2011

Effects of Fixed-Time Reinforcement Schedules on Resurgence of Positively Reinforced Problem Behavior

Tonya M. Marsteller
West Virginia University

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Effects of Fixed-Time Reinforcement Schedules on Resurgence of Positively Reinforced
Problem Behavior

Tonya M. Marsteller

Thesis submitted to the
Eberly College of Arts and Sciences
at West Virginia University
in partial fulfillment of the requirements
for the degree of

Master of Science
in
Psychology

Claire St. Peter Pipkin, Ph.D., Chair
Kennon A. Lattal, Ph.D.
Hawley Montgomery-Downs, Ph.D.

Department of Psychology

Morgantown, West Virginia

2011

Key words: Differential Reinforcement of Alternative Behavior (DRA), Disabilities,
Extinction (EXT), Fixed-Time Reinforcement Schedules, Problem Behavior, Resurgence

ABSTRACT

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Tonya M. Marsteller

Resurgence of problem behavior following the discontinuation of DRA interventions may be prevented by response-independent reinforcer delivery. In basic research, response-independent reinforcer delivery following DRA prevented resurgence of the initially reinforced response and maintained alternative responding. The present study evaluated if these results were generalizable humans by assessing if fixed-time (FT) reinforcer delivery following DRA would prevent resurgence of problem behavior and maintain appropriate behavior with 4 children with disabilities. For all participants, EXT following DRA produced resurgence of previously reinforced problem behavior and reduced appropriate requesting, but FT reinforcer delivery following DRA did not produce resurgence of problem behavior and maintained appropriate requesting. Thus, fixed-time reinforcer delivery following DRA may prevent resurgence of problem behavior and maintain appropriate behavior in clinical settings.

Acknowledgements

I would like to thank Claire St. Peter Pipkin, Andy Lattal, and Hawley Montgomery-Downs for serving as members of my thesis committee and for their valuable contributions to the preparation of this manuscript.

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Introduction

Extinction (nonreinforcement; EXT) is often thought of as a response-reductive procedure; however, it can be response generative, as is the case with resurgence.

Resurgence describes the recurrence of a previously reinforced response following the EXT of that response, and the subsequent reinforcement and EXT of an alternative response. Resurgence can be distinguished from other response-generative phenomena associated with EXT, such as spontaneous recovery, response reinstatement, and response induction (see Lattal, St. Peter Pipkin, & Escobar [in press] for a discussion of the distinction). The term *resurgence* describes a behavioral process, a behavioral outcome, and a behavioral procedure (Lattal & St. Peter Pipkin, 2010).

The typical resurgence procedure consists of three phases. First, a target response is reinforced. Second, that response is placed on EXT, and an alternative response is reinforced. Third, both responses are placed on EXT. During this third phase, the target response tends to recur. Resurgence may occur in a variety of applied situations, including reduced treatment integrity with differential reinforcement of alternative behavior (DRA) interventions (Volkert, Lerman, Call, & Trosclair-Lasserre, 2009). Much remains unknown, however, about the variables that induce or prevent resurgence in application.

Resurgence is a robust phenomenon that occurs across species and procedural variations. Resurgence has been demonstrated with rats (e.g., Leitenberg, Rawson, & Bath, 1970; Leitenberg, Rawson, & Mulick, 1975; Podlesnik, Jimenez-Gomez, & Shahan, 2006), pigeons (e.g., Leitenberg et al., 1975; Lieving & Lattal, 2003), squirrel monkeys (e.g., Mulick, Leitenberg, & Rawson, 1976), hens (Cleland, Foster, & Temple,

2000), and humans (e.g., Bruzek, Thompson, & Peters, 2009). Multiple exposures to EXT have reliably produced repeated resurgence in nonhuman and human animals (e.g., Doughty, da Silva, & Lattal, 2007; Lieving & Lattal, 2003; Volkert et al., 2009).

Bruzek and colleagues (2009) found resurgence of negatively reinforced infant-caregiving responses in a series of human-operant experiments. Participants in this study were left in a room with a baby doll and various care supplies (a bottle, infant toys, and a crib). Bruzek et al. randomly chose a target response (rocking, feeding, or playing) for each participant before the experiment began. The experimenter controlled a recorded infant cry, and played the cry at the start of each session. Each time the participant engaged in the target response for 3 s, the crying stopped. Crying was reinstated if the participant stopped engaging in the target response for 3 s. Once the participant engaged in the target response for 5 min in one session, this response was placed on EXT, and an alternative response was reinforced. Later, when both the target response and alternative response were placed on EXT, the target response resurged. In a second experiment, Bruzek et al. manipulated the number of sessions in which two target responses were reinforced. More resurgence occurred with behavior that had a longer reinforcement history, even though the response associated with a shorter history had been reinforced more recently.

The potential interaction between degree of resurgence and duration of reinforcement histories of the target response and the alternative response has particular relevance to application. Typically, when an individual seeks treatment for problem behavior, that behavior has a long reinforcement history. A new intervention plan, if implemented inconsistently, is likely to expose the individual to temporary EXT of the

alternative behavior (similar to the third phase of Bruzek and colleagues' [2009] analysis). Behavior with a longer history (typically the problem behavior for which an individual is seeking treatment) may be likely to resurge during EXT.

Another consideration with the treatment of problem behavior is resurgence of response-class hierarchies. A response-class hierarchy is "an operant class comprised of responses that occur typically in ordered sequences from low to high severity" (Lieving, Hagopian, Long, & O'Connor, 2004, p. 623). Lieving et al. analyzed resurgence of response-class hierarchies with children who engaged in problem behavior. The targeted response-class hierarchies were disruption and aggression for one participant, and disruption, dangerous acts, and cursing for the second participant. Lieving et al. first reinforced each instance of any topography of problem behavior. In the second phase, only the first problem behavior occurring in the targeted hierarchy (typically the lowest-severity problem behavior) was placed on EXT, while other topographies of problem behavior were reinforced. During the third phase, the first and second topographies of problem behavior occurring in the hierarchy were placed on EXT. For one participant, this phase was followed by placing the first, second, and third topographies of problem behavior in the hierarchy on EXT. Previously extinguished problem behavior resurged each time an additional problem behavior was placed on EXT. Resurgence of response-class hierarchies is relevant to the treatment of problem behavior because if a caregiver places a mildly disruptive behavior on EXT, a more severe form of problem behavior in the same response class may resurge.

