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RESURGENCE OF MANDS FOLLOWING FUNCTIONAL COMMUNICATION TRAINING

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Abstract

Experimental conditions similar to those described by Lieving and Lattal (2003) were used within two experiments to evaluate the resurgence of mands with humans. Two mands from the same operant class were trained with three participants with developmental disabilities during Experiment 1 and with two participants with developmental disabilities and a history of problem behavior during Experiment 2. The two mands were then placed on extinction. Both persisted, but showed different response strength during extinction. The mand with the weaker response strength was targeted for additional functional communication training and the alternative mand was placed on extinction. Following steady levels of occurrence of the targeted mand and no occurrences of the alternative mand, both mands were placed on extinction again. At least one instance of resurgence of the alternative mand occurred with every participant and resurgence of problem behavior occurred for both participants during Experiment 2.

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Keywords

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Basic research findings can inform applied research on problems of social significance. This is the case with basic research on resurgence of previously reinforced responses and the design of applied studies to evaluate maintenance of treatment effects during challenges to treatment such as extinction (Nevin & Wacker, 2013). Such basic research may be particularly germane to evaluations of the persistence and resurgence of recently trained desirable responses following differential–reinforcement–based treatments such as functional communication training (FCT; Carr & Durand, 1985). Based on the procedures described in Lieving and Lattal (2003) we evaluated the application of a four–phase procedure to study variations in responding following FCT with individuals with developmental disabilities.

Functional communication training is one of the most commonly used reinforcement–based treatments to address problem behavior maintained by social reinforcers for individuals with developmental disabilities (Tiger, Hanley, & Bruzek, 2008). In typical applications, FCT follows an experimental analysis (e.g., functional analysis; FA) of problem behavior (Iwata, Dorsey, Slifer, Bauman, & Richman 1982/1994) to identify social reinforcers that maintain such behavior. The social reinforcer that maintains the problem behavior is referred to as its functional reinforcer. Most commonly FCT includes two components: (a) strengthening an acceptable mand to gain the same functional reinforcer using a rich schedule of reinforcement (e.g., a fixed–ratio [FR] 1 schedule), and (b) weakening problem behavior by withholding reinforcement (i.e., extinction; Hagopian, Fisher, Sullivan, Acquisto, & LeBlanc, 1998; Rooker, Jessel, Kurtz, & Hagopian, 2013; Volkert, Lerman, Call, & Trosclaire–Leserre, 2009).

The effectiveness of FCT in increasing appropriate communication and reducing the occurrence of problem behavior during treatment is well documented (see Tiger et al., 2008 for a review). These studies have shown that the treatment effects of FCT (i.e., continued displays of the mand and reductions in problem behavior) can maintain over time (Durand & Carr, 1991), across changes in therapists and settings (Berg, Wacker, Harding, Ganzer, & Barretto, 2007; Wacker et al., 2005) and treatment materials (Dyches, Davis, Lucido, & Young, 2002).

Although FCT reduces problem behavior, such behavior may recur during challenges to the FCT treatment, even following months of treatment (Nevin & Wacker, 2013; Wacker et al., 2011). The recurrence of problem behavior during these challenges to treatment constitutes resurgence because a previously reinforced response (i.e., problem behavior) has been extinguished, or greatly reduced, but recurs (sometimes quickly) following the omission or delay of reinforcement of the recently reinforced communicative response (Hanley, Iwata, & Thompson, 2001; Lieving & Lattal, 2003; Volkert et al., 2009).

The lack of maintenance of treatment effects in the form of reductions in mands and resurgence of problem behavior is a major clinical concern with differential reinforcement

procedures such as FCT. For example, Volkert et al. (2009; Experiment 1) evaluated the resurgence of problem behavior during extinction sessions that followed FCT for three participants with histories of problem behavior. Each participant consistently exhibited the targeted mand during FCT and problem behavior decreased to low rates across FCT sessions. However, problem behavior resurged within 10 min of the mand contacting extinction for two of the three participants, even though problem behavior was not reinforced. Volkert et al. showed that maintenance of reduced problem behavior following FCT was dependent on the consistent reinforcement of the alternative response (i.e., mand). In a second experiment, Volkert et al. replaced the FR 1 reinforcement schedule used during FCT with a leaner one (FR 12). Resurgence of problem behavior again occurred within 10 min of exposure to the leaner reinforcement schedule for each participant.

Volkert et al.'s (2009) results demonstrate the fragility of FCT treatment effects when challenged with delays in or removal of reinforcement for the targeted mand. The omission of reinforcement (i.e., extinction) and thinning of the reinforcement schedule for the alternative response (i.e., mand) resulted in the resurgence of problem behavior even though the contingencies for problem behavior remained unchanged from FCT to the subsequent extinction condition.

As reported in Tiger et al. (2008), previous studies have shown that FCT is an effective procedure for reducing problem behavior because emission of the targeted mand results in the same functional reinforcer that maintained problem behavior during the FA; the mand and problem behavior are members of the same operant class. Mace et al. (2010) suggested that reinforcing an appropriate response such as mands during FCT could strengthen the mand response while concurrently strengthening other response topographies within the same operant class (e.g., problem behavior). Results such as those reported by Lieving, Hagopian, Long, and O'Connor (2004), Reed and Morgan (2006), Wacker et al. (2011, 2013), and Volkert et al. (2009) provide support for Mace et al.'s observations.

Potential insight to the lack of maintenance of treatment effects was provided by Bruzek, Thompson and Peters (2009) and Lieving and Lattal (2003; Experiment 1; see also Epstein, 1983), who showed the increased likelihood that a previously trained desirable response would reoccur (resurgence) when alternative members of the same operant class were extinguished. For example, Lieving and Lattal demonstrated resurgence of previously reinforced key pecking following the termination of reinforcement for an alternative response (treadle pressing for food delivery) using a four–phase procedure. Following key–peck training during Phase 1, in Phase 2, key pecking was extinguished such that a minimum of three consecutive sessions with no key pecking occurred. Key pecking remained on extinction during Phase 3, in which an alternative response, treadle press, was reinforced. Both responses then were extinguished during Phase 4. Resurgence of key pecking was observed during the initial extinction session for each pigeon during Phase 4.

