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Mitigating Resurgence in Functional Communication Training: Teaching Varied and Complex Responses

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by

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MITIGATING RESURGENCE IN FUNCTIONAL COMMUNICATION TRAINING:

TEACHING VARIED AND COMPLEX RESPONSES

by

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This manuscript has been read and accepted for the Graduate Faculty in Psychology to satisfy the dissertation requirement for the degree of Doctor of Philosophy

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ABSTRACT

Mitigating Resurgence in Functional Communication Training:
Teaching Varied and Complex Responses

by

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Functional communication training (FCT) is a commonly used intervention for treating problem behavior wherein the reinforcers contributing to problem behavior are (a) identified through functional analysis and (b) then provided contingent on an alternative communication response. However, following successful teaching of an FCR, resurgence of problem behavior may occur in natural settings when the FCR is exposed to intentional or unintentional extinction conditions. We investigated teaching a second FCR following initial FCT, in one of two forms (varied topography or increased complexity) as a method for reducing resurgence of problem behavior. In order to account for history of reinforcement, we used a translational paradigm with a pre-existing analogue problem behavior (pre-existing mands). We found that FCT teaching multiple FCRs was more effective at mitigating resurgence of the analogue problem behavior when compared to single-response FCT for 3 out of 4 participants. FCT teaching multiple FCRs also produced greater variability of other, untaught mands during extinction conditions for 3 out of 4 participants. Caregivers scored both treatments highly and all caregivers indicated a preference for multiple FCT treatment. Clinicians may consider teaching multiple FCRs in FCT treatments in order to reduce resurgence of problem behavior and increase variability of untaught mands.

Keywords: complex FCR, functional communication training, FCT, resurgence, serial FCT

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Autism spectrum disorder (ASD) is a developmental disorder characterized by challenges with communication and socialization, as well as increased rigidity of behavior (American Psychiatric Association et al., 2013). Children with ASD often struggle with communication skills and are more likely than the general population to engage in problem behavior such as aggression, self-injury, or destruction (Murphy et al., 2009). Problem behaviors can be defined as behaviors that negatively impact the education of an individual, are physically dangerous, and are considered to be socially unacceptable (Matson et al., 2010).

Functional communication training (FCT) has been identified as an empirically supported treatment for the problem behavior of children with ASD (Kurtz et al., 2011) and involves three steps (Tiger et al., 2008). First, the maintaining consequence(s) of a problem behavior are identified through functional assessment. Second, a replacement for the problem behavior from a socially acceptable communication modality is taught, such as a vocal verbal response or a picture exchange. This functional communication response (FCR) results in the same consequences as the problem behavior, thereby providing the individual with an alternative means for accessing functional reinforcers. Third, programs for continued maintenance and generalization of functional communication skills and decreased problem behavior are put into place.

Traditional FCT has demonstrated efficacy across populations, behaviors, modalities, interventionists, and settings (Durand & Merges, 2001; Ghaemmaghami et al., 2020). However, the majority of the studies investigating FCT take place in tightly controlled settings under dense schedules of reinforcement, typically a fixed ratio (FR) where every appropriate communication

response is followed by reinforcer delivery (FR 1). These dense schedules of reinforcement are challenging for caregivers to maintain in real-world settings as FCRs may occur at extremely high rates that are impossible or impractical to reinforce (e.g., Peck et al., 1996; Tiger et al., 2008). In addition, communication devices used for an FCR may be unavailable or broken, a relevant reinforcer may not be accessible, or a caregiver may need to complete other tasks before attending to an appropriate communication request. These treatment integrity failures can disrupt the response-reinforcer contingency between the FCR and the maintaining consequence (e.g., Carr et al., 2000; Volkert et al., 2009).

In addition to being prone to treatment integrity failures, dense schedules of reinforcement for FCRs may also be counter to the individual's well-being. For example, continuous delivery of positive reinforcers such as requests for unhealthy foods may have negative health impacts, while continuous delivery of negative reinforcers such as escape from demands may impede or delay a child's cognitive or social development. Schedule thinning procedures, where the continuous availability of the reinforcers is gradually decreased over time, may then be put into place to address these clinical concerns (for review, see Hagopian et al., 2011). For example, Hanley et al. (2001) treated the self-injurious behavior (SIB) of three participants with ASD using FCT, then investigated several different methods for thinning the reinforcement schedule following FCT. Reinforcement was thinned by progressively increasing the (a) delays between the FCR and reinforcer, (b) fixed interval (FI) schedules of reinforcer deliveries, or (c) signaled extinction period during a multiple-schedule arrangement. Hanley et al. found that problem behavior was more likely to reemerge during thinning procedures that did not signal the delay. Thus, thinning reinforcement or increasing delays between response and reinforcer may improve the long-term practicality of a treatment but is not exempt from the

concern of problem behavior returning, or resurging, while clinicians and caregivers attempt to reduce access to reinforcement. During thinning procedures, delay fading, or when exposed to treatment integrity failures, extinction or extinction-like conditions are in place that may result in resurgence of the problem behavior (e.g., Briggs et al., 2018; Hanley et al., 2001).

