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RESURGENCE DURING TREATMENT CHALLENGES

RESURGIMIENTO DE LA CONDUCTA DURANTE LOS DESAFÍOS DEL TRATAMIENTO

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Abstract

Two experiments assessed resurgence during differential reinforcement of alternative behavior (DRA) implemented with two types of treatment challenges: reduced reinforcement rate for the alternative response and discontinuation of reinforcement for the alternative response. Experiment 1 involved a human-operant preparation with three participants to compare response rates across four conditions: baseline, in which a target response was reinforced; DRA, in which the target response was placed on extinction and an alternative response was reinforced; DRA omission errors, in which some earned reinforcers were not delivered, and extinction, in which reinforcers were not delivered. Resurgence occurred during DRA omission errors and extinction; however, response rates were higher during extinction. Experiment 2 replicated the procedure and results of the first experiment, but it took place during treatment of a child diagnosed with autism and Attention Deficit/Hyperactivity Disorder.

Keywords: differential reinforcement of alternative behavior (DRA), extinction, resurgence, translational research, treatment integrity, treatment challenges

Resumen

En dos experimentos se evaluó el resurgimiento de la respuesta durante el reforzamiento diferencial de conducta alternativa (RDA) implementada con dos tipos de desafíos del tratamiento: reducción de la tasa de reforzamiento de la respuesta

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alternativa y la suspensión del reforzamiento de la respuesta alternativa. El Experimento 1 consistió en un procedimiento operante con tres sujetos humanos, en el cual se compararon las tasas de respuesta a través de cuatro condiciones: la línea base, durante la cual se reforzó una conducta blanco; una condición de RDA, durante la cual se usó un procedimiento de extinción y se reforzó una respuesta alternativa; la condición de errores de omisión conforme al RDA, en la cual algunos de los reforzadores que ganaron los participantes no se entregaron y la condición de extinción, en la cual no se entregaron los reforzadores. El resurgimiento de la conducta ocurrió durante la condición de errores de omisión conforme al RDA y durante la extinción, pero las tasas de respuesta fueron más altas durante la extinción. El procedimiento y los resultados del Experimento 1 se replicaron en el Experimento 2, pero se realizó durante el tratamiento de un niño diagnosticado con autismo y Trastorno de Déficit de la Atención/Hiperactividad (TDAH).

Palabras clave: reforzamiento diferencial de conducta alternativa (RDA), extinción, resurgimiento, investigación de puente, integridad del tratamiento, desafíos del tratamiento

Resurgence describes the reemergence of a previously reinforced behavior following the extinction of an alternative behavior. The conventional resurgence procedure has three phases (Lattal & St. Peter Pipkin, 2009). During the first, or *reinforcement,* phase, a target behavior is reinforced. During the second, or *alternative reinforcement*, phase, the target behavior is extinguished and an alternative behavior is reinforced. During the third, or *resurgence*, phase, when extinction is in effect for both the target behavior and alternative behavior, the target behavior typically reemerges. This reemergence is called "resurgence."

Although resurgence is a reliable effect using this three-phase procedure (e.g., Cleland, Foster, & Temple, 2000; Leitenberg, Rawson, & Bath, 1970; Leitenberg, Rawson, & Mulick, 1975; Mulick, Leitenberg, & Rawson, 1976; Podlesnik, Jimenez-Gomez, & Shahan, 2006), variations to each phase may produce differential resurgence. For example, Lieving and Lattal (2003, Experiment 4) varied the resurgence phase by rapidly reducing reinforcement rates for the alterative response—instead of discontinuing reinforcement (traditional extinction)—to assess the effect of local extinction (i.e., brief, intermittent periods of nonreinforcement) on resurgence. During the initial phase, pigeons' key pecking was reinforced with a variable-interval (VI) 30-s schedule. During the alternative reinforcement phase, key pecking was placed on extinction, and treadle pressing was reinforced with a VI 30-s schedule. During the *nonconventional resurgence phase*, key pecking remained on extinction, and the reinforcement schedule for treadle pressing was changed to a VI 360-s. During the *conventional resurgence* phase, all responses were placed on extinction. Resurgence of key-pecking occurred for two of three subjects when the reinforcement schedule for treadle-pressing was rapidly reduced (thinned); however, response rates were lower and more variable than those observed during extinction.

The finding that intermittent periods of nonreinforcement may be sufficient to produce resurgence could have clinical implications for the treatment of problem behavior. Differential reinforcement of alternative behavior (DRA) is a common and effective behavioral intervention in which problem behavior (i.e., previously reinforced behavior) typically is placed on extinction and an appropriate alternative behavior is reinforced (e.g., Vollmer & Iwata, 1992). Thus, a DRA intervention may be analogous to the second phase of the resurgence procedure. Although DRA is effective when implemented consistently (e.g., Carr & Durand, 1985; Tiger, Hanley, & Bruzek, 2008; Vollmer & Iwata, 1992), intermittent periods of nonreinforcement for the alternative behavior could result in resurgence of problem behavior (e.g., Lieving & Lattal, 2003, Experiment 4). In other words, if the alternative behavior is not consistently reinforced during DRA, both problem behavior and appropriate behavior would contact extinction (similar to the third phase of the resurgence procedure), and resurgence of problem behavior may result.