Volkert et al.'s (2009) results were consistent with those of Lieving and Lattal (2003) in that maintenance of treatment effects depended on the continued reinforcement of the alternative response. As discussed by Volkert et al. and Nevin and Wacker (2013), lapses in treatment integrity, such as the omission of reinforcement following a mand, would be expected

outside of FCT sessions – it is unlikely that every mand would be reinforced. Such omissions of reinforcement for a recently trained mand could occur for a variety of reasons, including instances in which a novel care provider might not recognize the mand (Durand & Carr, 1991), delays or other requirements to gain the reinforcer being increased too quickly (Hanley et al., 2001), or the unavailability of the reinforcer (St. Peter–Pipkin, Vollmer, & Sloman, 2010). Omission or delay of reinforcement for the mand can result in rapid resurgence of undesirable behavior that has not occurred for months (Wacker et. al., 2011).

The results of Volkert et al. (2009) are encouraging because they suggested that even though resurgence of problem behavior occurred following the absence of mand reinforcement, manding persisted during the initial extinction sessions and provided additional opportunities for reinforcement. In some cases, however, repetitions of the same mand may not obtain reinforcement (Durand & Carr, 1991). In these cases, an alternative mand might obtain such reinforcement and reduce the likelihood of problem behavior.

Lattal and St. Peter Pipkin (2009) and Robertson, Wehby, and King (2013) suggested that reinforcing multiple members of an operant class of appropriate behavior could increase the likelihood of resurgence of appropriate responses from that class, while reducing inappropriate responses. Developing larger numbers of appropriate mands represents a distinctly different approach from most FCT treatments because it capitalizes on anticipated resurgence. Lieving and Lattal's (2003) and Bruzek et al.'s (2009) analyses of resurgence suggest a method for studying how the variety of responses emitted might increase following the omission of reinforcement for a recently reinforced response.

The present experiments used procedures similar to Lieving and Lattal (2003, Experiment 1), but with (a) humans with developmental disabilities (b) socially important responses (i.e., independent mands) (c) conditioned reinforcers, and (d) in an open economy that resulted in access to the reinforcer outside of weekly experimental sessions. We sought to determine if a previously reinforced mand (analogous to key pecks) that was placed on extinction would recur when a second mand with a more recent reinforcement history (analogous to treadle presses) from the same operant class encountered extinction.

Method

General Procedure

Three assessments were conducted prior to the start of each experiment, and an additional assessment, FA, was conducted with the participants in Experiment 2. The three assessments common to both experiments are described first. A paired–choice preference assessment (Fisher, Piazza, Bowman, Hagopian, Owens, & Slevin, 1992) was conducted to identify preferred items or activities to use as reinforcers during FCT sessions. Lists of six items hypothesized to be preferred stimuli were obtained from care providers for each participant. Using the procedures described in Fisher et al. (1992), each of the items was paired with each of the remaining items to form 15 paired choices for each participant. Each paired–choice was presented and the participant was prompted to select their preferred item (e.g., "Show me which one you want"). The participant then received 30–s of access to the selected item and the next choice was presented. The number of times each item was

selected was recorded and compared to the number of selections for the remaining items. The item selected most often was identified as the preferred item for that participant.

The second assessment, mand modality assessment, was conducted using the procedures described by Ringdahl et al. (2009) to identify two mand topographies that the participant displayed with similar levels of proficiency. Three mand topographies (e.g., card touches, vocal words, manual signs, or microswitch presses) were identified for each participant based on information provided by the participant's care provider. Each topography was presented separately and the participant's proficiency with that topography was evaluated according to the level of prompting required before the participant emitted the target mand. Materials required for the mand (i.e., card or microswitch) were placed in front of the participant and the preferred item as identified during the paired–choice assessment was set in view of the participant. A brief period of play was initiated before access to the preferred item was restricted and a vocal prompt was provided for appropriate communication (e.g., "If you want to play with the toy, hand me the card."). After the initial prompt, the investigator waited 5 s for the participant to emit the mand. If the mand did not occur, there was another vocal prompt. If the participant did not emit the target mand following that vocal prompt, the mand was modeled. Finally, if the mand did not occur within the next 5–s, hand–over–hand guidance was provided to the participant to emit the targeted mand. In the case of a vocal modality, the participant's chin was touched while repeating the correct mand. As soon as the mand was emitted, regardless of the level of prompt provided, the participant received access to the preferred item for 30–s. Following the 30–s reinforcement interval, the item was removed and the next trial began. Blocks of ten trials were conducted for each mand modality and the level of prompt required during each trial was recorded. The number of trials with independent mands and vocal mands were compared across the three topographies, and the two topographies with the most similar scores were selected as the mand modalities for that participant. Table 1 lists the mands selected for FCT A and mands targeted for FCT B for each participant.

The FCT sessions were initiated to train the use of the two mands to request the stimuli identified during the preference assessment (Experiment 1) or FA (Experiment 2). Colored boards were paired with each mand modality to signal which mand would result in reinforcement during the FCT session. The FCT was conducted with each mand within alternating (Experiment 1) or counterbalanced (Experiment 2) treatment sessions to reduce potential confounds related to different lengths of reinforcement history (Winborn–Kemmerer, Ringdahl, Wacker, & Kitsukawa, 2009) within the experimental setting. The third assessment was an evaluation of the response allocation to each mand. This was conducted similarly to FCT sessions, but both mands were simultaneously available according to a concurrent FR 1 FR 1 schedule and the associated stimulus cards for both mands were present. Sessions were 5–min long.

An FA of problem behavior based on Iwata et al., (1982/1994), with the addition of a tangible condition, was conducted for both participants in Experiment 2. The FAs were conducted to evaluate the effects of common social reinforcers (increased attention, access to preferred tangibles, and escape from a nonpreferred activity) on the occurrence of problem behavior.

Data were collected using laptop computers with a Data Pal data collection program. Interobserver agreement (IOA) was calculated separately for problem behavior and mands using the same procedures. Two trained data collectors independently observed the variables described above. The primary data collector collected data *in vivo* (Experiment 1) and via video recordings (Experiment 2). The second data collector collected data either *in vivo* (Experiment 1) or via video recordings (Experiment 1 and Experiment 2). Interobserver agreement was calculated by dividing each session into 10–s intervals and then conducting an interval–by–interval comparison. Interobserver agreement was calculated by dividing the total number of intervals with exact agreement by the number of agreements plus disagreements and multiplying the number by 100 to obtain an overall agreement percentage. Table 2 summarizes the IOA for Experiments 1 and 2.