Resurgence is a behavioral mechanism that occurs when a currently reinforced response is placed on extinction, leading to the reoccurrence of a previously reinforced response (Epstein, 1983). A typical resurgence research paradigm consists of three phases. In Phase 1, Behavior A is trained and reinforced on a rich schedule of reinforcement. In Phase 2, Behavior A is placed on extinction while behavior B is trained and reinforced. In Phase 3, behavior A and B are both placed on extinction. Resurgence is said to occur if Behavior A reemerges during Phase 3. Resurgence is particularly relevant to the traditional FCT arrangement because a single FCR is taught, but the child may be exposed to conditions where this single FCR no longer continuously produces reinforcement (e.g., treatment integrity failure, reinforcement thinning). When this occurs, the previously reinforced problem behavior that had been put on extinction during FCT may resurge.

When additional responses are added to the sequence in a resurgence paradigm, different patterns can appear according to the order in which behavior reemerges first (e.g., Reed & Morgan, 2006). First, *primacy* in resurgence refers to the behavior learned first reemerging in comparison to behaviors learned later. On the other hand, the reemergence of behavior that was learned last is referred to as *recency* (e.g., Lieving & Lattal, 2003). Finally, *reversion* effects are observed when all responses reemerge sequentially in a reverse order of learning (e.g., Lieving & Lattal, 2003). Recently, researchers have attempted to capitalize on these sequential effects by modifying the traditional FCT intervention with a single FCR to include teaching multiple FCRs

(e.g., Adami et al., 2017; Falcomata et al., 2018; Ghaemmaghami et al., 2018; Lambert et al., 2017). However, the efficacy of the FCT approach of teaching multiple FCRs is dependent on the potential resurgence pattern. For example, primacy would be problematic in an FCT arrangement, as it would involve the return of the problem behavior that was previously extinguished. A more desirable outcome would be recency, in that the most recently taught FCR would reemerge instead of problem behavior. In addition, the potential chain of appropriate behavior exhibited during reversion provides caregivers with additional opportunities to reinforce appropriate requests as they sequentially reemerge. Therefore, teaching multiple FCRs has the potential to reduce resurgence of problem behavior.

The multiple FCRs taught can differ based on variations of modality, variations of topography, or increases in complexity. Falcomata et al. (2018) completed a functional analysis, then taught two children with ASD to mand in order to access functional reinforcers that varied across modality (e.g., vocal verbal, American Sign Language, microswitch). The authors then exposed the children to a progressively increasing lag schedule, wherein behavior was reinforced if it differed from previously reinforced behavior. The experimenters observed low levels of resurgence of problem behavior and high levels of manding, including variable mands during extinction tests, in this arrangement.

Lambert et al. (2015) evaluated variability of the FCR responses within a modality in a translational study using activation of different styles of light switch. The experimenters taught an initial arbitrary light switch response designated as a target response to serve as the analogue for problem behavior. The authors alternated a control condition similar to traditional FCR that consisted of teaching and reinforcing one light switch response, and a varied condition, where three alternative light switch responses were sequentially taught and reinforced. In an extinction

test, the authors found that teaching three alternative responses (multiple-mand variability within modality) decreased the number of responses allocated to the analogue for problem behavior when compared to more traditional FCT teaching a single response.

Other researchers have explored teaching multiple FCRs that increase the complexity of an initial FCR. Complex FCRs are more likely to be more developmentally and socially appropriate and therefore more likely to effectively recruit reinforcers in the natural environment (Ghaemmaghami et al., 2018). In Ghaemmaghami et al (2018), the authors initially taught children with ASD a simple FCR as an alternative to problem behavior (e.g., “my way”), then built upon the mand until a terminal topography complexity was reached (e.g., “excuse me, may I have my way please?”). Problem behavior was reduced to zero or near-zero levels throughout the intervention while the complexity of the FCR was gradually expanded.

While previous literature has investigated the effect of teaching multiple FCRs on resurgence of problem behavior with promising results, some translational and applied studies have found conflicting results regarding the extent to which resurgence is mitigated. For example, some applied researchers have found resurgence of problem behavior occurs despite the teaching of multiple mands (e.g., Gratz, Wilson, & Glassford, 2018). For example, Lambert et al. (2017) were unable to replicate the results of their 2015 translational study with a clinical population. The authors suggested that this replication failure was due to the effects of a longer history of reinforcement for problem behavior. It is unclear the extent to which multiple and initial FCRs will compete with a behavior within the same response class with a pre-existing history.

Other authors have proposed alternative explanations for this replication failure. In another paper extending this literature, Diaz-Salvat et al. (2020) investigated whether the number

of available alternative responses impacts distribution of resurgence responses in a translational model with undergraduate students completing a computer program. In Experiment 1, the authors replicated previous findings that fewer instances of resurgence of problem behavior occurred in FCT with multiple FCRs when compared to FCT with single FCR. In Experiment 2, they compared multiple and single training while the number of alternate responses was held constant. No difference was found between resurgence rates in this experiment. In Experiment 3, they compared varied numbers of alternative responses while holding training type constant (single training only). In this experiment, the condition with fewer alternative responses produced more resurgence. Diaz-Salvat et al. (2020) suggested that the type of training may not matter as much as the number of alternative responses. However, this explanation may be relevant only when response options can be physically restricted, such as with multiple FCRs involving several different modalities (pictures, an iPad) or multiple FCRs involving one modality that has removable parts (e.g., FCT with multiple pictures that can be withheld). No comparison has yet been done including FCT with multiple FCRs within one modality where the taught responses are always available such as vocal responding.

Further investigation of the effects of multiple FCRs will help determine whether teaching multiple mands within a single modality of communication is an effective strategy for reducing resurgence of problem behavior. However, exploring basic principles of behavior such as resurgence can be problematic when the behavior potentially resurging is dangerous to the individual or others. Research investigating teaching multiple FCRs with a pre-existing history (e.g., pre-existing mands) would help translate the principles of resurgence from basic to applied research and better demonstrate whether variables such as training type mitigate resurgence of

problem behavior because pre-existing mands are likely to have a history of reinforcement comparable to that of problem behavior, while arbitrary responses taught in a lab may not.