During DRA, intermittent nonreinforcement could result from various treatment challenges, including systematic schedule thinning for the appropriate behavior and unplanned schedule thinning as a result of omission of earned reinforcers. Unplanned schedule thinning can be considered a type of treatment integrity failure. Treatment integrity refers to the degree to which an intervention is implemented as it is designed. Several types of treatment integrity failures can occur. Of interest in the present research were omission errors, which occur when a caregiver does not deliver programmed reinforcers. Consider, for example, a DRA that includes providing attention each time a student requests "help" using sign language. If the teacher did not notice several requests because she was providing individual instruction to another student, this could result in intermittent nonreinforcement of requesting as a result of treatment integrity omission errors, and may produce resurgence of problem behavior. The most extreme case of omission errors would be complete extinction of the alternative response. In the previous example, this could occur if a substitute teacher were unaware of the DRA intervention and, therefore, did not provide attention following any requests for help. In this case, resurgence of problem behavior is likely to occur (e.g., Volkert, Lerman, Call, & Trosclair-Lasserre, 2009, Experiment 1). If resurgence occurs during treatment challenges, caregivers may conclude the intervention is not working, and stop implementing it altogether.

Few applied studies have examined the likelihood of resurgence of problem behavior during treatment challenges. In a notable exception, Volkert et al. (2009) assessed resurgence of problem behavior following a successful functional-communication-training (FCT) intervention with children diagnosed with developmental disabilities. Functional communication training is a specific example of DRA, in which the appropriate behavior is in the same response class as the problem behavior (e.g., Carr & Durand, 1985; Tiger et al., 2008). During the reinforcement phase of Volkert et al., problem behavior was reinforced according to a fixed-ratio (FR) 1 schedule (each instance of problem behavior was reinforced) and appropriate behavior produced no

programmed consequences. During the alternative reinforcement phase, an FCT intervention was implemented such that problem behavior was placed on extinction and an appropriate alternative behavior was reinforced with an FR 1 schedule. During Experiment 1, Volkert et al. implemented a traditional resurgence phase, in which both problem behavior and appropriate behavior were placed on extinction. Problem behavior resurged for two of three participants. During Experiment 2, Volkert et al. implemented a nonconventional resurgence phase (similar to the one described by Lieving & Lattal, 2003, Experiment 4), in which they rapidly reduced reinforcement rates for appropriate behavior by changing from an FR 1 to an FR 12 schedule. Problem behavior resurged for all three participants.

Hanley, Iwata, and Thompson (2001) observed increases in problem behavior during FCT when they systematically thinned an FR 1 schedule for the alternative response by adding a gradually increasing time delay between the response and reinforcer delivery, or by changing to a fixed-interval (FI) schedule, which was then gradually thinned. Although they did not explicitly target resurgence of problem behavior as an outcome, the increase in problem behavior response rates during both schedule-thinning procedures may be interpreted as resurgence.

The results of Hanley et al. (2001) and Volkert et al. (2009) suggest that treatment challenges, such as extinction of the alternative behavior, omission errors, and systematic schedule thinning of the alternative behavior may produce resurgence of problem behavior during DRA treatment. Increases in problem behavior during systematic (Hanley et al., 2001) and rapid (Volkert et al., 2009) schedule thinning were obtained across participants, response topographies, and behavioral functions (including both social-positive and social-negative functions). This consistent finding is in contrast with recent research examining the effect of treatment integrity errors during DRA. St. Peter Pipkin, Vollmer, and Sloman (2010) examined the effects of omission errors during DRA by reducing reinforcement for the alternative behavior from an FR 1—which can be conceptualized as 100% treatment integrity because each response is reinforced— to various random-ratio (RR) schedules designed to approximate 80%, 60%, 40%, and 20% treatment integrity by omitting reinforcers that would have been delivered under the FR 1 schedule (resulting in RR 1.3, RR 1.7, RR 2.5, and RR 5 schedules, respectively). Because treatment integrity is defined based on the programmed reinforcement schedule, these failures to deliver reinforcers that were programmed according to the FR 1 schedule would be considered omission errors. Although resurgence was not the focus of the experiment, low rates of problem behavior occurred during conditions in which omission errors occurred.

The low response rates obtained by St. Peter Pipkin et al. (2010) are in contrast to those obtained by Volkert et al. (2009), who rapidly changed the reinforcement schedule from FR 1 to FR 12. The magnitude of change in reinforcement schedule is one possible explanation for the discrepant findings. The change in reinforcement schedule in the study by St. Peter Pipkin et al. reduced reinforcement rates from an FR 1 to an RR 5 schedule. This reduction was lesser in both magnitude of change and predict-

ability of reinforcer delivery than the shift from an FR 1 to an FR 12. Neither experiment compared responding during reduced reinforcement rates to response rates during extinction. Another possible explanation for the discrepant findings are differences in experimental preparation. St. Peter Pipkin et al. (2010) conducted several experiments using nonclinical participants in a highly controlled laboratory situation, but the study by Volkert et al. used clinical participants in a treatment context.