Experiment 1

Participants and Setting

One female and two males with intellectual disabilities participated in Experiment 1. Cora, Seth and Milo were 50, 34, and 69 years old, respectively. Each was diagnosed with moderate to severe intellectual disabilities and none had a physical disability. Each also had a communication disorder, and none of the three used functional vocal speech. Cora and Seth communicated primarily through the use of gestures and nonword vocalizations. Milo's expressive communication consisted of a small repertoire of manual signs. Each could follow simple one– and two–step directions. Sessions occurred in a therapy room (5 m × 5 m) located at a rehabilitation facility on the campus of Southern Illinois University. The room was equipped with a table, chairs and session stimuli as described in the next section.

Materials

Communication devices—A card (8cm by 8 cm; Cora, Seth and Milo) and a round button style microswitch (BigMack®; Cora and Milo) were included during the mand modality assessment, FCT and extinction sessions. The microswitch was programmed to play a pre–recorded message (e.g., "Puzzles please") when the participant pressed the top of the switch.

Stimulus poster boards—Each communication modality was associated with a unique colored poster board measuring 91 cm by 61 cm to signal the modality that resulted in reinforcement during that FCT session (e.g., purple board for vocalization, orange board for card touches, and white board for manual sign). The relevant stimulus board was present during all FCT sessions and also was included during the extinction sessions for each mand, even though the mand was not reinforced during the extinction sessions.

Response Definitions

Two mands were recorded during FCT and extinction sessions for each participant. Mands included card touch (Cora, Seth, and Milo), defined as contact between any portion of the hand or fingers and the communication card; microswitch activation (Cora and Milo), defined as touching the microswitch with sufficient force to either play the recorded message or so that an audible "click" could be heard by the investigators; and manual sign

(i.e., manual sign for “please”; Seth), defined as the participant touching the palm to the middle of his chest. Reinforcement was defined as the experimenter delivering the identified stimulus. Rate measures for each mand and reinforcement were calculated by tallying the total number of occurrences of the variable and dividing that tally by the total session time (in minutes). Rate measure was considered appropriate because, although there was an element of discrete–trial training to the FCT sessions, latency to responding could vary from trial to trial and was not controlled by the experimenter.

Experimental Design and Procedure

An ABCB (FCT A, Extinction, FCT B, and Extinction) design was used to evaluate the effects of FCT treatments for two mands on the persistence of a recently reinforced mand and resurgence of a mand that was previously reinforced then extinguished or greatly reduced. A multiple schedule design was used to compare the occurrence of the two mands during FCT and extinction sessions.

Procedure

Phase 1: FCT A—During FCT A, the preferred item or activity was delivered following the designated mand on an FR 1 schedule. Prior to each session, the participant had 1 to 2 min of access to the preferred item or activity. After the leisure time elapsed, access to the reinforcer was restricted and the participant was directed to attend to the stimulus board paired with the mand targeted for that FCT session. Next, the participant was prompted to emit the designated mand to gain reinforcement. After the mand occurred, 30 s of access to the preferred item or activity was provided. Any mand other than the designated one was on extinction. The FCT continued until equivalent rates of reinforcement occurred for both mands across five consecutive FCT sessions. This was done to reduce possible confounds related to different histories of amount of reinforcement during the evaluations of persistence of the two mands during extinction. Sessions lasted 2 to 5 min. Variation in session time was due to latency to manding following removal of the preferred item.

Phase 2: Extinction A—This phase was conducted to compare the relative response strength of the two mands. The multiple schedule used during FCT A continued with two changes. First, mands no longer were reinforced. Second, each session was time based (5 min), as opposed to trial–based (e.g., 5 trials). Trial–based extinction would have resulted in multiple brief exposures to reinforcement during extinction; thus, a time–based extinction procedure was selected that provided continuous disruption of the communication response.

Phase 3: FCT B—During this phase, reinforcement was re–established only for the mand that was the least persistent, based on proportional responding during Extinction A.

Sessions for FCT B were conducted using the procedures described for FCT A except that sessions were conducted with only one mand and were time, rather than trial, based. During each 5–min session, the stimulus board associated with the targeted mand was present and mands were reinforced on an FR1 schedule. Both mand modalities were available to each participant (i.e., the card and/or microswitch were both available for Milo and Cora, and the

picture card was available for Seth) during each session of FCT B, but the nontargeted mand was on extinction.

Phase 4: Extinction B—Extinction B was conducted using the procedures described for Phase 2 (Extinction A) with two changes. First, the stimulus board for the mand trained during FCT B was present during all sessions; the stimulus board for the other mand was not included during Extinction B. Second, both mand modalities were available to each participant during every Extinction B session.

Results

Figure 1 shows the results for each participant. Each emitted both assigned mands at similar rates according to which stimulus card was present during the FCT A sessions (left panel of each graph). Rates of reinforcement of the two mands were within +/– 10% of one another during FCT A. Both mands persisted during Extinction A, but rate of card touches was greater than microswitch presses (Cora and Milo) or manual signs (Seth). Thus, microswitch presses and manual signs were targeted for additional FCT sessions during FCT B. Milo emitted the targeted mand (i.e., microswitch presses) at rates similar to those observed during FCT A and emitted the card mand three times during FCT B. Neither Cora nor Seth emitted the targeted mands (i.e., microswitch presses and manual signs, respectively) during the initial FCT B session, but rates of the targeted mands increased across FCT B sessions to levels similar to those observed during FCT A for both participants. The targeted mand continued at reduced rates across all Extinction B sessions for Cora and Milo, and for the first four Extinction B sessions for Seth.

The card mand rate decreased to zero by the fourth FCT B session for each participant. When extinction was reinstated, resurgence of the card mand occurred during at least one Extinction B session for each participant. The card mand resurged to rates similar to those observed during FCT A during the first Extinction B session for Cora. It resurged, but at low rates, during the third and fifth Extinction B session for Milo, and during the fourth Extinction B session for Seth.

The results for Cora, Milo and Seth are similar to the results reported by Lieving and Lattal (2003, Experiment 1) with pigeons and Bruzek et al. (2009) with college students. The results of these studies suggest that a four– phase procedure may provide a method for studying recurrence of an alternative desirable response when a recently reinforced response encounters extinction. In fact, Bruzek et al. demonstrated this effect (i.e., re–emergence of a desirable response). However, it was demonstrated in the context of a simulation of infant care giving, rather than an *in vivo* context.