A better understanding of variables that prevent resurgence of problem behavior during EXT could enhance treatment outcomes when periods of EXT are likely. Various

aspects of the EXT phase of the resurgence procedure have been examined to identify factors that affect the likelihood of resurgence. Of interest to application is whether nontraditional forms of EXT, such as response-independent delivery of reinforcers or brief periods of nonreinforcement, also will result in resurgence.

Lieving and Lattal (2003, Experiment 4) assessed resurgence of previously reinforced behavior during periods of nonreinforcement (local EXT) of the alternative response. Lieving and Lattal first reinforced key pecking of pigeons using a variable-interval (VI) 30-s schedule. During VI schedules, the first response that occurs after a varying period of time has elapsed is reinforced (Ferster & Skinner, 1957). The interval values vary around a mean schedule value (in this instance, 30 s). Key pecking was then placed on EXT, and treadle pressing was reinforced with a VI 30-s schedule. During the resurgence condition, key pecking remained on EXT, and treadle pressing was reinforced with a VI 360-s schedule. This was followed by traditional EXT of all responses. Resurgence of key pecking occurred during the VI 360-s schedule for treadle pressing; however, the rate of responding was lower and more variable than resurgence that occurred during the traditional EXT phase.

Lieving and Lattal's (2003, Experiment 4) finding that intermittent periods of nonreinforcement are sufficient to produce resurgence may have implications for DRA treatment. During a typical DRA procedure, an appropriate alternative response is reinforced, while the problem behavior is placed on EXT (e.g., Vollmer & Iwata, 1992). If a caregiver does not reinforce every instance of appropriate requesting during DRA, the situation may be analogous to local EXT, and sufficient to produce resurgence (Volkert et al., 2009).

Volkert et al. (2009, Experiment 2) conducted a systematic replication of Lieving and Lattal's (2003) experiment by examining the effects of a rapid decrease in reinforcement-schedule density for the alternative response during DRA treatment with children diagnosed with a developmental disability. During the baseline condition, problem behavior was reinforced on a fixed-ratio (FR) 1 schedule, during which each response resulted in a reinforcer. During the alternative-reinforcement condition, problem behavior was placed on EXT, and an appropriate communicative response was reinforced according to an FR 1 schedule. During the resurgence condition, the reinforcement schedule for the communicative response was decreased to an FR 12 schedule, in which every twelfth response was reinforced, while problem behavior remained on EXT. Problem behavior resurged for each participant.

The results obtained by Lieving and Lattal (2003) and Volkert et al. (2009) indicate that even intermittent periods of nonreinforcement (local EXT) of the alternative response are sufficient to produce resurgence. This finding has treatment implications for DRA interventions. Inconsistent implementation of DRA may be analogous to the typical resurgence procedure. Appropriate requests that are not reinforced may be similar to local EXT of the alternative response, while the problem behavior remains on EXT (Volkert et al., 2009), and resurgence of the problem behavior may occur. It is often difficult for caregivers to implement DRA with perfect integrity (e.g., Wickstrom, Jones, LaFleur, & Witt, 1998). Thus, an otherwise effective behavior plan could be deemed ineffective and discarded due to resurgence resulting from periods of local EXT. Identification of variables that prevent resurgence of problem behavior during EXT could lead to more effective DRA interventions.

Time-based reinforcement schedules may prevent resurgence of problem behavior. During time-based reinforcement schedules, the reinforcer is delivered independently of responding, thereby removing the response-reinforcer dependency. Thus, it has been suggested that response-independent reinforcer delivery is a form of EXT (e.g., Rescorla & Skucy, 1969). Lieving and Lattal (2003, Experiment 3) assessed if response-independent reinforcer delivery would produce resurgence. They first reinforced key pecking of pigeons according to a VI 30-s schedule. Next, key pecking was placed on EXT, and treadle pressing was reinforced according to a VI 30-s schedule. During the resurgence phase, the dependency between treadle pressing and reinforcer delivery was broken by implementing variable-time (VT) 30-s reinforcer delivery. During VT schedules, the reinforcer is delivered independently of responding after varying durations of time have passed (Ferster & Skinner, 1957). Resurgence of key pecking did not occur, and the treadle pressing was maintained, albeit at lower rates, during the VT schedule. Lieving and Lattal then implemented traditional EXT, during which key pecking resurged and treadle pressing decreased. Next, the procedure was repeated with VI and VT 120-s schedules to reduce the likelihood of adventitious reinforcement of treadle pressing during the VT condition. Lieving and Lattal found consistent results with the VT 120-s schedule; resurgence of key pecking did not occur, and treadle pressing was maintained. If generalizable to humans, then time-based reinforcement schedules may prevent resurgence of problem behavior and maintain appropriate behavior during EXT.

The use of time-based reinforcement schedules to prevent resurgence of problem behavior and maintain appropriate behavior has not been directly assessed with humans.

Fixed-time (FT) schedules - in which the reinforcer is delivered after a fixed interval of time, independently of responding (Ferster & Skinner, 1957) - typically reduce problem behavior (e.g., Austin & Soeda, 2008; O'Callaghan, Allen, Powell, & Salama, 2006; Rasmussen & O'Neill, 2006; Vollmer et al. 1993; Vollmer, Marcus, & Ringdahl, 1995). Fixed-time schedules also have maintained high and stable rates of in-seat behavior and compliance, and reduced rates of destructive behavior in a classroom setting (Roane, Fisher, & Sgro, 2001). Thus, it seems plausible that FT schedules may prevent resurgence of problem behavior and maintain appropriate behavior following DRA in treatment contexts. Further, time-based reinforcement procedures, such as FT schedules, may be easier to for caregivers implement than differential-reinforcement procedures, such as DRA (Vollmer, Iwata, Zarcone, Smith, & Mazaleski, 1993). Whereas differential-reinforcement procedures require vigilance by the treatment agent to determine if the target behavior has occurred, time-based procedures involve response-independent delivery of the reinforcer (Vollmer et al., 1993).

When FT schedules are used to reduce problem behavior, they are typically first implemented with a dense reinforcement schedule, often continuous or near-continuous access to the reinforcer. This is followed by gradually thinning the schedule until the value is appropriate for applied settings, such as FT 5 min or FT 10 min (Carr et al., 2000; Vollmer et al., 1998). If an FT schedule initially were implemented at a 5-min or 10-min value, it is possible that the schedule could be too lean to reduce problem behavior, which may explain why initially dense or continuous schedules are more common. Initially lean FT schedules, however, may reduce problem behavior if they are yoked to previous response rates.