The present experiment extended the results of St. Peter Pipkin et al. (2010) and Volkert et al. (2009) by directly comparing responding during reduced reinforcement rates and extinction in both controlled laboratory and treatment contexts. The purposes were twofold. Experiment 1 directly compared response rates and potential resurgence during extinction and reduced reinforcement rates (omission errors) using a human-operant procedure. Experiment 2 replicated the results of the human-operant procedure with a child diagnosed with autism and Attention Deficit/Hyperactivity Disorder, who engaged in problem behavior maintained by escape from social interaction.

Experiment 1

Method

Participants and setting. Three undergraduate students participated. Amos was a 31-year-old male. Jane and Kate were both 23-year-old females. All participants signed an informed consent prior to participation. Each received $0.14 for every 100 points earned during the experiment. Across all experimental conditions, Amos earned $21.00, Jane earned $17.21, and Kate earned $17.00. Each participant completed all phases of the experiment during one session, which was conducted with the participant alone in a 2-m x 3-m room containing a desk, computer, and chair.

Procedure. Once participants signed the consent form, the experimenter informed them that the experiment involved responding during different reinforcement contingencies, but did not provide details the specific reinforcement schedules. The experimenter removed all electronics, including watches, from the participants to prevent overt timing of the phases or reinforcement schedules. The experimenter instructed the participant to sit at the computer and use only the mouse to earn as many points as possible during the session.

Throughout the experiment, the computer screen was blank except for two moving circles (one red and one black) and a cumulative point score. The circles were 25mm in diameter, and moved in random directions across the computer screen at a speed of 25mm/s. Participants earned points by clicking on the circles, based on the reinforcement schedule that was in effect.

A reversal design was used to assess resurgence during extinction and omission errors. The evaluation consisted of baseline (reinforcement), DRA (alterative reinforcement), extinction (conventional resurgence), and omission-errors (alternative resurgence) phases. During the baseline phase, points were delivered on an FR 1 schedule

for clicking on the black circle. Clicking the red circle resulted in no programmed consequences (extinction). During the DRA phase, clicking the black circle was placed on extinction and points were delivered for clicking the red circle on an FR 1 schedule. During the extinction phase, clicking on both circles was placed on extinction and, therefore, no points were delivered. During the omission-errors phase, reinforcement rate was reduced by delivering points for clicking the red circle on a RR 1.4 schedule. During this schedule, each response had a 0.7 probability of resulting in point delivery.

Resurgence was defined as a rate of clicking on the black circle during any minute of an extinction or omission-errors phase that exceeded the rate of clicking on the black circle during any of the final three minutes of the preceding DRA phase. This definition was consistent with previous evaluations of resurgence (e.g., Volkert et al., 2009).

All phases were 15-min in duration, and the sequence of phases was held constant across all participants. Each participant completed the experiment during an individually scheduled single session. The session was 110 min in duration, and consisted of two session blocks, separated by a 5-min break. The first, 45-min session block included baseline, DRA, and extinction phases. The second, 60-min session block included DRA, omission errors, extinction, and DRA phases. In an attempt to make the experiment more similar to evaluations in a treatment context, baseline was not replicated during the second block. Following a complete breakdown of treatment (i.e., extinction), it is more likely that a clinician would recommend a return to a DRA intervention implemented with 100% treatment integrity (i.e., FR 1) rather than reinforcing problem behavior (i.e., baseline). No schedule-correlated stimuli were associated with any of the phases.

Results and Discussion

Figure 1 displays the participants' overall rates of clicking on the black circle and red circle. During the baseline phase, when points were delivered for clicking on the black circle, participants clicked on the black circle at high rates and clicked on the red circle at low rates. During the DRA phases, when points were delivered for clicking on the red circle, participants clicked on the red circle at high rates and clicked on the black circle at low rates. During the extinction phases, when points were not delivered, rates of clicking on the red circle decreased.

The obtained proportion of alternative responses that resulted in point delivery during the omission-errors phase averaged 0.70 across participants (.70, .71 and .71 for Amos, Jane, and Kate, respectively). In other words, approximately 70% of clicks on the red circle were reinforced, and approximately 30% were not. Mean reinforcement rates during the omission-errors phase were an average of 24.9% lower than mean reinforcement rates during the DRA phases across participants (33.2%, 30.4% and 11% for Amos, Jane, and Kate, respectively; see Table 1 for mean reinforcement rates during all phases for each participant). Responding during the omission-errors phase globally resembled responding during the DRA phases.