From a conceptual standpoint, the current findings, along with those of Lieving and Lattal (2003) and Bruzek et al. (2009) suggested that the recurrence of Response A was not simply reinstatement of some other, nonextinguished, response when Response B was extinguished. As discussed by Epstein (1983), using the four–component procedure ensured that Response A was extinguished prior to establishing, then extinguishing, Response B providing a method to demonstrate resurgence as distinct from other effects of extinction.

Experiment 1 replicated Bruzek et al.'s (2009) earlier translational work and moved a step beyond the simulation created by Bruzek et al. The results do not, however, provide evidence of whether resurgence of a previously extinguished communicative response would occur in the context of FCT–based treatment of problem behavior. Experiment 2 was conducted to address this question.

Experiment 2

Experiment 2 extended Experiment 1 by evaluating resurgence and persistence of two appropriate responses when a third set of responses (problem behavior) were a part of the participant's history, but currently were extinguished. From an applied standpoint, Experiment 2 evaluated the four–phase procedure used in Experiment 1 to identify factors that might increase displays of alternative desirable responses and also evaluated the recurrence of problem behavior when reinforcement was withheld for a recently reinforced desirable response.

Participants and Setting

Two young children with developmental disabilities, speech and language delays, and a history of problem behavior participated in Experiment 2. An FA of problem behavior preceded the pre–study assessments and FCT treatment conditions described earlier.

Kami was a 7–year–old girl with multiple physical, developmental, and cognitive disabilities. She exhibited aggressive (e.g., hitting, kicking, biting and pinching others) and destructive (e.g., throwing and destroying objects) behavior. The results of her FA indicated that problem behavior was maintained by escape from nonpreferred tasks. Prior to the study, Kami showed limited functional vocalizations and some manual signs.

Cyrus was a 3–year–old boy diagnosed with a developmental speech delay and disruptive behavior disorder. Behavior of concern included destruction (throwing items) and aggression (i.e., biting, hitting, or jumping on his mother). A functional analysis showed that his problem behavior was maintained by gaining access to preferred items and his mother's attention. Cyrus used gestures and nonfunctional vocalizations.

All FCT and extinction sessions occurred in the participant's homes. All of Kami's sessions were conducted in a room in the family's lower level. Sessions for Cyrus were conducted in his bedroom with both the investigator and his mother participating in each session.

Materials

Communication devices—Picture cards (7.5 cm by 6 cm picture) depicting a play scene accompanied by the word "play" were used for Kami and Cyrus.

Stimulus poster boards—Each communication modality was paired with a unique colored poster board measuring 91 cm by 61 cm to signal the modality that resulted in reinforcement (e.g., purple board for vocalization, orange board for picture exchange). The relevant stimulus board was present during all FCT and extinction sessions, as in Experiment 1.

Response Definitions

Data were collected on mands, reinforcement delivery, and problem behavior during all FCT and extinction sessions. Two mands were scored for each participant. Vocal mands (Kami only) were scored each time Kami vocalized the word “play” while oriented toward the investigator. Manual signs (Cyrus only) were scored each time Cyrus touched his chest with his palm while oriented towards his mother or investigator. Card touches (Kami and Cyrus) were scored each time Kami or Cyrus touched the card. Reinforcement was scored each time the investigator delivered the functional reinforcer identified during the functional analysis. The reinforcer was available for 30 s. Problem behavior also was scored during FCT and extinction sessions. Problem behavior for Kami was defined as aggressive (i.e., hit, kick, spit, or pinch another person) and destructive (i.e.., throwing or destroying objects) behavior. Problem behavior for Cyrus was defined as aggressive (i.e., biting, hitting, or jumping on his mother) and destructive (i.e., throwing toys) behavior. Rate measures for each mand, reinforcement, and problem behavior were calculated by tallying the total number of occurrences of the variable and dividing that tally by the total session time (in minutes). Data were collected on the occurrence of mands, reinforcement delivery and problem behavior during all FCT A and B and Extinction A and B sessions. See the general procedure section for Interobserver agreement (IOA) calculations, the results of which are shown in Table 2.

Experimental Design and Procedures

The same ABCB (FCT A, Extinction, FCT B, and Extinction) format described for Experiment 1 was used for Experiment 2. A multiple schedule design was used to evaluate the occurrence of mands and problem behavior during FCT and extinction sessions.

Procedure

Experiment 2 used the same procedures described in Experiment 1, with the addition of placing problem behavior on extinction throughout all FCT and extinction sessions. Cyrus’s problem behavior was maintained by positive reinforcement (i.e., preferred items and parent attention) and his functional communication training was the same as described for the participants in Experiment 1. Kami’s problem behavior was maintained by negative reinforcement (i.e., escape from non–preferred activities) and she received FCT for negative reinforcement (i.e., her mands resulted in removal of the work task and access to the preferred item). The investigator presented a brief task (i.e., put a bear in the matching colored container) and continued to present the task until Kami emitted the mand. The task and prompt to mand were presented on the same schedule during the extinction sessions except reinforcement was withheld. Table 1 provides the preferred stimuli and mands.

Results

Figures 2 and 3 show the results of Experiment 2 for mands (top panel) and problem behavior (bottom panel) for Kami and Cyrus, respectively. During FCT A, Kami and Cyrus emitted the two assigned mands at similar rates and reinforcement deliveries were equivalent across both mands. Problem behavior occurred during only one FCT A session for Kami, but across several sessions and at higher and more variable rates for Cyrus. This

behavior did not occur during the last seven FCT A sessions for either participant. During Extinction A, Kami's rate of manding decreased but both mands persisted through all but one Extinction A session. In contrast, Cyrus showed an immediate increase in card manding during the first Extinction A session before card manding decreased and then extinguished. Sign manding decreased to zero for all but one Extinction A session. Problem behavior resurged with both participants when reinforcement was withheld for both mands. Kami showed an early resurgence of problem behavior during Extinction A and problem behavior continued at variable but relatively high rates throughout Extinction A. Problem behavior resurged during only one of the first five Extinction A sessions for Cyrus, but showed an increasing trend during the final five sessions. Card manding persisted at a higher rate than the alternative mand (i.e., vocal mands for Kami and manual signs for Cyrus) during Extinction A.