Initially lean FT schedules that were yoked to mean interresponse times during baseline sessions (Kahng, Iwata, DeLeon, & Wallace, 2000), or mean latencies to the first instance of problem behavior during baseline sessions (Waller & Higbee, 2010) or functional-analysis sessions (Lalli, Casey, & Kates, 1997) have suppressed problem behavior. For example, Kahng et al. (2000) compared arbitrarily chosen and yoked FT values on self-injurious behavior (SIB) maintained by positive reinforcement. The arbitrarily chosen FT schedule initially was programmed at 10 s, which resulted in 6 reinforcers per minute. If SIB occurred at or below 0.5 responses per minute during a session, the FT schedule was thinned the following session. The schedule initially was thinned by removing one reinforcer per minute, until a value of FT 1 min, or 1 reinforcer per min was obtained. Following this value, subsequent thinning proceeded by adding 1 min to the FT interval, until a terminal value of FT 5 min, or 0.2 reinforcers per min was obtained. The yoked FT schedule initially was yoked to baseline interresponse times (IRTs), and was thinned based on IRTs during subsequent treatment sessions. Both FT schedules reduced rates of SIB, but the yoked FT schedule required fewer sessions to meet the terminal value of 5 min. Lalli et al. (1997) programmed initial FT values to the mean latency to the first instance of problem behavior during functional-analysis sessions, and found that FT schedules reduced severe aggression and SIB maintained by access to tangible items or activities. Waller and Higbee (2010) programmed initial FT values to the mean latency to the first disruptive behavior during baseline sessions, and found that FT schedules reduced escape-maintained disruption and increased appropriate academic behavior. Taken together, these results indicate that yoked FT schedules may

reduce problem behavior, and initial FT values need not include continuous or near-continuous access to the reinforcer.

Other research suggests that yoked FT schedules may maintain responding. For instance, Ringdahl, Vollmer, Borrero, and Connell (2001) found FT schedule values that yielded reinforcement rates similar to the previous FR 1 schedule did not reduce response rates as much as FT schedule values that were dissimilar to previous reinforcer rates. Dozier et al. (2001) assessed the efficacy of FT schedules at maintaining responses previously reinforced according to a variable-ratio (VR) 3 schedule (reinforcers are delivered after a number of responses, which vary around the mean schedule value). Dozier et al. assessed three values of FT schedules: yoked, rich, and lean. During yoked FT schedules, the value was the mean interreinforcer interval obtained during the VR 3 schedule. During rich FT schedules, the value of the yoked FT schedule was doubled. During the lean FT schedules, the value of the yoked FT schedule was halved. Response rates decreased during exposure to the rich FT schedules. Both yoked FT and lean FT schedules maintained response rates that were similar to responding during the VR 3 schedule. The results obtained by Ringdahl et al. and Dozier et al. indicate that FT schedules may maintain previously reinforced responding under certain conditions. Both studies used arbitrary (nonclinical) responses; thus, the generality of these findings to treatment application remains unknown.

Given the applied FT research, and Lieving and Lattal's (2003) findings with pigeons, it seems plausible that FT schedules yoked to DRA reinforcement rates could be an effective intervention to maintain appropriate responding established with a DRA, and prevent resurgence of problem behavior with humans.

Statement of the Problem

Differential reinforcement of alternative behavior is a common and effective behavioral intervention. During a typical DRA procedure, an appropriate alternative response is reinforced, while the problem behavior is placed on EXT (e.g., Vollmer & Iwata, 1992). Although DRA can be effective when implemented consistently, Wickstrom et al. (1998) found that teachers tend to implement behavioral interventions, including DRA, with an average of 4% integrity. In other words, teachers provided programmed consequences once per every 20 opportunities. Therefore, it seems unlikely that the integrity with which caregivers implement treatments is 100%.

As Volkert et al. (2009) reported, DRA interventions implemented with reduced treatment integrity may be analogous to the typical resurgence procedure. Problem behavior (Behavior A) is first reinforced. Next, DRA is implemented, during which the problem behavior (Behavior A) is placed on EXT, and an alternative response (Behavior B) is reinforced. Later, if the alternative response is not consistently reinforced, as is the case with reduced treatment integrity, both responses contact EXT. Brief periods of EXT are sufficient to cause resurgence of Behavior A and a reduction of Behavior B (Lieving & Lattal, 2003; Volkert et al., 2009). If resurgence occurs during inappropriate treatment implementation, it is possible that caregivers may conclude that the intervention is not working, and stop implementing it altogether.

The extent to which time-based schedules would prevent resurgence in a treatment context is currently unclear. If the results obtained by Lieving and Lattal (2003) are generalizable, then a time-based reinforcement schedule could be a useful intervention to prevent resurgence of problem behavior and maintain appropriate

responding following DRA implementation, particularly when continued use of the DRA would be difficult because of the level of monitoring required to accurately implement the intervention. The current study examined the effects of a time-based schedule on resurgence of problem behavior and maintenance of appropriate requesting with children.

Method

Participants

Four participants were recruited through local schools. Michelle was a 6-year-old female diagnosed with Oppositional Defiant Disorder, Attention-Deficit/Hyperactivity Disorder, and Bipolar Disorder. Michelle's problem behavior was inappropriate vocalizations. Ben was a 7-year-old male diagnosed with Attention-Deficit/Hyperactivity Disorder and Adjustment Disorder. Ben's problem behavior included inappropriate vocalizations, disruption, and aggression. Matthew was a 10-year-old male diagnosed with moderate mental retardation. Matthew's problem behavior included inappropriate vocalizations, disruption, and aggression. Chris was a 5-year-old male diagnosed with autism. Chris's problem behavior was inappropriate vocalizations.

Parents of participants were asked to sign a consent form, and participants aged 7 years and older who did not have severe cognitive impairment were asked for assent (only Ben met this criterion). Topographies of appropriate and problem behavior were identified by participant's caregivers during consent process, and are discussed in the Data Collection and Analysis section below.

Setting and Materials

Sessions were conducted in a local elementary school. The session area was relatively barren, and contained only a countertop, two chairs, and materials necessary for

the sessions. Necessary materials depended on the experimental condition and the reinforcers identified during the functional analysis, and included academic materials, such as worksheets and writing utensils, or tangible items, such as toys or games.

Procedure

All sessions, except DRA-training sessions, were 5 min in duration. DRA-training sessions (described below) were up to 10 min in duration. Two to 16 sessions were conducted in a block, 2 to 5 days per week. During intersession intervals, the experimenter stood in the doorway with her back towards the participant. Data were collected on appropriate behavior and problem behavior throughout the study.