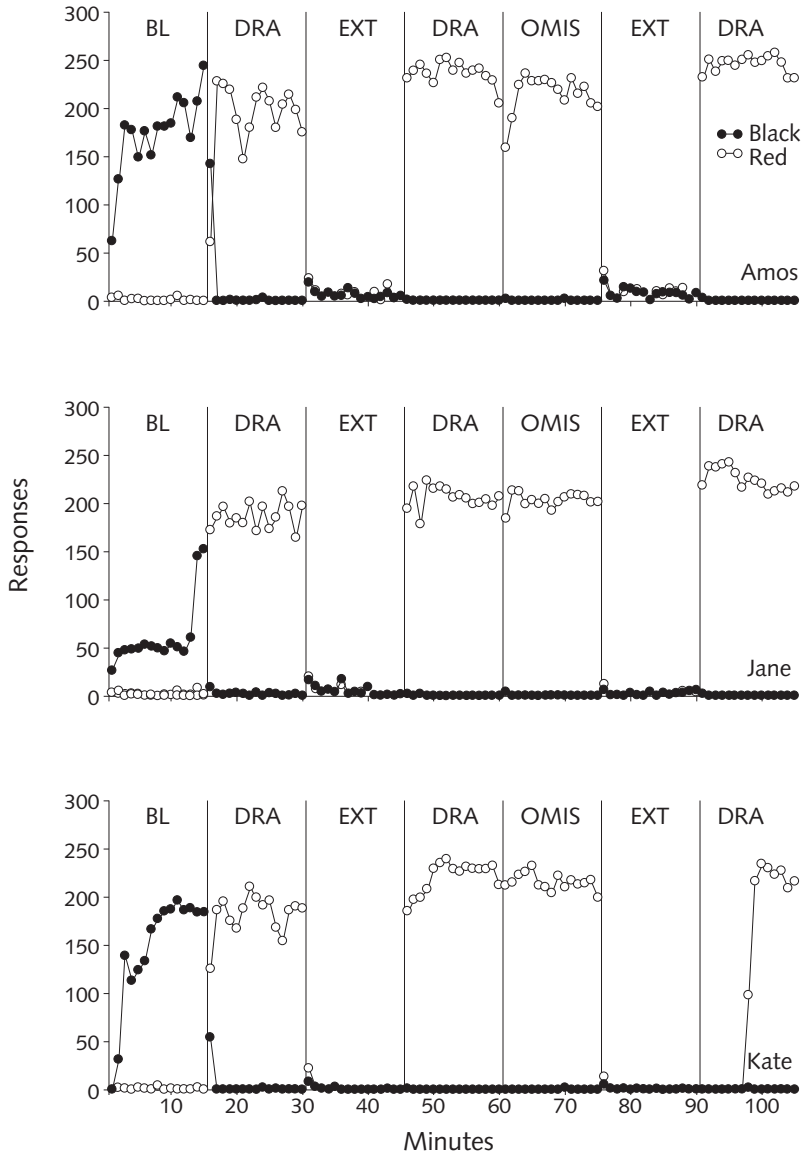

Figure 1. Responses rates of clicking on the black circle (filled circles) and clicking on the red circle (open circles) during the baseline (BL), differential reinforcement of alternative behavior (DRA), extinction (EXT), and omission-errors (OMIS) phases of the human-operant resurgence evaluation.

Table 1
Mean reinforcement rates for each participant during resurgence-analysis phases during Experiment 1 and Experiment 2

	Reinforcers Per Min			
	Experiment 1			Experiment 2
	Amos	Jane	Kate	Nathan
Baseline	173.7	61.3	146.2	0.6
Extinction	0.0	0.0	0.0	0.0
DRA	224.2	205.1	170.7	1.0
Omission	149.7	142.8	152.0	0.8

To highlight potential resurgence, Figure 2 reproduces response-rate data on the black circle during the DRA, extinction, and omission-errors phases only. Although these data are included in Figure 1, the scale of that figure limits visual inspection. Clicking on the black circle resurged for all participants during both extinction phases. For Jane and Kate, higher response rates occurred during the first extinction phase than during the second extinction phase. For Amos, similar response rates occurred during the first and second extinction phases. These results replicate the findings by Lieving and Lattal (2003) and Volkert et al. (2009) in that resurgence occurred during repeated exposures to extinction.

Clicking on the black circle resurged during the omission-errors phase with all participants; however, the degree of resurgence during omission errors was less than that obtained during extinction. For all participants, resurgence during omission errors consisted of only a few intermittent responses, which were reduced to zero for at least the final 5 min of the phase.

To our knowledge, this experiment is the first to directly compare resurgence produced by reduced reinforcement rates and extinction with humans. Resurgence consistently occurred despite a relatively minor reduction in reinforcement rate. For all participants, response rates were lower during omission-errors than during extinction. To begin an assessment of the extent to which the human-operant results were representative of those from clinical populations, such as the participants in Volkert et al.'s (2009) analysis, we examined resurgence during extinction and reduced reinforcement rate during treatment with Experiment 2.