Vocal manding (Kami) and manual sign manding (Cyrus) were targeted for additional training and card touches were placed on extinction during FCT B. Rates of the targeted mands of both participants increased to the levels observed during FCT A and card touches did not occur during FCT B. When reinforcement of an alternative response was reinstated, problem behavior rates decreased to between 0 and 1 occurrence per min for Kami and were zero during all but one FCT B session for Cyrus. During Extinction B, Kami's card manding resurged, albeit at low rates, during the second, fourth, and fifth Extinction B sessions. Vocal manding persisted at low rates across the first six Extinction B sessions before ceasing. Cyrus's card manding rates resurged during the first session of Extinction B and thereafter gradually decreased across sessions before ceasing. Cyrus's sign manding gradually decreased across the first five Extinction B sessions before ceasing. Resurgence of problem behavior occurred during the first Extinction B session for both participants and continued throughout Extinction B. Kami emitted the recently reinforced mand prior to problem behavior during the first five sessions. Cyrus emitted both mands multiple times prior to showing problem behavior before manding extinguished.

Resurgence of the alternative mand, persistence of target manding and resurgence of problem behavior during Extinction B were manifest in both participants. They appropriately manded at the start of the initial extinction sessions, but such manding was followed by a rapid resurgence of problem behavior during each of those sessions. These results suggest that even brief lapses in a care provider's response to manding can resurge problem behavior following extended time in treatment (Nevin & Wacker, 2013, Wacker et al., 2011; Volkert et al., 2009).

The results for Experiment 2 are similar to those of Volkert et al. (2009) and suggest that unless a recently trained mand is reinforced, a history of reinforcement for another mand in the same operant class may not prevent or delay the onset of problem behavior when mands are placed on extinction. Collectively, the results of Volkert et al., and Experiment 2 are similar to those reported by Winborn, Wacker, Richman, Asmus, and Geier (2002), who showed that problem behavior and mands co–occurred during treatment. The results of Volkert et al. and Experiment 2 demonstrated the same finding in the context of extinction.

General Discussion

The purpose of these experiments was to examine if recently trained appropriate responses (i.e., mands) exhibited by humans would show patterns of resurgence similar to those found with operant responses of pigeons (Lieving & Lattal, 2003) and with caregiver responses of college students (Bruzek et al., 2009). The four–phase procedure revealed resurgence of an alternative (and desired) response when another response from the same operant class with a more recent reinforcement history encountered extinction. These findings were consistent with results of previous research that has evaluated responding using both a four– (e.g., Epstein, 1983; Lieving & Lattal, 2003, Experiment 1) and a three–phase resurgence procedure (e.g., Lieving and Lattal, 2003; Experiment 2).

The four–phase resurgence procedure had several advantages. In both Experiments 1 and 2, Phase 1 (FCT A) included a multiple schedule of reinforcement that programmed reinforcement for two mands in separate components of the schedule. The inclusion of FCT A as Phase 1 showed that the two mands occurred at similar rates prior to Extinction A and differences in persistence between the two mands during Extinction A could be attributed to differences in response strength. The inclusion of FCT A in Experiment 2 also showed that problem behavior had extinguished for both participants in Experiment 2, and the increase in problem behavior during Extinction A represented resurgence of a previously reinforced, but extinguished response.

The three–phase procedure (e.g., Lieving & Lattal, 2003; Experiment 2) includes a) reinforcement of response A, b) reinforcement of response B with concurrent extinction of response A, and c) extinction of response B with concurrent extinction of response A. As discussed by Epstein (1983) providing reinforcement for Response B prior to extinguishing Response A raises the possibility that reinforcement of Response B prevented extinction of Response A, and the recurrence of Response A during the final extinction phase might represent recurrence of a nonextinguished response when another response is extinguished, as opposed to resurgence (Epstein, 1983). The inclusion of a separate extinction phase (Extinction A) in the four–phase procedure provided a method to demonstrate that recurrence of card mands during Extinction B represented resurgence of that behavior.

From a clinical standpoint, the results of Experiment 2 suggested that the most recently reinforced member of the operant class was emitted when extinction was encountered. This finding is similar to results obtained by Lambert, Bloom, Samaha, Dayton, and Rodewald (in press) related to the mitigating effects serial instruction of alternative responses may have on resurgence. The results of Lambert et al., and the participants in Experiment 2 suggest that mands that are reinforced most recently may occur first during an extinction challenge. Thus, treatment procedures that end with reinforcement for one or more appropriate mands may produce greater persistence of those mands during subsequent challenge conditions.

The current study was conducted to directly translate the results of basic studies on resurgence to clinically relevant concerns. One difficulty that applied researchers encounter in studying the recurrence of problem behavior is that problem behavior may continue to be

reinforced outside of treatment sessions. Although this same problem can also occur even in basic studies (for example, when food reinforcers need to be delivered for maintenance), the ongoing delivery of the functional reinforcer for problem behavior will likely interact with and possibly disrupt the results of extinction during the final extinction phase of the four–phase procedure. The likelihood of outside reinforcement is often a problem in clinical contexts and warrants further analysis in more controlled studies conducted by translational researchers. For example, previous researchers have examined the disruptive effects of response–independent reinforcement during differential reinforcement of alternative behavior. Specifically, Marcus and Vollmer (1995) and Reed, Ringdahl, Wacker, Barretto and Andelman (2005) demonstrated that frequent deliveries of response–independent reinforcers resulted in relatively low (near zero) rates of alternative, appropriate behavior. However, lean such schedules did not disrupt alternative, appropriate behavior. A similar approach might be conducted to evaluate the effects of different schedules of reinforcement that occur outside of the resurgence phases, and to identify the conditions under which various schedules are most disruptive. For example, in the current study, the participants' access to the functional reinforcers (i.e., those responsible for the maintenance of problem and appropriate behavior) outside of treatment sessions was unknown and may have resulted in variations in the participant's motivation to gain the reinforcer during experimental sessions.