Functional analysis. A multielement functional analysis was conducted with each participant, similar to the methods described by Iwata, Dorsey, Slifer, Bauman, and Richman (1994). The functional analysis included attention, tangible, escape, ignore, and play conditions. The therapist wore a colored t-shirt to signal which condition was in effect. Red, blue, green, pink and gray t-shirts were used. For each participant, a color was randomly assigned to each condition before the start of the functional analysis, and remained the same for that condition throughout the experiment.

An attention condition was used to determine if attention served as a reinforcer for problem behavior. During the attention condition, the experimenter remained in the session room with the participant, and pretended to complete work while ignoring the participant. Chris and Ben had access to low-preferred leisure items. Matthew and Michelle did not have access to leisure items because classroom observations indicated that access to leisure items potentially could reduce the value of attention as a reinforcer. The experimenter provided 30 s of attention after each instance of problem behavior in

the form of reprimands and statements of concern, such as “don’t do that; you’re going to hurt yourself.” No demands were given during the attention condition.

A tangible condition was used to determine if access to preferred items served as a reinforcer for problem behavior. The participant had free access to a preferred item for approximately 60 s prior to the start of the session. The experimenter removed the item at the start of the session, but kept it in view of the participant. If the participant engaged in problem behavior, the item was returned to the participant for 30 s. The experimenter provided continuous attention to the participant throughout the tangible condition, and no demands were presented.

An escape condition was used to determine if escape from demands served as a reinforcer for problem behavior. During the escape condition, the experimenter presented the participant with academic demands using a three-prompt sequence. Demands were similar to those the children experienced in their natural environments, and were selected based on conversations with the children’s teachers. The prompts were given at 10-s intervals. The first prompt was a vocal demand to complete the task, such as “write *cat*”. The second prompt was a model, such as “write *cat* like this,” while the experimenter wrote the word. The experimenter provided a brief praise statement, such as “good job” for compliance within 10 s of a vocal or modeled prompt, and immediately presented the next demand by delivering another vocal prompt. If the participant did not comply after the vocal or model prompts, the third prompt consisted of hand-over-hand guidance to complete the demand, such as “write *cat* like this,” while the experimenter guided the participant’s hand to write. Problem behavior at any point in the demand

sequence resulted in a 30-s break from demands, during which the experimenter removed the academic materials and turned away from the participant.

An ignore condition was used to assess if the participant's behavior was maintained independently of social consequences. An ignore condition was only conducted if caregiver report or observations of the child suggested that problem behavior might be maintained by automatic reinforcement, and the topography of the response could be safely ignored. During the ignore condition, the participant was in a room with a therapist, without access to tangible items, and no social consequences were provided. The therapist stood or sat in a corner of the room and did not attend to the child.

A play condition was used as a control to assess the participant's behavior during an enriched environment. During the play condition, the participant had continuous access to high-preferred leisure items and continuous attention in the form of child-directed play. No demands were presented to the participant during the play condition.

The session order within the functional analysis was randomized without replacement for each participant, and included at least three sessions of each condition. Functional-analysis sessions were conducted until a function of problem behavior was determined. Visual inspection of graphed rates of problem behavior was used to determine the function of the behavior. The function was determined by comparing the rates of problem behavior during the attention, escape, tangible, and ignore conditions with rates of problem behavior during the control (play) condition. Any condition that produced consistently higher rates of problem behavior than the control condition was considered a function of the behavior. If a clear socially mediated positive function was

not identified, then the participant would have been excluded from the remainder of the study, but this did not occur.

Reinforcer assessment. If the functional analysis indicated that both access to tangible items and attention served as reinforcers, a concurrent free-operant reinforcer assessment was conducted, similar to methods described by Dozier et al. (2007). This reinforcer assessment was used to determine to which reinforcer the participant would allocate more time when given the opportunity to choose. The session room was divided in half with masking tape on the floor. Tangible items (toys or computer games) were present in one half of the room, and the therapist was seated in the other half of the room. Prior to the first session, the experimenter explained that the participant was free to move around the room throughout the session. She also explained that if the participant's entire body was on the tangible side, then toys were available for solitary play, and the therapist would not talk or play. If the participant's entire body was on the attention side, then the therapist would talk and play, but no toys were allowed on that side of the room. If any part of the participant's body touched the tape (i.e. body was on both sides of the room) then the participant did not have access to toys or therapist interaction. The therapist then prompted the participant to stand on the tangible side, the attention side, and the tape one time each to demonstrate the contingencies prior to the first session. The participant was prompted to stand on the tape (i.e. in between both sides of the room) at the start of each session, and was directed to choose an area after the experimenter said, "three, two, one, go." The experimenter collected duration data on the amount of time the participant spent on each side of the room. The reinforcer assessment continued until the participant displayed a clear preference for one side of the room across three consecutive sessions.

The reinforcer delivered on the side of the room to which the participant allocated the most time was used as the reinforcer during the resurgence evaluation.

Multiple stimulus without replacement preference assessment. If access to tangible items was the reinforcer identified during the functional analysis or reinforcer assessment, then a multiple stimulus without replacement (MSWO) preference assessment (DeLeon & Iwata, 1996) was conducted prior to the first resurgence-evaluation session (described below) of the day. During the MSWO, the therapist presented a variety of tangible items to the participant simultaneously, and delivered the instruction “pick one.” Attempts to choose more than one item were blocked. The item that was selected was then removed, and the remaining items were re-presented to the participant with the instruction. This process continued until the child chose between one and three objects, which were used as reinforcers during the resurgence-evaluation sessions.

Resurgence evaluation. The evaluation of resurgence consisted of five conditions: baseline, DRA training, DRA, FT, and EXT. The baseline condition was identical to the functional-analysis condition in which the identified reinforcer was used, either attention or tangible. The identified reinforcer was delivered for 30 s on an FR 1 schedule for problem behavior. Appropriate requests resulted in no programmed consequences. To prevent adventitious reinforcement of appropriate requests, 5-s change-over delay (COD) was in effect such that problem behavior that occurred within 5 s of an appropriate request resulted in no programmed consequences. Rates of appropriate requests and problem behavior were graphed. Baseline continued for at least

five sessions, and until problem behavior occurred at a steady-state or increasing trend for three consecutive sessions, determined by visual inspection of graphed rates of behavior.