The purpose of this study was to investigate the effect of teaching multiple FCRs of either varied or complex topographies on resurgence of a pre-existing behavior within a translational paradigm. We selected pre-existing mands already within the individual's repertoire to represent the analogue for problem behavior with a history of reinforcement. This translational experimental arrangement allowed for the investigation of the principles of resurgence with a relevant population without the ethical considerations involved in intentionally evoking problem behavior.

Method

Participants

Four children with ASD between the ages of 5 and 8 years old (M = 6 years old) were recruited for this study from a group of children receiving services to improve communication and socialization skills. Ali was a 5 year-old girl with Korean and Venezuelan heritage who could speak in fully-fluent English sentences and used a range of mands to ask for items such as preferred snacks or leisure items. She could also speak in single-word utterances in Korean and used disfluent Spanish sentences. Ali had been receiving one-on-one ABA services for approximately 15-20 hrs per week for the past three years to improve her social, communication, and attention/focus skills. Yaritza, the older sister of Ali, was 8 years old, spoke primarily in disfluent English phrases and was able to mand for snack or leisure items. Yaritza could also use single-word utterances in both Korean and Spanish. Yaritza had been receiving ABA services for the past 4 years to improve her communication, socialization, and activities of daily living skills.

Lev was a 6-year-old boy of Korean heritage who could speak in fully-fluent English sentences and used a range of mands to ask for items or activities. Lev could use single-word utterances in Korean. He had been receiving one-on-one ABA services for two years for approximately 15-20 hours per week to improve his social skills and activities of daily living. Robin was a 5 year-old boy of Korean heritage who was able to speak in disfluent phrases in English and Korean. He had recently been diagnosed with ASD and was on a waitlist for ABA services in order to target deficits in communication, socialization, and functional skills.

Children below the age of 5 were excluded from this study in order to ensure all participants had the physical structural capacity to make all developmentally appropriate speech sounds and therefore control for the possibility of physical developmental change as a source of variability of mand topography. Participants all had a caregiver-reported history of using functional mands and no caregiver-reported severe problem behavior that interfered with daily life within the last 3 months. We only included participants who did not exhibit severe problem behavior to avoid resurgence of unsafe behavior.

Settings and Materials

The study took place at a university-based clinic in rooms that were approximately 2 by 2 m and contained child-sized furniture (e.g., tables, chairs, couches). For participants that were unable to attend the university-based clinic, sessions were conducted within the child's homes in a bedroom or spare room with a small table and chair as well as any other furniture used in the room (e.g., a bed or dresser). Toys in the rooms were placed out of sight in closets or bins before the onset of the sessions. Caregivers and siblings were able to watch live from outside the room. All FCT sessions teaching multiple FCRs (FCT-M) were completed in one area, while FCT teaching a single FCR (FCT-S) was completed in a separate area in order to minimize the

influence of contextually irrelevant variables between conditions. All procedures were recorded by video for later review for inter-observer agreement and treatment integrity measures. During all procedures, leisure items identified by caregivers as far less desirable were available in the rooms at all times to mitigate aversiveness of extinction sessions and increase social acceptability of the experimental arrangement. Although available, participants never engaged with these items during FCT sessions. Additional materials included individualized reinforcers identified by caregiver interview, observation, and preference assessments.

Response Measurement

Participant selections were measured during the multiple stimulus without replacement (MSWO) preference assessment. Selection of an item was defined as when the participant picked up and interacted with an item from the array in response to the instruction, "pick one." Each item was then scored according to its rank selected within the array (i.e., the first item selected was ranked as "1" while the fifth item selected was ranked as "5"). Rankings for each item across the MSWO three trials were then averaged across trials to obtain an overall ranking per item.

Data were collected on all communication responses as a count and then converted to a rate for the mand analysis and treatment conditions. All participants engaged in a maximum of 5 pre-existing mands during the mand analysis in at least one condition. Mands are transcribed in Table 2 for each individual participant. We saw a number of pre-existing mands across participants as expected from caregiver report. All reinforced pre-existing mands were accompanied by eye contact towards the experimenter or the item and reaching or leaning towards the item. Verbal utterances that were not accompanied by these non-verbal cues were not reinforced during the mand analysis. All pre-existing mands were tallied and converted to

rate (5 pre-existing mands per participant). The pre-existing mand that occurred at the highest rate was selected as the analogue problem behavior. This mand could have been any modality exhibited by the participant (e.g., vocal, picture exchange). For example, a child could say, "car" to gain access to their favorite toy car, or exchange a picture to gain access to their favorite toy car. However, all participants communicated with vocal mands in this study.

During the FCT treatment comparison, the initial FCR was a novel response within the same modality as the pre-existing mand individually identified for each participant (vocal). In addition, the initial FCR had the same or fewer vocal syllables (i.e., single or simple) than the analogue problem behavior. For example, if the pre-existing mand was "car," the initial FCR could be "toy." The terminal FCR was taught after the initial FCR was mastered and was either complex or varied. A varied mand is a mand within the same communication modality as the initial FCR that maintained the same number of syllables. In other words, the terminal mand varied in response topography from the initial mand but was not more complex. A complex mand contained the initial FCR in a larger frame of syllables than the initial FCR and pre-existing mand. For example, additional words could be added to the initial FCR to create the sentence, "my toy, please." That is, the terminal mand included more syllables to increase complexity of the response but maintained the same base topography as the initial response. In addition, any other untaught FCRs were measured. These were defined as any request for the functional reinforcer that had not been taught or reinforced within the context of this study.