One peripheral result of the current study was that one mand persisted more than the other (Extinction A), even though both had been reinforced at similar rates. One hypothesis to interpret these results is that the mand with greater strength is the preferred mand. To establish preference, one could first conduct a choice analysis using the procedures described by Winborn–Kemmerer et al. (2009), who showed that individuals with intellectual disabilities exhibited mand preferences when multiple mand topographies were reinforced on a concurrent schedule. If preferred mands display greater persistence when an FCT program encounters challenges such as brief periods of extinction, then greater emphasis should be given to identifying preferred mands prior to the initiation of FCT.

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References

Berg WK, Wacker DP, Harding JW, Ganzer J, Barretto A. An evaluation of multiple dependent variables across distinct classes of antecedent stimuli pre and post functional communication training. Journal of Early and Intensive Behavioral Intervention. 2007; 34(4)(1):305–333.

Bruzek JL, Thompson RH, Peters LC. Resurgence of Infant Caregiving Responses. Journal of the Experimental Analysis of Behavior. 2009; 92:32–343.

Carr EG, Durand VM. Reducing behavior problems through functional communication training. Journal of Applied Behavior Analysis. 1985; 18:111–126. [PubMed: 2410400]

Durand VM, Carr EG. Functional communication training to reduce challenging behavior: Maintenance and application in new settings. Journal of Applied Behavior Analysis. 1991; 24:251–264.s. [PubMed: 1890046]

Dyches TT, Davis A, Lucido BR, Young JR. Generalization of skills using pictographic and voice output communication devices. Augmentative and Alternative Communication. 2002; 18:124–131.

Epstein R. Resurgence of previously reinforced behavior during extinction. Behaviour Analysis Letters. 1983; 3:391–397.

Fisher WW, Piazza CC, Bowman LG, Hagopian LP, Owens JC, Slevin I. A comparison of two approaches for identifying reinforcers for persons with severe and profound disabilities. Journal of Applied Behavior Analysis. 1992; 25:491–498. [PubMed: 1634435]

Hagopian LP, Fisher WW, Sullivan MT, Acquisto J, LeBlanc LA. Effectiveness of functional communication training with and without extinction and punishment: A summary of 21 inpatient cases. Journal of Applied Behavior Analysis. 1998; 31:211–235. [PubMed: 9652101]

Hanley GP, Iwata BA, Thompson RH. Reinforcement schedule thinning following treatment with functional communication training. Journal of Applied Behavioral Analysis. 2001; 34:17–38.

Iwata BA, Dorsey MF, Slifer KJ, Bauman KE, Richman GS. Toward a functional analysis of self–injury. Journal of Applied Behavior Analysis. 1994; 27:197–209. Reprinted from Analysis and Intervention in Developmental Disabilities, 2, 3–20, 1982. [PubMed: 8063622]

Lambert JM, Bloom SE, Samaha AL, Dayton E, Rodewald A. Serial alternative response training as intervention for target response resurgence. Journal of Applied Behavior Analysis.

Lattal KA, Peter Pipkin C. Resurgence of previously reinforced responding: Research and application. The Behavior Analyst Today. 2009; 10:254–265.

Lieving GA, Lattal KA. Recency, repeatability, and reinforcer retrenchment: An experimental analysis of resurgence. Journal of the Experimental Analysis of Behavior. 2003; 80:217–233. [PubMed: 14674730]

Lieving GA, Hagopian LP, Long ES, O'Connor J. Response class hierarchies and resurgence of severe problem behavior. The Psychological Record. 2004; 54:621–634.

Mace FC, McComas JJ, Mauro BC, Progar PR, Taylor B, Ervin R, Zangrillo AN. Differential reinforcement of alternative behavior increases resistance to extinction: Clinical demonstration, animal modeling, and clinical test of one solution. Journal of the Experimental Analysis of Behavior. 2010; 93:349–367. [PubMed: 21119850]

Marcus BH, Vollmer TR. Effects of differential negative reinforcement on disruption and compliance. Journal of Applied Behavior Analysis. 1995; 28:229–230. [PubMed: 16795864]

Nevin, JA.; Wacker, DP. Response strength and persistence. In: Madden, GJ., editor. APA handbook of behavior analysis. Vol. 2. Washington, DC: APA Books; 2013. p. 109-128.

Reed GK, Ringdahl JE, Wacker DP, Barretto A, Andelman MS. The effects of fixed time and contingent schedules of negative reinforcement on compliance and aberrant behavior. Research in Developmental Disabilities. 2005; 3:281–295. [PubMed: 15668078]

Reed P, Morgan TA. Resurgence of response sequences during extinction in rats shows a primacy effect. Journal of the Experimental Analysis of Behavior. 2006; 86:307–315. [PubMed: 17191755]

Ringdahl JE, Falcomata TS, Christensen TJ, Bass–Ringdahl SM, Lentz A, Dutt A, Schuh–Claus J. Evaluation of a pretreatment assessment to select mand topographies for functional communication training. Research in Developmental Disabilities. 2009; 30:330–341. [PubMed: 18672344]

Robertson RE, Wehby JH, King SM. Increased parent reinforcement of spontaneous requests in children with autism spectrum disorder: Effects on problem behavior. Research in Developmental Disabilities. 2013; 34:1069–1082. [PubMed: 23299185]

Rooker GW, Jessel J, Kurtz PF, Hagopian LP. Functional communication training with and without alternative reinforcement and punishment: An analysis of 58 applications. Journal of Applied Behavior Analysis. 2013; 46:708–722. [PubMed: 24114463]

Peter–Pipkin C, Vollmer TR, Sloman KN. Effects of treatment integrity failures during differential reinforcement of alternative behavior: A translational model. Journal of Applied Behavior Analysis. 2010; 43:47–70. [PubMed: 20808495]

Tiger JH, Hanley GP, Bruzek J. Functional communication training: A review and practical guide. Behavior Analysis in Practice. 2008; 1:16–23. [PubMed: 22477675]

Volkert VM, Lerman DC, Call NA, Trosclair–Lasserre N. An evaluation of resurgence during treatment with functional communication training. Journal of Applied Behavior Analysis. 2009; 42:145–160. [PubMed: 19721735]

Wacker DP, Berg WK, Harding JW, Barretto A, Rankin B, Ganzer J. Treatment effectiveness, stimulus generalization, and parent acceptability of functional communication training. Educational Psychology. 2005; 25:231–254.