An appropriate request was taught during the DRA-training condition. The training sessions consisted of up to ten 1-min trials. A three-prompt sequence similar to the sequence used by Bourret, Vollmer, and Rapp (2004) was used. A nonspecific prompt (“if you want this, ask me for it”) was given 10 s after the onset of the trial. A specific and modeled prompt (“if you want to play, say *play, please*”) was given 20 s after the onset of the trial. If the participant spoke the target response at any point, prompts ceased, and access to the reinforcer was given for the remainder of the trial. If a participant did not vocalize target response, a specific phoneme prompt (“if you want to play, say *pl*”) was given 30 s after the onset of the trial. If the participant said the full target or the phoneme after this prompt, access to the reinforcer was given for the remainder of the trial. Each training session continued for 10 min or until the participant vocalized the target response independently three consecutive times during one session.

During the DRA condition, problem behavior was placed on EXT, and appropriate requests were reinforced according to an FR 1 schedule. To prevent adventitious reinforcement of problem behavior, 5-s COD was in effect such that appropriate requests that occurred within 5 s of a problem behavior resulted in no programmed consequences. Appropriate requests were not prompted during DRA sessions. One prompt “remember, if you want (the reinforcer), you just have to ask for it” was given prior to the first DRA session following an EXT or baseline-reversal phase, with two exceptions. For Matthew, the prompt was also given prior to the first session of the first DRA phase (following DRA training). For Ben, the prompt was given prior to

the second session (not the first session) of the third DRA phase, and prior to any session in which an appropriate request did not occur in the previous session.

The DRA condition continued for at least five sessions and until three criteria were met. First, rates of problem behavior were reduced by at least 80% of the average of the final three baseline sessions for three consecutive sessions. Second, rates of appropriate behavior exceeded rates of problem behavior. Third, appropriate requests occurred at a steady-state or increasing trend for three consecutive sessions, determined by visual inspection of graphed rates of behavior.

The term “alternative resurgence” is used to describe the FT condition because EXT was implemented by removing the response-reinforcer dependency, rather than withholding the reinforcer (“traditional” EXT). During this condition, both problem behavior and appropriate requests were placed on EXT, and the reinforcer was delivered on a yoked FT schedule. The value of the FT schedule was equated to the mean time between reinforcer deliveries (interreinforcement interval, or IRI) during the final three sessions of the preceding DRA phase. This calculation yielded an FT 1-s schedule for Ben, Matthew, and Chris, and an FT 2-s schedule for Michelle. The reinforcer was delivered independently of the participant’s behavior. This condition continued for at least five sessions, and until steady-state responding was achieved for three consecutive sessions, determined by visual inspection of graphed rates of behavior.

The term “traditional resurgence” is used to describe the EXT condition because EXT is typically used in traditional resurgence procedures. This condition consisted of EXT for both problem behavior and appropriate requests. During this condition, the

reinforcer was not provided. This condition continued for at least five sessions, and until steady-state responding was achieved, as determined by visual inspection of the graphs.

All participants began with the initial sequence of baseline, DRA-training, and DRA. Extinction and FT were counterbalanced across participants to control for potential sequence effects. For Michelle and Ben, the initial sequence was followed by FT, EXT, and DRA. Because problem behavior occurred during two sessions of Ben's FT phase, we implemented an additional DRA phase before EXT. For Matthew and Chris, the initial sequence was followed by EXT, DRA, FT, and DRA.

It is possible that resurgence of problem behavior during the second resurgence phase, either FT or EXT, was reduced by the temporal distance from the baseline phase, in which problem behavior was reinforced. Therefore, the entire sequence of baseline, DRA, and the second resurgence phase presented (EXT for Ben, FT for Matthew and Chris) was repeated to analyze the effects of the temporal proximity to baseline on resurgence of problem behavior. This sequence was not repeated for Michelle because her problem behavior resurged at high rates during the second resurgence phase (EXT).

The experiment concluded with a DRA phase for Michelle and Ben, and an FT phase for Matthew and Chris. The final phase continued for at least five sessions, and until three criteria were met. First, rates of problem behavior were reduced by at least 80% of the average of the final three baseline sessions for three consecutive sessions. Second, steady-state responding or an increasing trend in appropriate requests occurred for three consecutive sessions, as determined by visual inspection of the graphed rates of behavior. Third, rates of appropriate behavior exceeded rates of problem behavior.

Data collection and analysis. Data were collected by trained observers using computers and a real-time data collection program, InstantData v1.1 for PC. One or two observers collected data during each session. Observers collected frequency data on appropriate requests, which were defined as asking for attention or a tangible item with a normal conversational volume and tone, using a question or the word “please.” Observers also collected frequency data on problem behavior, which included inappropriate vocalizations, disruption, or aggression. Operational definitions of problem behavior are listed in Table 1.

Observers collected frequency data on therapist demands. Demands were defined as anything the therapist asked the participant to do, including questions or academic tasks. A modeled prompt was defined as the therapist showing the participant how to complete the demand; for example, saying “write *cat* like this,” while writing the word. A physical prompt was defined as the therapist using hand-over-hand guidance to obtain compliance from the participant; for example, saying “write *cat* like this,” while guiding the participant’s hand to write the word.

Duration data were collected on attention from therapist, break from demands, and access to leisure items. Attention was defined as the therapist talking to the participant, physically attending to the participant, or making eye contact with the participant. Break from demands was defined as the removal of work materials or demands for more than 15 s or had an immediate onset when the therapist said “take a break.” Access to leisure items was defined as having leisure items present in the therapy room and accessible by the participant. During the reinforcer assessment, duration data were also collected the side of the room that participant’s body was on, including the

tangible side or the attention side. The participant's entire body had to be on one side of the room, with no part of the body touching the masking tape that divided the room. These data were used to assess the therapist's delivery of reinforcers and treatment integrity.

Treatment integrity. Treatment integrity during the functional analysis and resurgence analysis was calculated by dividing the number of correct therapist responses (defined as appropriately delivering or withholding the reinforcer within 3 s of the response or programmed interval) by the number of opportunities to respond. For example, treatment integrity was 100% if the therapist attended to the participant within 3 s of each instance of problem behavior during the attention condition of the functional analysis. Treatment integrity during the reinforcer assessment was calculated by dividing the number of instances that the participant did not have access to the incorrect reinforcer given his or her location in the room, by the number of instances the participant entered that side of the room. For example, if the participant entered the tangible side of the room four times, and the therapist provided attention during one of those times, then treatment integrity would be 3 divided by 4, or 75%. Treatment integrity data for the functional analysis, reinforcer assessment, and resurgence analysis are presented in Table 2.