Interobserver Agreement and Treatment Integrity

Interobserver agreement (IOA) was calculated for selection of items and ranking of items during the preference assessments by comparing the rank order of each item selected during each trial as scored by two independent observers. If the items were scored as the same rank in a trial,

they were considered to be in agreement. We divided the number of agreements by the total number of potential agreements (agreements plus disagreements) and then multiplied by 100 to obtain a percentage. IOA was 100% for preference assessment rankings for all participants.

During the mand analysis, IOA was calculated for 40% of all sessions across participants. Each mand analysis session was divided into 10-s intervals and then two independent observers tallied the frequency of each mand within each interval, scoring an agreement if the exact count in each interval matched between observers. We divided the number of intervals with agreement by the total number of intervals and then multiplied by 100 to obtain a percentage. Each participant used 5 mands for at least one condition, but not all participants used 5 mands for both conditions. For Ali, IOA during the mand analysis preceding the FCT-M treatment evaluation was 96% (range, 94-100) for mand 4 while the IOA for all other mands was 100%. During the mand analysis preceding the FCT-S treatment evaluation, Ali's IOA for all mands was 100%. Yaritza's IOA during the mand analysis preceding the FCT-M treatment was 94% (range, 89-100) for mand 1, 97% (range, 94-100) for mand 2, and 100% for remaining mands. During Yaritza's FCT-S treatment evaluation, IOA for mand 1 was 97% (range, 94-100), for mand 2 was 92% (range 83-100), for mand 3 was 97% (range 94-100), and mand 4 was 94% (range 89-100). During Lev's mand analysis that preceded the FCT-M treatment condition, IOA for mand 1 was 94% (range, 83-100), for mand 2 was 98% (range, 94-100), for mand 3 was 94% (range, 83-100), for mand 4 was 100%, and for mand 5 was 100%. For the mand analysis preceding the FCT-S treatment condition for Lev, IOA for all mands was 100%. Robin's FCT-M treatment evaluation had 100% IOA for all mands, while IOA for his FCT-S treatment evaluation was 96% (range, 89-100) for mand 1, 99% (range, 94-100) for mand 2, 93% (range, 83-100) for mand 3, 94% (range, 94-100), and 99% (range, 94-100) for mand 5.

Exact agreement was again used to calculate IOA during the FCT treatment comparison for all target responses including analogue problem behavior, initial FCRs, terminal FCRs, and other untaught mands. IOA was calculated for 43% (range, 37 to 58%) of sessions across participants. During the FCT-M treatment evaluation, Ali's IOA was 100% for analogue problem behavior, the initial FCR, the terminal FCR, and other FCRs. During the FCT-S treatment evaluation, IOA for Ali was 100% for analogue problem behavior, 100% for the initial FCR, 100% for the terminal FCR, and 100% for other FCRs. Yaritza's IOA during the FCT-M treatment evaluation for analogue problem behavior was 100%. IOA for the initial FCR was 100%, while the IOA for the terminal FCR was 99% (range 94-100%), and IOA for other mands was 98% (range, 94-100%). During the FCT-S treatment evaluation, Yaritza's IOA for analogue problem behavior was 100%, the simple FCR was 97% (range 89-100%), and for other untaught mands IOA was 100%. During the FCT-M treatment evaluation, Lev's IOA was 100% for analogue problem behavior, 100% for initial FCRs, 99% (range, 97-100) for terminal FCRs, and 99% for other mands. During the FCT-S treatment evaluation, Lev's IOA was 100% for analogue problem behavior, 98% (range, 93-100) for the initial FCR, and 100% for other untaught mands. For Robin's FCT-M treatment evaluation, IOA was 100% for the analogue problem behavior, 98% (range, 89-100) for the initial FCT, 100% for the terminal FCR, and 99% (range, 94-100) for other mands. During the FCT-S treatment evaluation for Robin, the analogue problem behavior IOA was 100%, the initial FCR IOA was 99% (range, 98-100), and the other untaught mands were 100%. A summary of all IOA can be found in Table 1.

We also analyzed the accuracy of implementation of different components of treatment (see Appendix for checklist) to calculate treatment integrity for a minimum of 34% of sessions per participant. Since this experiment involves evaluated rate of behavior during extinction

conditions, our analysis of treatment fidelity components included dependent fidelity, or whether reinforcers are dependent on the target mand for a particular phase in order to ensure that participants were not exposed to extinction prior to resurgence tests. Within our analysis, we identified the number of errors of omission, where the interventionist failed to deliver the reinforcer following the target mand. We then divided the number of non-errors of omission by the total opportunities to deliver a reinforcer and multiplied the quotient by 100 to get the percentage of target mands that were accurately followed by reinforcement delivery. Percentage of correctly reinforced mands was 100% for all participants in the mand analysis as well as across all phases of FCT-S and FCT-M, meaning there were no errors of omission. We also identified errors of commission, where the interventionist delivered the reinforcer before a target mand or after an incorrect response. We then divided the number of correctly delivered reinforcers by the total number of times reinforcers were delivered for each phase, then multiplied the quotient by 100 to get the percentage of times the reinforcer was delivered correctly. The percentage of correctly reinforced mands was 100% for all participants in the mand analysis and across all phases of FCT-S and FCT-M, meaning there were no errors of commission. We calculated overall dependent fidelity by dividing the number of occurrences with fidelity, or no errors of commission or omission, by the number of fidelity plus error, then multiplied by 100. Dependent fidelity was 100% for all participants across all phases for the analyzed IOA sessions.