Wacker DP, Harding JW, Berg WK, Lee JF, Schieltz KM, Padilla YC, Nevin JA, Shahan TA. An evaluation of persistence of treatment effects during long–term treatment of destructive behavior. Journal of the Experimental Analysis of Behavior. 2011; 96:261–282. [PubMed: 21909168]

Wacker DP, Harding JW, Morgan TA, Berg WK, Schieltz KM, Lee JF, Padilla YC. An evaluation of resurgence during functional communication training. The Psychological Record. 2013; 63:3–20.

Winborn L, Wacker DP, Richman DM, Asmus J, Geier D. Assessment for mand selection for functional communication training packages. Journal of Applied Behavior Analysis. 2002; 35:295–298. [PubMed: 12365744]

Winborn–Kemmerer L, Ringdahl JE, Wacker DP, Kitsukawa K. A demonstration of individual preference for novel mands during functional communication training. Journal of Applied Behavior Analysis. 2009; 42:185–189. [PubMed: 19721740]

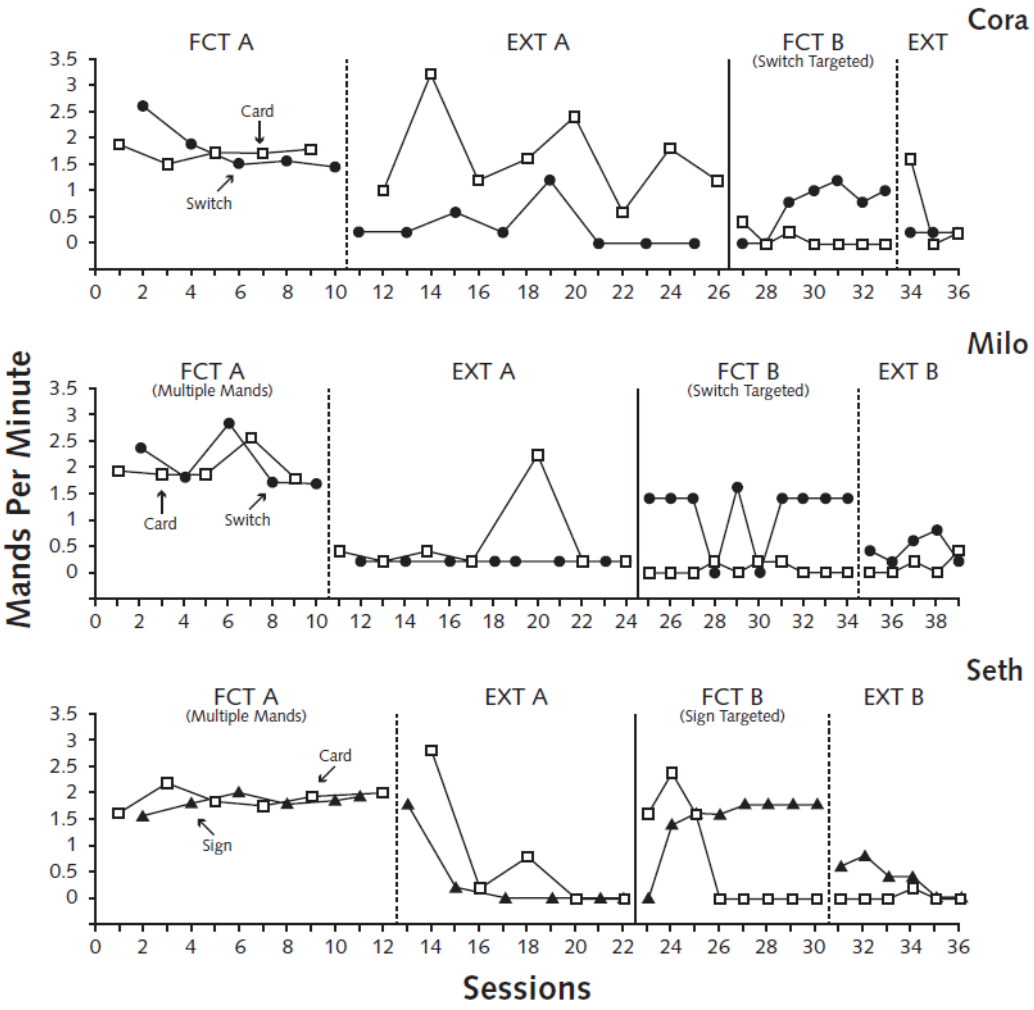

Figure 1.

Results for mands for Cora, Milo and Seth for Experiment 1. The top panel shows the occurrence of mands during FCT an Extinction sessions for Cora. The middle panel shows the occurrence of mands during FCT an Extinction sessions for Milo. The bottom panel shows the occurrence of mands during FCT an Extinction sessions for Seth.