Interobserver agreement. Two trained independent observers collected data for interobserver agreement (IOA). Interobserver agreement was calculated using a block-per-block method (Mudford, Taylor, & Martin, 2009), and was calculated separately for each target behavior. To calculate IOA, each session was divided into 10-s intervals. The percent agreement for each behavior within each interval was calculated by dividing

the smaller number or duration of events scored by the larger number or duration of events scored, and multiplying by 100. For example, if Observer A scored three appropriate requests and two instances of disruption during a 10-s interval, and Observer B scored one appropriate request and four instances of disruption during the same interval, the IOA score for appropriate requests would be 1 divided by 3, and multiplied by 100, or 33%. The IOA score for disruption would be 2 divided by 4, and multiplied by 100, or 50%. The IOA scores for each target response during each 10-s interval were summed and divided by the total number of intervals to obtain a mean IOA score for each target behavior for the entire session. For Michelle, IOA was calculated for 31% of functional-analysis sessions, and averaged 98% (range: 84%-100%), 43% of preference-assessment sessions, and averaged 98% (range: 94%-100%), and 31% of resurgence-evaluation sessions, and averaged 99% (range: 88%-100%). For Ben, IOA was calculated for 30% of functional-analysis sessions, and averaged 99% (range: 86%-100%), and 31% of resurgence-evaluation sessions, and averaged 99% (range: 84%-100%). For Matthew, IOA was calculated for 30% of functional-analysis sessions, and averaged 99% (range: 83%-100%), 33% of preference-assessment sessions, and averaged 98% (range: 97%-98%), and 34% of resurgence-evaluation sessions, and averaged 99% (range: 81%-100%). For Chris, IOA was calculated for 31% of functional-analysis sessions, and averaged 97% (range: 84%-100%), 33% of preference-assessment sessions, and averaged 97% (range: 95%-99%), and 32% of resurgence-evaluation sessions, and averaged 98% (range: 80%-100%).

Results

Functional Analysis and Reinforcer Assessment

The functional-analysis and reinforcer-assessment results are displayed in Figure 1. Ben's functional-analysis results are displayed in the first column of Figure 1. Ben engaged in high rates of the target responses during the escape condition ($M = 0.5$ responses per minute) and the attention condition ($M = 0.2$ responses per minute). Thus, attention and escape were identified as reinforcers. Because only one socially mediated positive reinforcer was identified during the functional analysis, a reinforcer assessment was not conducted. Attention was the reinforcer used during the resurgence evaluation.

Michelle's functional-analysis results are displayed in the second column of Figure 1, in the upper row. During the functional analysis, Michelle's rate of inappropriate vocalizations was consistently high during the tangible condition ($M = 1.8$ responses per minute). She also engaged in high rates of inappropriate vocalizations during the escape ($M = 0.8$ responses per minute) and attention conditions ($M = 0.5$ responses per minute). Thus, access to tangible items, attention, and escape were identified as reinforcers. Because two socially mediated positive reinforcers were identified during the functional analysis, a reinforcer assessment was conducted to determine if Michelle would allocate more time towards attention or access to tangible items. Michelle's reinforcer-assessment results are displayed in the second column of Figure 1, in the lower row. Michelle allocated more time towards the attention side of the room ($M = 81\%$) than the tangible side of the room ($M = 15\%$). Thus, attention was used as the reinforcer during the resurgence evaluation.

Chris's functional-analysis results are displayed in the third column of Figure 1, in the upper row. Chris's rate of inappropriate vocalizations was consistently high during the tangible condition ($M = 1.7$ responses per minute). Chris also engaged in elevated

rates of inappropriate vocalizations during the escape ($M = 0.5$ responses per minute) and attention conditions ($M = 0.4$ responses per minute). Thus, access to tangibles, escape, and attention were identified as reinforcers. Because two socially mediated positive reinforcers were identified, a reinforcer assessment was conducted. Chris's reinforcer-assessment results are displayed in the third column of Figure 1, in the lower row. Chris allocated more time towards the tangible side of the room ($M = 82\%$) than the attention side of the room ($M = 6\%$). Thus, access to tangible items was used as the reinforcer during the resurgence evaluation.

Matthew's functional-analysis results are displayed in the fourth column of Figure 1, in the upper row. The ignore condition of the functional analysis was discontinued after two sessions due to inappropriate sexual behavior that could not be ignored. Matthew engaged in high rates of the target responses during the tangible condition ($M = 0.9$ responses per minute), the attention condition ($M = 0.8$ responses per minute), and the escape condition ($M = 0.7$ responses per minute). Thus, access to tangible items, attention, and escape were identified as reinforcers. Because two socially mediated positive reinforcers were identified, a reinforcer assessment was conducted. Matthew's reinforcer-assessment results are displayed in the fourth column of Figure 1, in the lower row. During the reinforcer assessment, Matthew allocated more time towards the tangible side of the room ($M = 96\%$) than the attention side of the room ($M = 4\%$). Thus, access to tangibles was used as the reinforcer during the resurgence evaluation.

Resurgence Evaluation

Rates of problem behavior and appropriate requests during the resurgence evaluation are displayed in Figure 2. For all participants, rates of problem behavior were

high and rates of appropriate requests were low during baseline. Rates of problem behavior were low and rates of appropriate requests were high during DRA, with the exception of Matthew's second DRA phase (lower-right graph of Figure 2). During this phase, Matthew engaged in increasingly high rates of problem behavior. When new computer games were added to the MSWO prior to session 38, rates of problem behavior decreased and remained low throughout the remainder of the phase. This change is denoted by a dotted vertical line on Figure 2.

Resurgence was defined as a rate of problem behavior during any session of a resurgence phase (EXT or FT) that was higher than the rate of problem behavior during the any of the final five sessions of the previous DRA phase. Resurgence of problem behavior occurred with all participants during at least one EXT phase. Notable resurgence occurred for Michelle, Ben, and Chris, who engaged in rates of problem behavior during at least one session of EXT that were comparable to or greater than baseline response rates. For Ben (upper-right graph of Figure 2), problem behavior did not resurge during the first EXT phase, but did resurge during the second EXT phase following a reversal of baseline and DRA. For all participants, appropriate requests decreased during EXT.