We also analyzed individual components of treatment and calculated overall treatment integrity across the FCT-M and FCT-S phases (see Appendix B for details). We scored each category for each trial as correct or incorrect, then calculated the number of correctly

administered trials and divided it by the total number of trials. Overall treatment integrity across all phases for all participants was 100%.

General Procedures

Each participant experienced the sequence of a preference assessment, mand analysis, and then the FCT treatment comparison. Visits were approximately 30 to 60 min with no more than one visit per day per participant. We conducted a mand analysis as described in Ghaemmaghami et al. (2016) for all participants to identify the most prominent pre-existing mand form specific to each reinforcer. The first FCT condition (FCT-M) used the results of the test condition from the mand analysis as the baseline. The FCT-M treatment included the most-preferred item from the preference assessment because it was assumed to be more likely to contribute to resurgence in the condition hypothesized to result in less resurgence (i.e., preparations counter to the confounds). In addition, participants experienced FCT-M with terminal FCRs that were varied or complex from the initial FCR. A random number generator was used to randomly assign participants to either varied or complex FCRs. Ali and Lev were taught varied FCRs, while Yaritza and Robin were taught complex FCRs. The sequence was then repeated starting with another mand analysis. In the second mand analysis, we used the second preferred item from the preference assessment before the FCT-S condition. In order to enhance the social validity of the procedures, we also followed sessions of FCT with the parent's preferred mand form for each participant following all treatment procedures so that the participant did not leave the translational evaluation having last experienced extinction conditions for appropriate manding (data available upon request). Parents were also provided with a summary report describing how to continue teaching mands and a short session of modeling and role-play with a BCBA for teaching mands was provided to all caregivers.

Procedures

Preference Assessment

To determine preferred items for inclusion in the treatment evaluation, we conducted an MSWO preference assessment (DeLeon & Iwata, 1996). First, we selected five to seven items identified by caregivers as possible preferred items. Only items that were sufficiently considered to be "different" from each other were included to reduce any interactive effects (e.g., if two electronic devices like a tablet and an iPad were available, we ensured that different activities such as the camera app versus videos or games were available on each, then further differentiated the items with colored cases). Then, we arranged these items in an array in front of the participant. Participants were allowed to select an item to engage with for 30 s or a small piece to consume until finished, then the item was removed from the array until all items were selected. This process was repeated three times. The most-preferred item was identified as the item consistently selected first from the array and was assigned to the FCT-M condition. The second preferred item was the item consistently selected second from the array and was assigned to the FCT-S condition. These assignments were made because greater preference for an item is expected to be an establishing operation for greater rates of responding. If we still see an experimental effect of greater resurgence in the FCT-S condition despite the systematic confound of differential preference, we can more confidently state that this effect is due to treatment type, not preference.

Mand Analysis

To identify a pre-existing mand response form, we used the mand analysis described by Ghaemmaghami et al. (2016). First, we asked parents to identify any idiosyncratic forms of communication previously used by the participant to pinpoint potential mands for the experimenter to reinforce. The control condition of the mand analysis consisted of non-

contingent continuous access to the more-preferred item. Any communication that occurred during the control condition was ignored. The test condition of the mand analysis was preceded by brief (30 s to 1 min) access to the more-preferred item, after which the session began and the item was removed. The experimenter blocked access to the more-preferred item and any form of mand (including non-verbal mands such as sign or pointing) resulted in 30 s access to the item. The mand (i.e., pre-existing mand form) that occurred at the highest rate was selected for use in the remainder of the study as the analogue for problem behavior.

FCT Treatment Comparison

Training on all FCRs across all conditions took place prior to sessions. The experimenter first explained to the participant how they should communicate for their preferred items. Then the experimenter modeled the target form of communication, followed by practicing with the participant. Once the participant exhibited the target mand independently two times consecutively, the session began. All FCT sessions were five minutes long.

The FCT treatment comparison included an FCT-M condition and an FCT-S condition. FCT-M consisted of teaching an initial FCR followed by a terminal FCR. The FCRs were taught in pairs in that the participant either experienced single (initial) and varied (terminal) or simple (initial) and complex (terminal). Teaching the initial FCR began with the removal of the item. If the participant emitted the targeted initial FCR, the item was returned for 30 s. If the child attempted to get up from the table, they were told they needed to stay. If the participant indicated interest in the item (e.g., looking, reaching, emitting the pre-existing mand) but did not emit the initial FCR within 5 s or emitted a mand other than the initial FCR, we provided an indirect verbal model (“Remember, you can ask for it”), followed by a full-verbal model as needed. For Robin, we used written prompts due to his difficulty with verbal imitation skills. If the

participant did not express interest in the item (e.g., engaged with other items, left the area where the item was), we provided a reminder such as, “remember if you would like to play with your [item], all you have to say is, ‘[target FCR]’”. After three consecutive sessions of stable responding of the initial FCR, we progressed to teaching the terminal FCR. For this stage, we used the same procedures as during the initial FCR condition, but shifted the contingency to the terminal FCR. If the participant emitted the terminal FCR, the item was returned for 30 s. In addition, the initial FCR no longer produced the item and the pre-existing mand continued to be on extinction. Sessions continued until the participant engaged in three consecutive sessions of stable responding of the terminal FCR.