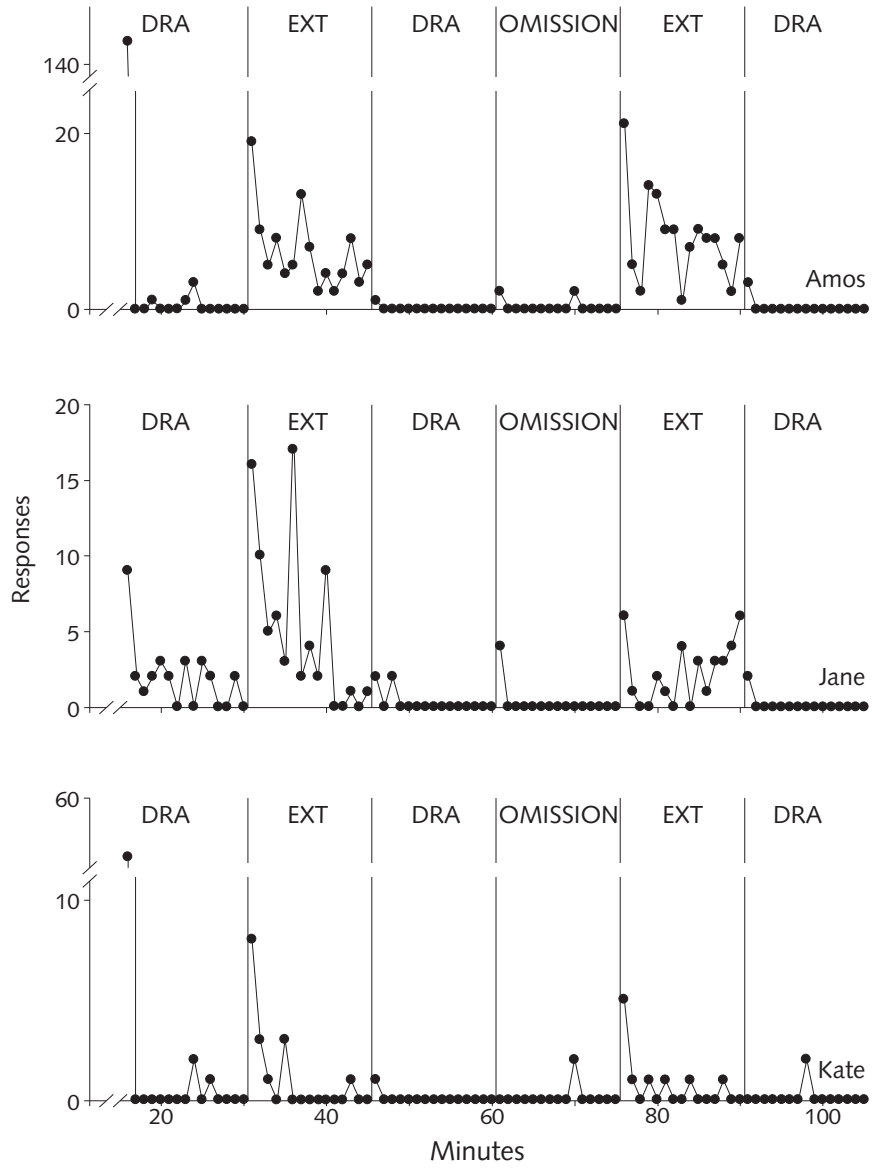

Figure 2. Responses rates of clicking on the black circle during differential reinforcement of alternative behavior (DRA), extinction (EXT), and omission-errors (OMISSION) phases of the human-operant resurgence evaluation.

Experiment 2

Method

Participant and setting. Nathan was a 7-year-old male diagnosed with autism and Attention Deficit/Hyperactivity Disorder. He completed self-care tasks independently and requested items and activities using complete sentences. Nathan's mother sought assistance for his aggressive, disruptive, and inappropriate vocal behavior (operational definitions are provided in the Data Collection and Analysis section below).

All sessions were 5 min in duration. Five to seven sessions were conducted per day, one or two days per week, in a university laboratory room that was approximately 2m by 3m. The session area contained only a table and tangible items, such as toys and crayons.

Data collection and analysis. Trained graduate and undergraduate observers collected data independently using computers and a real-time data collection program. One or two observers collected data during each session. Observers collected frequency data on problem behavior, including aggression, disruptive behavior, and inappropriate vocal behavior.

Aggression was defined as hitting, kicking, grabbing, pinching, scratching, biting, pulling the hair of another person, and throwing an item and spitting within 0.5 m of another person. Disruption was defined as climbing on furniture and the window sill, jumping off furniture and the window sill, pushing furniture, banging on walls and windows, ripping materials, dropping to the floor, pulling, ripping, crawling under the mat on the floor, and throwing an item and spitting beyond 0.5 m of another person. Inappropriate vocal behavior was defined as using a vocal volume above conversational level, growling, groaning, complaining, name calling, and cursing. Observers also collected frequency data on appropriate requests. An appropriate request was defined as asking for a break (i.e., *Can I have a break, please?)* using normal conversational volume and tone.

Observers collected duration data on the experimenter's delivery of attention. Attention was defined as the experimenter talking to the participant and making eye contact with the participant. These data were used to determine the obtained treatment integrity.

