding during reinforcement and extinction components of the four-component momentum test.

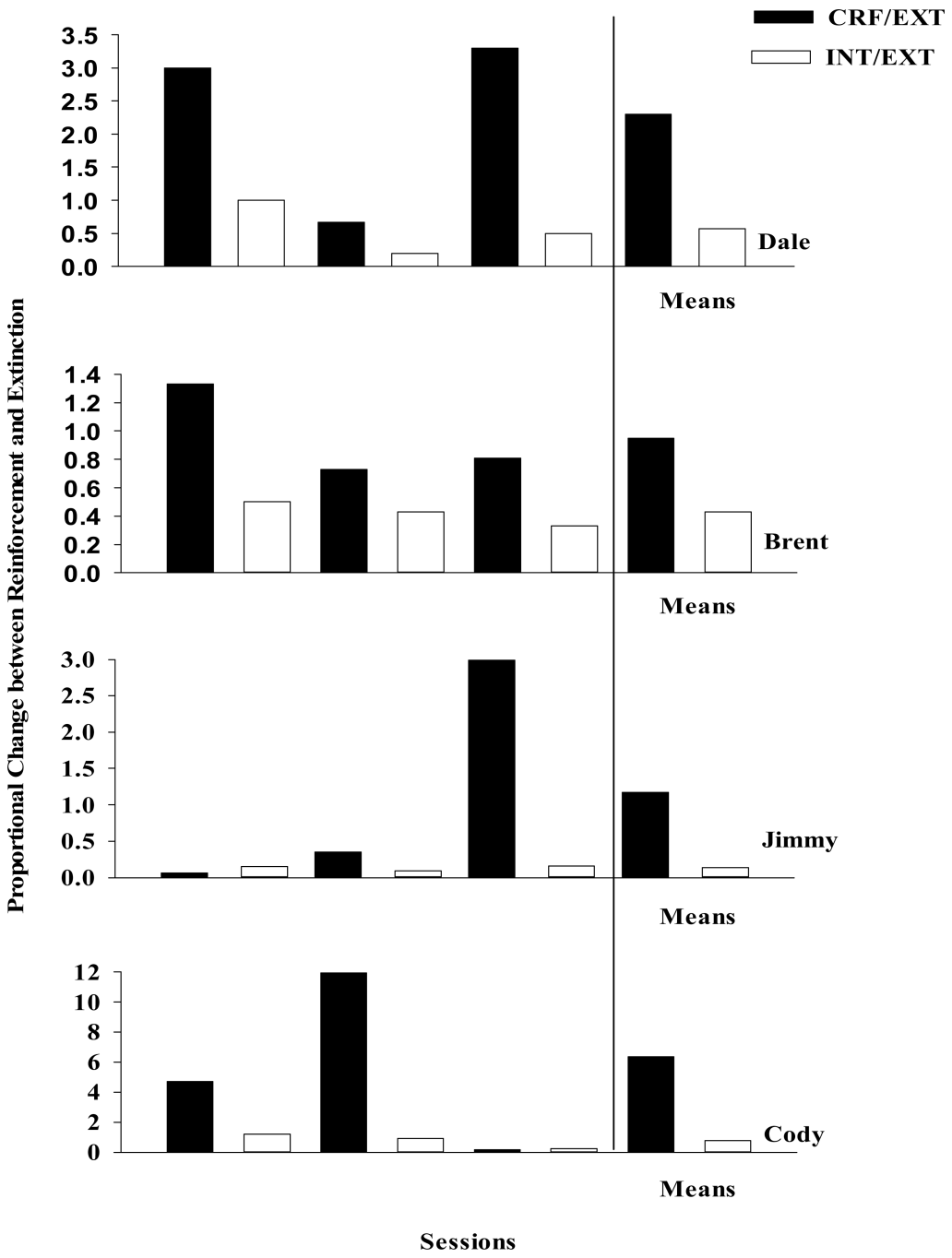


**Figure 2.**
Responding during extinction expressed as a proportion of rates observed during preceding reinforcement components.