The FCT-S condition consisted of the initial FCR procedures only (i.e., single or simple FCRs). The number of sessions in the FCT-S condition was yoked to the total number of sessions in the previous FCT-M condition for each participant. That is, even though the participant was taught two separate FCRs in the FCT-M condition and only one FCR in the FCT-S condition, they experienced the same number of sessions in both conditions. We did this to equate reinforcement history prior to implementation of extinction.

Extinction was the final phase conducted twice, once following FCT-M and once following FCT-S. Prior to session, the participant was provided with 30 s of access to the preferred item. Then, the item was removed and placed out of reach but within view of the participant. The experimenter remained in the session room but all previously reinforced mands and problem behavior were ignored. During all extinction sessions, the same low-preferred leisure items identified by caregivers that were present throughout all previous sessions continued to be freely available. The number of sessions in the FCT-S resurgence test condition

was also yoked to the number of resurgence test sessions in the FCT-M condition to provide an equal comparison.

Social Validity

Caregivers completed a social validity questionnaire following treatment that asked them to rate 9 questions on a 7-point Likert scale ranging from acceptable/not acceptable, helpful/not helpful, and satisfied/not satisfied. Caregivers were also asked which treatment they would recommend to others: FCT-M, FCT-S, or neither. The social validity questionnaire was administered following completion of all participants. Due to COVID-19 quarantine, the questionnaire was administered by phone for all participants.

Experimental Design

For the mand analysis, we used a multi-element design with a test and matched control condition rapidly alternated in the following order: control, test, control, test, and test. Beginning each session with a control condition allowed the experimenter to pair themselves with rich reinforcement conditions and build rapport with the participant. We conducted two back-to-back test conditions in the final two sessions to confirm that sequence effects were not impacting behavior.

During the FCT-S treatment evaluation, we used a standard resurgence ABC design (e.g., Epstein, 1983) where A refers to the reinforcement of the analogue problem behavior, B refers to the shift in contingency to reinforcing the target FCR, and C refers to the final step of placing all behavior on extinction. The experimental design included an additional step (ABCD) during the FCT-M treatment evaluation, which involved teaching an additional form of communication before initiating extinction. In the standard research paradigm, demonstration of functional control is indicated by behavioral change as a function of changing reinforcement schedules.

Each participant experienced two FCT conditions to provide a within-subjects comparison between the FCT-M and the FCT-S condition, in that order, in an AB design similar to those used in previous investigations of resurgence (e.g., Falcomata et al., 2018; Lambert et al., 2015). All participants experienced that specific order to counter the hypothesized sequence effects of repeated exposure to extinction. In other words, extinction conditions are expected to have less pronounced effects on resurgence behavior each time extinction is implemented (Kestner et al., 2018) and this would act as a confound if the subsequent condition is expected to result in similar effects. Therefore, we isolated the effects of the treatment from those of the possible confound of repeated exposure by conducting the FCT-M condition first (i.e., the condition hypothesized to contribute to less resurgence) and the FCT-S condition last (i.e., the condition hypothesized to contribute to greater resurgence).

Results

Preference Assessment

Results of the MSWOs for all participants are presented in Figure 1. We calculated a mean ranking across the three MSWO applications to identify a top-ranked item, which we selected for use in the FCT-M evaluation, and a second-ranked item, which we selected for use in the FCT-S evaluation. The top-ranked and second-ranked items for Ali were crayons and glitter putty, respectively. For Yaritza, the top- and second-ranked items were iPad and tablet. Lev's top item was a sand tray (small portable sand box and toys) and his second-ranked item was an alphabet puzzle. Robin's top-ranked item was play-doh and his second-ranked item was silly putty.

Mand Analysis

Overall rates for all mands for Ali (Figure 2) were elevated during the test condition of the mand analysis that preceded the FCT-M treatment (top left panel) and the mand analysis that preceded the FCT-S treatment (top right panel). No manding was observed during the control condition for either the multiple or single conditions. In the disaggregated representation of pre-existing mands, Mand 1 occurred most often (*M* = 3.67 RPM; range, 2 to 5 RPM), with other mands occurring infrequently in the mand analysis that preceded the FCT-M treatment (bottom left panel). In the mand analysis that preceded the FCT-S treatment (bottom right panel), Mand 1 occurred most often (*M* = 3 RPM; range, 2 to 4). In addition, by the final session only one mand was occurring in both mand analyses. Ali's Mand 1 represented as the analogue problem behavior in the FCT-M treatment was "Can I have the crayons please", while Mand 1 represented in the FCT-S treatment was "Can I have it now".

In the mand analysis for Yaritza's FCT-M evaluation, no manding occurred during the control sessions, while high rates of manding occurred during the test sessions (Figure 3, top left panel). Manding in the test sessions was allocated to several different mands; however, one mand topography occurred at high rates during all sessions, so was selected for the analogue problem behavior. In the disaggregated representation of the pre-existing mands (bottom left panel), Mand 1 occurred across all sessions and at the highest rates during the last two sessions (*M* = 2 RPM; range, 1 to 3). In the mand analysis for Yaritza's FCT-S evaluation, a similar pattern was observed: no manding during the control sessions and high rates of manding during the test sessions (top right panel). Manding during the test sessions was allocated across several mand forms, but one mand topography occurred at high rates during all test sessions (*M* = 3 RPM; range, 2 to 4), so was selected as the analogue problem behavior. Yaritza's most frequently used

mand during the mand analysis preceding the FCT-M treatment was “watch it again” and in the FCT-S treatment was “I need a video.”