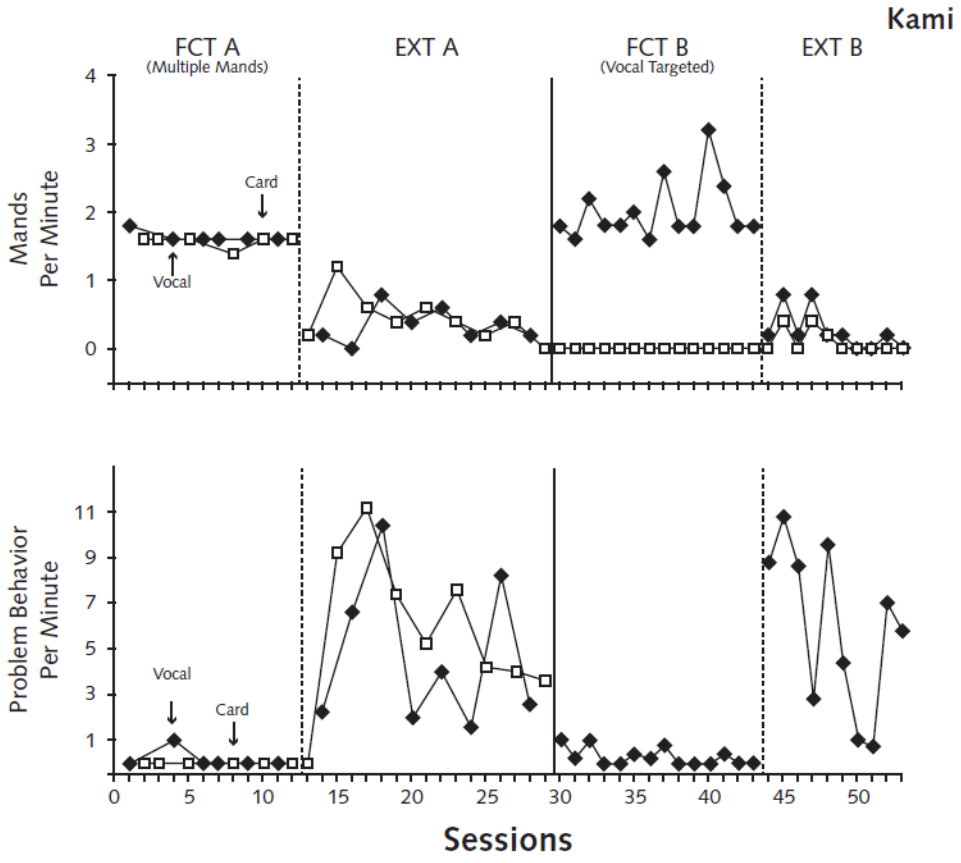

Figure 2.

Results for mands and problem behavior for Kami for Experiment 2. The top panel shows the occurrence of mands for Kami. The bottom panel shows the ocurrence of problem behavior.

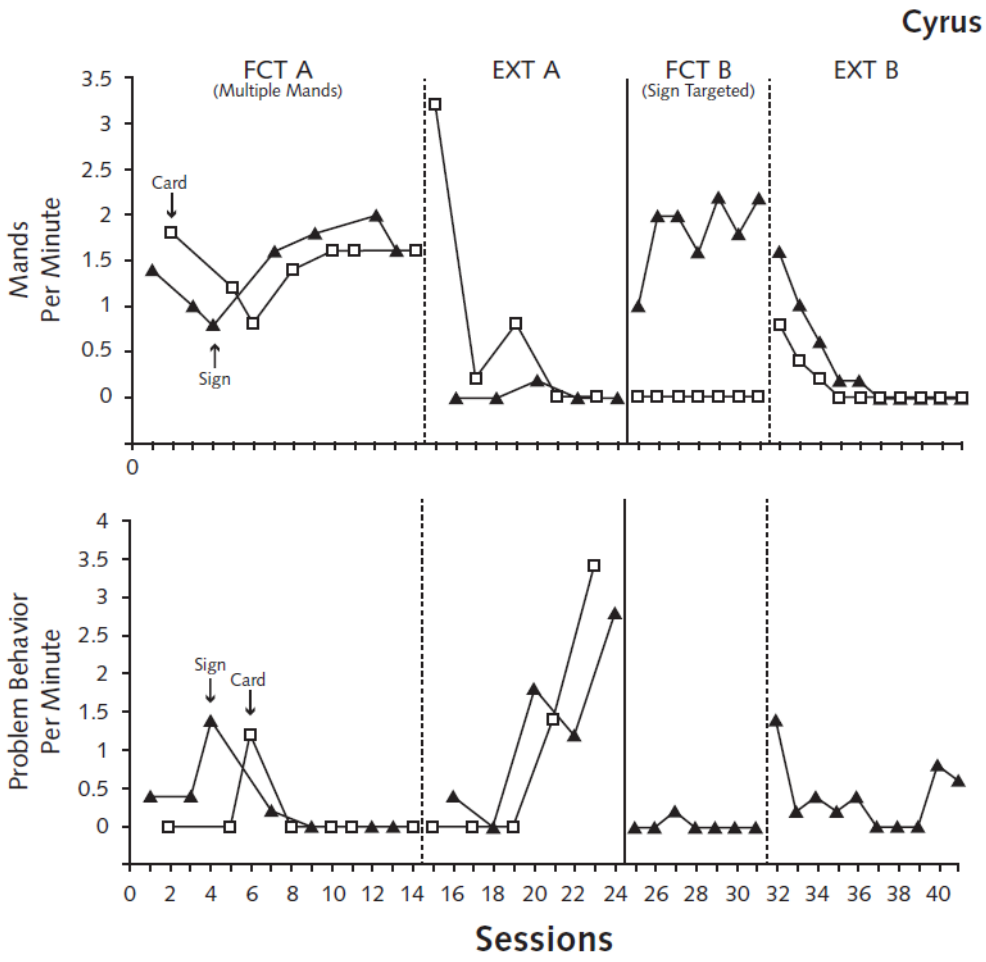

Figure 3.

Results for mands and problem behavior for Cyrus for Experiment 2. The top panel of Figure 3 shows the occurrence of mands for Cyrus. The bottom panel of Figure 3 shows the occurrence of problem behavior.

Table 1

Participants, Preferred Stimuli, Target Mands for FCT A and Target Mands for FCT B

Experiment 1			
Participant	**Preferred Stimuli**	**Target Mands for FCT A**	**Target Mand for FCT B**
Cora	Puzzles	Card and Microswitch	Microswitch
Milo	Musical Instruments	Card and Microswitch	Microswitch
Seth	Indoor Basketball Hoop	Card and Manual Sign	Manual Sign
Experiment 2			
Participant	Preferred Stimuli	Target Mands for FCT A	Target Mand for FCT B
Kami	Video	Vocal Word and Card	Vocal Word
Cyrus	items for Cyrus	Manual Sign and Card	Manual Sign

Table 2

Interobserver Agreement for All Participants and Phases

Phase	Experiment	Participants	Mands *Mean (Range)*	Problem Behavior *Mean (Range)*
FCT A	1	Cora	100%	
		Milo	94% (85%–100%)	
		Seth	99% (93%–100%)	
	2	Kami	98% (93%–100%)	100%
		Cyrus	99% (97%–100%)	100%
EXT A	1	Cora	97% (92%–100%)	
		Milo	100%	
		Seth	100%	
	2	Kami	99% (93%–100%)	97% (77%–100%)
		Cyrus	97% (78%–100%)	98% (93%–100%)
FCT B	1	Cora	99% (98%–100%)	
		Milo	94% (89%–100%)	
		Seth	93% (88%–100%)	
	2	Kami	98% (87%–100%)	99% (97%–100%)
		Cyrus	99% (95%–100%)	98% (90%–100%)
EXT B	1	Cora	97% (95%–98%)	
		Milo	100%	
		Seth	99% (96%–100%)	
	2	Kami	99% (97%–100%)	95% (75%–100%)
		Cyrus	100%	99% (93%–100%)