During FT, resurgence of problem behavior did not occur with Michelle, Ben, or Matthew. According to the operational definition, resurgence occurred with Chris; however, one instance of problem behavior throughout an FT phase typically would not be considered resurgence. In the basic literature, resurgence of the target response typically occurs within the first few sessions of the phase, and tapers throughout the phase (e.g., da Silva, Maxwell, & Lattal, 2008; Lieving & Lattal, 2003; Rawson,

Leitenberg, Mulick, Lefebvre, 1977). Thus, the operational definition used in the present experiment, and the slight increase in Chris' problem behavior during session 29, did not capture the characteristic pattern of resurgence.

For all participants, rates of problem behavior during FT were less than or comparable to rates observed during DRA, and were markedly less than rates observed during EXT. Michelle's highest rate of problem behavior during an FT session was .2 responses per minute, compared to 3.8 responses per minute during an EXT session. Ben's highest rate of problem behavior 0.4 responses per minute during an FT session, compared to 1.4 responses per minute during an EXT session. Chris's highest rate of problem behavior during an FT session was 0.2 responses per minute, compared to 4.8 responses per minute during EXT session. Matthew's highest rate of problem behavior during an FT session was 0 responses per minute, compared to 1.2 responses per minute during EXT session. For all participants, appropriate requests continued during the FT phases, but for Michelle, Matthew, and Chris, rates became more variable.

Discussion

The present experiment replicated Lieving and Lattal's (2003, Experiment 3) finding that response-independent reinforcer delivery following DRA prevented resurgence of the previously reinforced response, and maintained the alternative response. In the present experiment, EXT produced resurgence of problem behavior and decreased appropriate responding for all participants. Fixed-time reinforcer delivery yoked to DRA reinforcement rates did not produce resurgence, and maintained appropriate responding. Rates of appropriate responding, however, were generally more

variable than during DRA. Thus, the generality of Lieving and Lattal's finding was extended to humans in a treatment context.

One limitation of the present experiment was the operational definition of resurgence, which was a rate of problem behavior during any session of a resurgence phase (EXT or FT) that exceeded the rate of problem behavior during any of the final five sessions of the previous DRA phase. Based on this definition, Chris' problem behavior resurged when he engaged in one instance of problem behavior during an entire FT phase because he engaged in 0 instances of problem behavior during the final five sessions of the previous DRA phase. The degree to which minimal reemergence of a previously reinforced response constitutes resurgence - as opposed to another phenomenon, such as extinction-induced variability - remains unclear because there is no consistent operational definition of resurgence in the literature. Lieving and Lattal (2003, Experiment 1) defined resurgence as the number of key pecks, or previously reinforced responses, per extinction session. Although low rates of key pecking occurred during some sessions of VT reinforcer delivery (Experiment 3), the rate of pecking was comparable with that observed during DRA, and was not considered resurgence. Volkert and colleagues (2009) defined resurgence as a rate of problem behavior during a resurgence-evaluation session that exceeded rates observed during FCT-maintenance sessions. Lieving et al. (2004) did not provide an operational definition of resurgence, but appeared to define it as any occurrence of the previously reinforced behavior. Bruzek and colleagues (2009) included a control response that was never reinforced during their resurgence evaluation. They operationalized resurgence a rate of behavior during a resurgence session that was higher than the rate of the control response in the same session.

As demonstrated by the few examples provided, a consistent operational definition of resurgence has not been established, particularly in applied resurgence evaluations. Defining resurgence as any reemergence of the previously reinforced response seems too broad of a definition, particularly if low rates of the previously reinforced response also occur during DRA. Comparing rates of the previously reinforced response to those of a control response that is never reinforced may be acceptable for basic or human operant evaluations of resurgence. This definition, however, is limited in applied evaluations because one can never know the extra-experimental reinforcement history for the “control” response. For instance, Lieving and colleagues (2004) demonstrated resurgence of response-class hierarchies. The “control” response could be part of a response-class hierarchy that resurges when early responses in the hierarchy are placed on EXT.

Volkert and colleagues’ (2009) definition of resurgence as a rate of problem behavior during a resurgence-evaluation session that is higher than rates observed during steady-state FCT (or DRA) responding, seems to be the most appropriate for applied evaluations. Importantly, an acceptable number of DRA sessions must be included for this definition to capture the characteristic pattern of resurgence, as demonstrated by Chris in the present experiment. The operational definition of resurgence used in the present experiment only included the final five sessions of DRA. The limitations of including so few sessions are highlighted by Chris’s one instance of problem behavior during FT meeting the definition of “resurgence.” Thus, to define resurgence by comparing rates of the previously reinforced response during a resurgence-evaluation

session to those observed during DRA, an appropriate number of DRA sessions with steady state responding must be included.

The extent to which recency of reinforcement for behavior affects resurgence of that behavior remains largely unknown. In the present experiment, Ben's problem behavior did not resurge during the first EXT phase, but did resurge during the second EXT phase. This differential resurgence may have been influenced by the duration of time since problem behavior had been reinforced (baseline). The first EXT phase followed BL, DRA, FT, and DRA. The second EXT phase followed BL and DRA. It is possible that problem behavior did not resurge during the first EXT phase because that phase was too temporally distant from baseline, and did resurge during the second EXT phase because it was temporally closer to a baseline. Previous evaluations of recency on resurgence have yielded inconsistent results. Leitenberg, Rawson, and Mulick (1975, Exp. 4) found less resurgence of the target response during EXT when the alternative response was reinforced for 27 days than when the alternative response was reinforced for 3 days or 9 days. Lieving and Lattal (2003, Experiment 1) varied the duration of a DRA phase in which treadle presses were reinforced for either 5 days or 30 days, and found that recency of reinforcement did not differentially effect resurgence of key pecking. Bruzek and colleagues (2009) found that infant caregiving responses with a longer and more temporally distant reinforcement history were more likely to resurge than responses that were more recently reinforced, but the isolated effects of recency could not be determined because temporal distance and duration of reinforcement history were confounded. Future research should evaluate the effects of recency of reinforcement history on resurgence of problem behavior in treatment contexts by

manipulating the number of sessions in which the alternative response is reinforced during DRA. If responses with a more temporally distant history are less likely to resurge, then EXT may not result in resurgence of problem behavior when it follows a lengthy DRA phase.