Functional analysis. Nathan's mother reported that he frequently engaged in problem behavior when adults talked to each other or tried to interact with him. This report was supported by experimenter observation of Nathan repeatedly engaging in problem behavior and telling adults to "shut up" while they conversed during the consent process. As a result of Nathan's dangerous and severe aggressive behavior, a brief pairwise analysis of test and control conditions (Iwata, Duncan, Zarcone, Lerman, & Shore, 1994) was used to assess whether problem behavior (aggression, disruption and inappropriate vocalizations) was sensitive to escape from adult attention. During the functional analysis, response rates during an attention-removal

(test) condition were compared to an attention-delivery (control) condition. One condition was chosen randomly on a session-by-session basis. During the attention-removal condition, Nathan had continuous access to leisure items and the experimenter continuously talked to him. Each instance of problem behavior resulted in a 30-s break from the experimenter's attention, during which the experimenter stopped talking and turned away from Nathan. During the attention-delivery condition, Nathan had continuous access to leisure items and the experimenter pretended to complete work while ignoring him. Each instance of problem behavior resulted in 30 s of the experimenter's attention in the form of reprimands and statements of concern. Throughout the functional analysis, no programmed consequences followed appropriate requests. The analysis continued until Nathan engaged in higher rates of problem behavior during the attention-removal condition than during the attention-delivery condition for a minimum of two consecutive sessions, determined by visual inspection of graphed rates of problem behavior.

Resurgence evaluation. A reversal design was used to assess resurgence of problem behavior during extinction and omission errors. During each session of the resurgence evaluation, Nathan had continuous access to leisure items. The experimenter provided continuous attention until a reinforcer was delivered. Reinforcers consisted of a 30-s break from attention, during which the experimenter stopped talking and turned away from Nathan.

The resurgence evaluation consisted of baseline (i.e., reinforcement), DRA (i.e., alternative reinforcement), extinction (i.e., conventional resurgence), and omission-errors (i.e., alternative resurgence) phases. Each phase was conducted for at least three sessions, and until responding stabilized or trended in a countertherapeutic direction, as assessed by visual inspection. During the first, baseline, phase problem behavior was reinforced on an FR 1 schedule, and appropriate requests resulted in no programmed consequences. During DRA (the second, fourth, and seventh phases) problem behavior resulted in no programmed consequences, and appropriate requests were reinforced on an FR 1 schedule. Prior to the first session of second and seventh phases, the experimenter told Nathan, "If you want to be left alone, you can ask for a break like this: *can I have a break please?* You have to say it with a nice voice. You try it." Nathan practiced the response once. The experimenter did not provide the instruction prior to the fourth phase to assess if the response would occur without it. Because the response did not occur during the first or second sessions, the experimenter provided the instruction, and Nathan practiced the response, once prior to the third session.

Resurgence was assessed during extinction and omission-errors phases. During extinction (the third and sixth phases), both problem behavior and appropriate requests were placed on extinction. Thus, the experimenter did not provide any breaks from attention. During omission-errors (the fifth phase), problem behavior resulted in no programmed consequences. Appropriate requests were reinforced according to a computer-generated RR 1.4 schedule to approximate 70% treatment integrity. The mean obtained probability of reinforcement was .68. Resurgence was defined as a

rate of problem behavior during any session of an extinction or omission-errors phase that exceeded the rate of problem behavior during any of the final three sessions of the preceding DRA phase.

Results and Discussion

Interobserver agreement and treatment integrity. A second trained, independent observer collected data for 50% of the functional-analysis sessions and 62% of the resurgence-evaluation sessions. Interobserver agreement was calculated separately for each behavior using a block-by-block method (Mudford, Taylor, & Martin, 2009). Each session was divided into 10-s bins. The smaller number of events (or duration) scored in each bin was divided by the larger number of events (or duration) scored in that bin, and the resulting quotient was multiplied by 100%. The IOA scores for all bins in a session were averaged, yielding a mean IOA score for each behavior. The mean IOA scores for each behavior were then averaged across all sessions.

During the functional-analysis sessions, the mean IOA scores were 96% (range, 83% to 100%) for problem behavior (aggression, disruption, and inappropriate vocalizations), 100% for appropriate requests, and 94% (range, 82% to 100%) for attention delivery. During the resurgence-analysis sessions, the mean IOA scores were 97% (range, 74% to 100%) for problem behavior, 98% (range, 87% to 100%) for appropriate requests, and 94% (range, 82% to 100%) for attention delivery.

Treatment integrity was calculated by dividing the number of correct experimenter responses to child behavior (defined as appropriately delivering or withholding the reinforcer within 2 s of the response) by the number of child responses, and the resulting quotient was multiplied by 100. During the omission-errors phase, the experimenter had a piece of paper that informed her whether or not she should reinforce each appropriate request according to a computer-generated RR 1.4 schedule. A response was scored as correct if the experimenter withheld or delivered the reinforcer within 2 s of appropriate requests according to the reinforcement schedule. Treatment integrity was calculated for 31% of sessions, including at least 25% of sessions within each phase, and averaged across sessions. The mean treatment integrity was 96% (range 80%-100%). The mean duration of breaks from attention was 32 s (range 28-33s).

Functional analysis. Nathan's rates of problem behavior during the functional analysis are displayed in Figure 3. He engaged in high rates of problem behavior during the attention-removal condition, and low rates of problem behavior during the attention-delivery condition. Thus, removal of the experimenter's attention as the reinforcer was used during the resurgence evaluation.

Resurgence evaluation. Table 1 displays mean reinforcement rates during all phases of the resurgence evaluation. The mean reinforcement rate during the omission-errors phase was 20% lower than the mean reinforcement rate during the DRA phases.