The results of Lev’s mand analysis are presented in Figure 4. Elevated rates of all mands were observed in the test conditions preceding the FCT-M treatment, while no manding occurred in the control conditions. In the disaggregated representation of pre-existing mands, Mand 1 occurred the most during the mand analysis that preceded the FCT-M treatment (*M* = 0.89 RPM; range, 0.33 to 1.33) and FCT-S treatment (*M* = 1.44 RPM; range, 0.33 to 2.00). When the topographies of the pre-existing mands were disaggregated, we observed an increased variety in mand topography in the final test session of the mand analysis preceding the FCT-M treatment. However, one mand was emitted more often in both mand analyses. Lev’s Mand 1 in the FCT-M treatment and FCT-S treatment was “I love to play with this too” and “Could I have those please”, respectively.

No manding occurred during Robin’s control sessions in the mand analysis that preceded the FCT-M evaluation (Figure 5, top right panel). During the mand analysis test sessions, elevated rates of all mands were observed. In the disaggregated representation of pre-existing mands, Mand 1 occurred most often (*M* = 4.67 RPM; range, 3 to 6), with other mands occurring infrequently (bottom left panel). In the mand analysis preceding the FCT-S treatment (bottom right panel), Mand 1 occurred most often (*M* = 4.33 RPM; range, 2 to 6). In addition, by the final session, only one mand was occurring in both mand analyses. During the mand analysis preceding Robin’s FCT-S evaluation, manding was allocated to one mand topography in test sessions 2 and 3. We selected this mand as the analogue problem behavior for the FCT-S evaluation. Robin’s most frequently used mand in the mand analysis preceding the FCT-M

treatment was “blue again” and was “play-doh please” in the mand analysis preceding the FCT-S treatment.

FCT Treatment Comparison

Results of the FCT treatment comparison for Ali are presented in Figure 6. During baseline of the FCT-M treatment evaluation (left panels), we observed elevated rates of the analogue problem behavior (*M* = 1.22 RPM; *SD* = 0.51) while no single or varied FCRs occurred. Other untargeted FCRs remained low and on a decreasing trend (*M* = 0.44 RPM; *SD* = 0.51). When FCT was introduced reinforcing the single FCR, analogue problem behavior was eliminated and remained eliminated, the single FCR increased (*M* = 1.77 RPM; *SD* = 0.29), and the other untargeted FCRs that had been present during the mand analysis remained low and eventually decreased to zero (*M* = 0.03 RPM; *SD* = 0.08)The varied FCR was then reinforced and the analogue problem behavior remained eliminated while single FCRs decreased (*M* = 0.08 RPM; *SD* = 0.11) and the varied FCR increased (*M* = 1.56 RPM; *SD* = 0.43). Other untargeted FCRs remained low (*M* = 0.04 RPM; *SD* = 0.09). Only the varied FCR (*M* = 0.40 RPM; *SD* = 0.87) and the other untargeted FCRs (*M* = 0.60 RPM; *SD* = 0.69) occurred during the extinction condition and were eliminated by the final sessions. All other mands were different topographies than those present in the mand analysis. The baseline of the FCT-S treatment evaluation (right panels) was then introduced for Ali and elevated rates of the analogue problem behavior were observed (*M* = 1.00 RPM; *SD* = 0.33). The single FCR increased (*M* = 1.67 RPM; *SD* = 0.34) when FCT was initiated and no other behavior occurred. During the extinction condition, low rates of the single FCR (*M* = 0.15 RPM; *SD* = 0.19) and other untargeted FCRs (*M* = 0.05 RPM; *SD* = 0.10) were observed while analogue problem behavior remained eliminated. All other untargeted mands were novel and had not been present during the mand analysis.

Yaritza's FCT treatment comparison data are found in Figure 7. During baseline of the FCT-M treatment evaluation (left panels), we observed elevated rates of the analogue problem behavior (*M* = 0.67 RPM; *SD* = 0.33) while no simple or complex FCRs occurred. Other untargeted FCRs remained low (*M* = 0.78 RPM; *SD* = 0.19). When FCT was introduced reinforcing the simple FCR, analogue problem behavior occurred at low rates and on a decreasing trend (*M* = 0.14 RPM; *SD* = 0.38), the simple FCR increased (*M* = 1.31 RPM; *SD* = 0.59), and the other untargeted FCRs followed a decreasing trend (*M* = 0.20 RPM; *SD* = 0.28). The complex FCR was then reinforced and the analogue problem behavior remained eliminated while simple FCRs decreased (*M* = 0.96 RPM; *SD* = 0.78) and the complex FCR increased (*M* = 1.08 RPM; *SD* = 0.52). Other untargeted FCRs remained low (*M* = 0.04 RPM; *SD* = 0.08) and were all different topographies from those in the mand analysis During the extinction condition, the complex FCR occurred at elevated rates initially but followed a decreasing trend (*M* = 1.56 RPM; *SD* = 2.33), the simple FCR occurred at low rates and also followed a decreasing trend (*M* = 0.04 RPM; *SD* = 0.09) and the other untargeted FCRs that were present during the mand analysis occurred at low rates and followed a decreasing trend as well (*M* = 0.20 RPM; *SD* = 0.24). All mands were eliminated by the final sessions. The baseline of the FCT-S treatment evaluation (right panels) was then introduced for Yaritza and elevated rates of the analogue problem behavior were observed (*M* = 1.00 RPM; *SD* = 0.33), as well as for other untargeted FCRs (*M* = 0.89 RPM; *SD* = 0.19). The single FCR increased (*M* = 1.60 RPM; *SD* = 0.39) when FCT was initiated and no other behavior occurred, but some analogue problem behavior did continue during the first sessions (*M* = 0.06 RPM; *SD* = 0.17). During the extinction condition, low rates of the single FCR (*M* = 0.64 RPM; *SD* = 0.70) and other untargeted FCRs (*M* = 0.24 RPM; *SD* = 0.36) were observed. Other untargeted mands were all different topographies from

the mands used in the mand analysis. Resurgence of the analogue problem behavior also occurred at low rates during initial extinction sessions (*M* = 0.04 RPM; *SD* = 0.09).