In the current experiment, yoked FT reinforcer delivery prevented resurgence of problem behavior and maintained appropriate requesting. The present results extend the generality of findings by Ringdahl et al. (2001) and Dozier et al. (2001) from maintenance of arbitrary responses to maintenance of appropriate responses in a treatment context. This finding is important because reduction of problem behavior does not necessarily lead to maintenance of appropriate responding. Intuitively, it seems unlikely that responding would maintain during yoked FT reinforcer delivery because all responses were placed on EXT. Results of the current experiment, however, suggest that yoked FT reinforcer delivery on a dense schedule may be a useful treatment because these schedules simultaneously maintain appropriate requesting and reduce problem behavior.

When FT schedules are used to reduce problem behavior, they are typically first implemented with a very dense reinforcement schedule, which is gradually thinned to a value that is more appropriate for applied settings (Carr et al., 2000; Vollmer et al., 1998). This procedure has resulted in problem behavior reduction (Hagopian, Fisher, & Legacy, 1994; Hagopian, LeBlanc, & Maglieri, 2000; O'Callaghan et al., 2006; Vollmer et al., 1993; Vollmer et al., 1995; Vollmer et al., 1998). Although the present experiment found that yoked FT schedules failed to induce resurgence of problem behavior, it is unknown if resurgence would occur if the schedule values were systematically thinned.

A limitation of the present experiment is that the programmed yoked FT schedules ranged from 1 s to 2 s, and were not thinned to a value that would be manageable in a classroom. Future research should evaluate if initially dense and gradually thinned FT schedules would produce resurgence of problem behavior.

Time-based schedules are sometimes conceptualized as a form of EXT because they break the response-reinforcer dependency (e.g., Catania, 1969; Rescorla & Skucy, 1969). The present experiment demonstrated that the two procedures produce different behavioral outcomes. Specifically, EXT produced resurgence of a previously reinforced response, and FT schedules did not produce resurgence. Vollmer et al. (1998) compared the relative effects of FT schedules and EXT on severe problem behavior using a multielement experimental design. Although they did not assess resurgence of problem behavior, Vollmer and colleagues found that FT schedules resulted in lower rates of problem behavior than EXT, and did not produce the initial bursts of problem behavior that were observed during EXT. Our results extend those of Vollmer and colleagues by showing when an alternative source of reinforcement is withdrawn, FT schedules produce lower rates of previously reinforced problem behavior than EXT.

The behavioral mechanisms that underlie the reductive effect of FT schedules on problem behavior remain unknown. Time-based schedules could exert their effects through breaking the response-reinforcer dependency (i.e. EXT), satiation from continued reinforcer delivery, or reinforcement of responses that temporarily displace the problem behavior (e.g., Carr et al., 2000). For example, FT attention delivery could reduce attention-maintained disruption via EXT because disruption no longer produces attention, via satiation from regularly scheduled attention delivery, or via reinforcement of an

alternative behavior (like conversation) during attention delivery. Satiation requires adequate rates of reinforcer delivery; EXT requires that the behavior occurs without reinforcement. Vollmer et al. (1993) proposed that dense time-based schedules may reduce problem behavior via satiation, but lean schedules may reduce behavior via EXT. In the present study, it is likely that yoked FT schedules reduced problem behavior as a result of satiation rather than EXT. The programmed FT schedule values ranged from 1 s to 2 s, resulting in dense reinforcer delivery, and near continuous access to the reinforcer. Further, the low rates of problem behavior that occurred during FT make it unlikely that problem behavior contacted EXT.

The reliable finding that FT schedules reduce problem behavior supports their use as a clinical intervention. The present experiment found that FT schedules yoked to DRA reinforcement rates did not induce resurgence of problem behavior, and maintained appropriate responding. Fixed-time schedules may be easier to implement than DRA because the reinforcer is delivered independently of responding, making it unnecessary to constantly monitor the individual's behavior (Vollmer et al., 1993). It is possible that the relative ease of FT interventions could result in higher levels of consistent caregiver implementation than those observed with DRA. Thus, a brief consistently implemented DRA could be used to teach an appropriate alternative response in a clinical setting. Once the appropriate response is acquired, an FT schedule could replace the DRA intervention, making it easier for caregivers to implement. Based on the current findings, FT reinforcer delivery may maintain the appropriate response, and prevent resurgence of problem behavior.

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Table 1

Operational definitions of problem behavior for each participant

Participant	Problem Behavior	Operational Definition
Chris and Ben	Inappropriate vocalization	High-pitched screaming
Michelle, Ben, Matthew	Inappropriate vocalization	Complaining about activity, whining, name calling, or cursing
Michelle	Inappropriate vocalization	Vocalizations of pain (such as ouch), or above conversational level
Ben and Matthew	Disruption	Throwing an item or spitting beyond 1 ft from a person, banging, kicking, or ripping items, climbing on, standing on, or jumping off furniture
Matthew	Disruption	Attempting to open, opening, or crawling into cabinets
Ben and Matthew	Aggression	Hitting, kicking, pinching, biting, or scratching another person, throwing an item or spitting within 1 ft of another person, or attempts

Table 2

The percent of sessions that treatment integrity was calculated, and the average and range of treatment integrity are presented. The average and range of reinforcer-interval durations during the functional analysis and resurgence analysis, and the average and range of implemented FT values during the resurgence evaluation are also presented.

	Michelle	Ben	Matthew	Chris
Functional Analysis				
Percent of sessions	31%	30%	30%	31%
Average integrity	94%	100%	100%	94%
Range integrity	80-100%			75-100%
Average (Range) SR interval	30s (29-31)	32s (28-39)	30s (28-32)	29s (28-30)
Concurrent Reinforcer Assessment				
Percent of sessions	100%	N/A	100%	100%
Average integrity	99%	N/A	100%	100%
Range integrity	93-100%	N/A		
Resurgence Analysis				
Percent of sessions	31%	30%	30%	32%
Average integrity	100%	99%	98%	99%
Range integrity		78-100%	78-100%	88-100%
Average (Range) SR interval	30s (29-32)	30s (27-32)	31s (29-36)	30s (28-33)

Figure 1. The top graphs display responses per minute of problem behavior during the functional analysis. The bottom graphs display the percent of time allocated to each side of the room during the reinforcer assessment. During each session, the percents do not

always sum to 100% because if any part of the participant's body touched the tape in the middle of the room, the participant was not considered to be on either side.

Figure 2. Responses per minute during baseline (BL), differential reinforcement of alternative behavior (DRA), fixed-time (FT), and extinction (EXT) phases of resurgence analysis. Filled circles depict problem behavior, and open circles depict appropriate

requesting. Asterisks depict delivery of a pre-session appropriate-request prompt. For Matthew, the dotted vertical line depicts new reinforcers added to the pre-session preference assessment.