Nathan's rates of problem behavior and appropriate requests during the resurgence evaluation are displayed in Figure 4. During the baseline phase, he engaged in high

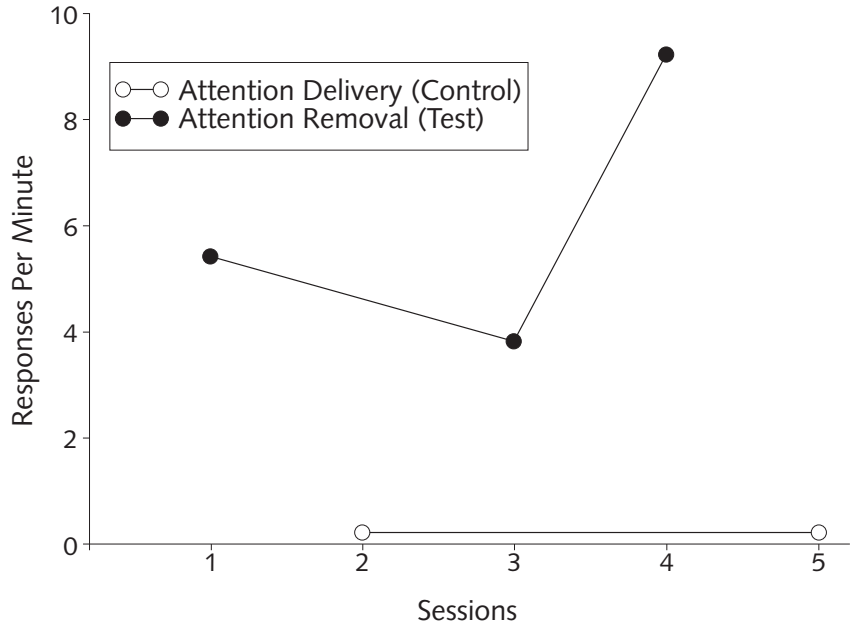

Figure 3. Responses rates of problem behavior during Nathan's functional analysis.

rates of problem behavior, and few appropriate requests. During the DRA phases, rates of problem behavior decreased (with the exception of a burst during beginning the first DRA phase), and rates of appropriate requests increased. Problem behavior occurred no more than twice per session during the final three sessions of the first DRA phase, and no problem behavior occurred during the final three sessions of the second DRA phase. These response rates were used as a comparison for rates of problem behavior during the extinction and omission-errors phases to assess resurgence.

Rates of problem behavior during at least one session of both extinction phases and the omission-errors phase exceeded rates of problem behavior during the final three sessions of the preceding DRA phase. Thus, resurgence of problem behavior occurred during extinction and omission errors. A greater degree of resurgence occurred during both extinction phases than during the omission-errors phase, with the greatest degree occurring during the first extinction phase. The first extinction phase was terminated after only three sessions because problem behavior occurred at such high rates that Nathan and the experimenter were at risk for injury.

Problem behavior maintained by negative reinforcement resurged during extinction and omission errors following a successful DRA intervention. The higher rate and greater persistence of problem behavior during the first extinction phase appeared

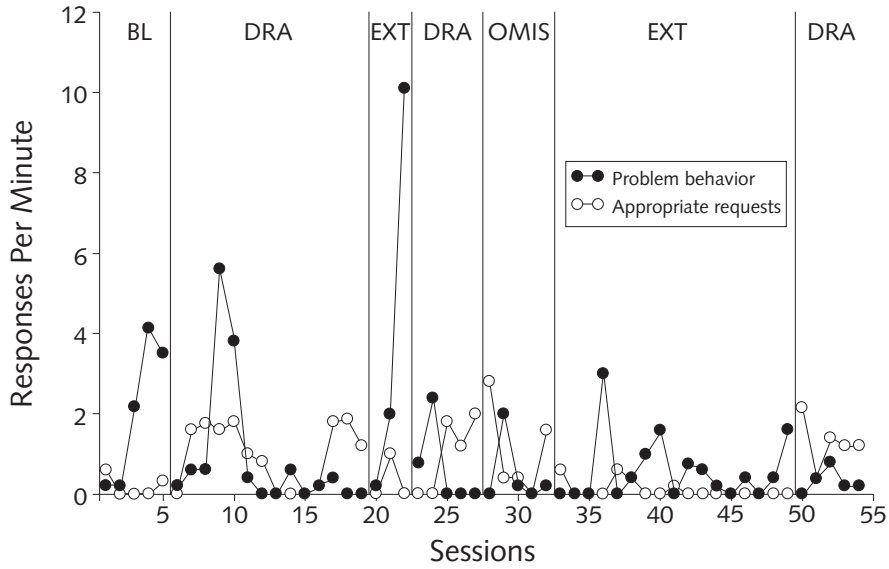

Figure 4. Responses rates of problem behavior (filled circles) and appropriate requests (open circles) during the baseline (BL), differential reinforcement of alternative behavior (DRA), extinction (EXT), and omission-error (OMIS) phases of Nathan's resurgence analysis.

different from those observed during the omission-errors and second extinction phases. Multiple exposures to extinction may have mitigated the effects of resurgence. Furthermore, exposure to a reduced reinforcement rate (as in the omission-errors phase) may reduce resurgence during subsequent exposures to extinction. These conclusions are tentative because only one participant was included in Experiment 2.

Volkert et al. (2009) suggested that extending the extinction phase of a resurgence evaluation could provide information about the course of the behavior that resurges. In the present experiment, problem behavior continued to occur until the final (17th) session of the second extinction phase. It is likely that problem behavior was reinforced with escape from social interaction outside of experimental sessions for an extended period of time, whereas the alternative response was only reinforced for 24 sessions during the experiment. Therefore, Nathan's reinforcement history may have contributed to the persistence of problem behavior throughout the extended extinction phase. In fact, Bruzek, Thompson, and Peters (2009) found greater resurgence of behavior that had been reinforced for longer periods than behavior with a shorter reinforcement history.

General Discussion

The current experiments evaluated responding during reduced reinforcement rates and extinction in controlled laboratory (Experiment 1) and treatment (Experiment 2) contexts. In both experiments, small but consistent resurgence occurred during minor decreases in reinforcement rate, and robust resurgence occurred during extinction. These findings suggest that DRA omission errors may not be as detrimental as complete extinction, and are consistent with previous basic and applied research. For example, Lieving and Lattal (2003, Experiment 4) found resurgence of previously reinforced key pecking with two of three pigeons when the reinforcement schedule for treadle pressing was leaned from a VI 30 s to a VI 360 s; however, the magnitude of resurgence was not as great as that observed during extinction of treadle pressing. Similarly, Volkert et al. (2009, Experiment 2) found resurgence of children's problem behavior when the reinforcement schedule for appropriate behavior was leaned from an FR 1 to an FR 12. The consistent finding that resurgence occurs not only during extinction but also during reduced reinforcement rates suggests that the process of resurgence may contribute to treatment failure during a variety of treatment challenges.

The current experiments are an example of translating laboratory-based findings into a treatment context. The interpretation of data from Experiment 1 is somewhat limited by the brief duration of exposure to each condition and the phase changes that occurred every 15 min, regardless of participant responding. The results of Experiment 1, however, suggested that reduced reinforcement rates and extinction may result in clinically significant differences in responding. These data then informed the clinical replication in Experiment 2. Initial highly controlled laboratory procedures may allow researchers to identify functional relations that may be operating in applied contexts without the constraints associated with applied research. In the case of resurgence evaluations, those applied constraints include ethical issues associated with terminating an effective treatment and potential hazards associated with an increase in the frequency or intensity of problem behavior during extinction phases.

One limitation of the present experiment is that the DRA omission errors and extinction phases occurred in the same sequence across participants. Although our results were consistent with previous findings (Lieving & Lattal, 2003, Experiment 4; Volkert et al., 2009, Experiment 2), it is possible that a greater degree of resurgence would occur when omission errors are presented prior to extinction. Future research could evaluate resurgence during omission errors that are presented prior to and following extinction of the alternative response.

Resurgence during omission errors may be a graded effect, with greater resurgence occurring as local exposure to extinction increases. In the present experiment, response rates increased despite a relatively small decrement in reinforcement rate, from an FR 1 to an RR 1.4 schedule. The transient increase in responding with this relatively small shift in the density of reinforcer delivery should be further explored.

In particular, the "threshold" for obtaining resurgence of problem behavior remains unknown, as do the intricacies of interactions between the second-phase reinforcement schedule and the occurrence of resurgence during the third phase. We may have obtained resurgence because the shift from an FR 1 to an RR 1.4 was discriminable to the participants, who had a history of each response receiving reinforcement during the second phase. A similar decrease in reinforcement density, but from a variable schedule to another, thinner variable schedule may not be sufficient to produce resurgence. In other words, the participant's reinforcement history may be a larger contributor to resurgence than the absolute change in reinforcement rate.

Resurgence was a repeatable effect within participants. Participants did not show a consistent pattern of greater resurgence during the first or second exposure to extinction. Our findings from the human-operant laboratory mirror those of Lieving and Lattal (2003) and Volkert et al. (2009), but our applied replication differed in that Nathan's problem behavior resurged to a lesser extent during the second and third tests for resurgence. Thus, it remains possible that repeated exposures to extinction could reduce the likelihood of resurgence during clinical applications of DRA.

The results of the present experiment extend previous findings of resurgence of negatively reinforced responses with escape from demands (Volkert et al., 2009), and escape from simulated infant crying (Bruzek et al., 2009), to include escape from social interaction. This finding may be significant for children with autism, for whom escape from social interaction may be a potent reinforcer.

Resurgence has occurred repeatedly in the context of FCT and DRA with positive and negative social reinforcement, and it is likely the new alternative response will have a shorter reinforcement history than the problem behavior. Therefore, identifying factors that prevent resurgence of problem behavior could be a future extension of this research. As stated earlier, previous research has found that treatment integrity errors of omission are not always detrimental with DRA treatment (St. Peter Pipkin et al., 2010). Continued research about specific schedule thinning strategies that prevent or minimize resurgence of problem behavior during DRA treatment may be warranted.

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