Lev's treatment comparison results are presented in Figure 8. Elevated rates of the analogue problem behavior were observed in baseline of the FCT-M treatment evaluation (left panels, *M* = 0.89 RPM; *SD* = 0.51). During baseline of the FCT-M treatment evaluation (left panels), no single or varied FCRs occurred. Other untargeted FCRs remained low for the first two sessions and increased during session 3 (*M* = 0.67 RPM; *SD* = 0.58). When the single FCR was reinforced during FCT, analogue problem behavior was eliminated, the single FCR increased (*M* = 1.80 RPM; *SD* = 0.00), and the other untargeted FCRs from the mand analysis were eliminated. The varied FCR was then reinforced and the analogue problem behavior remained eliminated while single FCRs decreased (*M* = 0.07 RPM; *SD* = 0.12) and the varied FCR increased (*M* = 1.53 RPM; *SD* = 0.12) ,while other untargeted FCRs remained eliminated. Only the varied FCR (*M* = 1.00 RPM; *SD* = 1.73) and the other untargeted FCRs (*M* = 0.47 RPM; *SD* = 0.64) occurred during the extinction condition and were eliminated by the final sessions. The other untargeted FCRs were all novel topographies when compared to the mands present in the mand analysis. During Lev's FCT-S treatment evaluation (right panels), elevated rates of the analogue problem behavior were observed (*M* = 1.44 RPM; *SD* = 0.96) during baseline. The single FCR increased (*M* = 1.73 RPM; *SD* = 0.21) when FCT was initiated and no other behavior occurred. During the extinction condition, low rates of the single FCR (*M* = 0.73 RPM; *SD* = 1.10) were observed while no other behavior occurred. Some resurgence of the analogue problem behavior occurred (*M* = 0.07 RPM; *SD* = 0.12).

Results of Robin's FCT treatment comparison are presented in Figure 9. During the FCT-M evaluation baseline, we observed elevated rates of the analogue problem behavior (*M* = 1.56

RPM; *SD* = 0.51) while no simple or complex FCRs occurred. Other untargeted FCRs occurred at elevated rates as well (*M* = 1.00 RPM; *SD* = 1.20). When FCT was introduced with reinforcement of the simple FCR, analogue problem behavior decreased and remained at low rates (*M* = 0.33 RPM; *SD* = 0.52), the simple FCR increased (*M* = 1.60 RPM; *SD* = 0.22), and other untargeted FCRs remained low (*M* = 0.23 RPM; *SD* = 0.23). The complex FCR was then reinforced and the analogue problem behavior remained eliminated while simple FCRs decreased (*M* = 0.32 RPM; *SD* = 0.52) and the complex FCR increased (*M* = 1.40 RPM; *SD* = 0.58). Other untargeted FCRs remained low (*M* = 0.16 RPM; *SD* = 0.26). During the extinction condition, the simple FCR (*M* = 0.12 RPM; *SD* = 0.18), complex FCR (*M* = 0.60 RPM; *SD* = 0.96) and the other untargeted FCRs (*M* = 0.24 RPM; *SD* = 0.34) occurred. All other untargeted mands were novel topographies from the mand analysis. All were eliminated by the final sessions. The baseline of the FCT-S treatment evaluation (right panels) was then introduced for Robin and elevated rates of the analogue problem behavior were observed (*M* = 1.44 RPM; *SD* = 0.69). When FCT was initiated, the single FCR increased (*M* = 1.78 RPM; *SD* = 0.17) and relatively low rates of other behavior occurred (*M* = 0.67 RPM; *SD* = 0.88). During the extinction condition, the single FCR occurred and followed a decreasing trend (*M* = 0.44 RPM; *SD* = 0.88), while other untaught behavior occurred at low rates and also followed a decreasing trend. All other mands were novel forms compared to the mand analysis. Some resurgence of the analogue problem behavior was also observed (*M* = 0.12 RPM; *SD* = 0.18).

Proportion to Baseline

As individual variability in response rates is common, proportion of responding in treatment as compared to baseline for each individual is a way to control for differences in response rates in baseline (e.g., Nevin et al., 2017). We calculated proportion of analogue

problem behavior in baseline by calculating a mean rate of responding across baseline sessions. The response rates for each response during the extinction sessions were then determined by dividing by the mean baseline rate to get values of proportion to baseline. Values below 1 indicate the target response was occurring less than the respective baseline rate of problem behavior, while values above 1 indicate that the target response was occurring more than the problem behavior during baseline.

The proportion of responding in extinction to baseline responding data for all participants is presented in Figures 10 and 11. Higher proportions of the terminal FCRs (both varied and complex topographies) tended to occur across participants during the first extinction session of the FCT-M treatment with all four participants exhibiting proportions above 1. This indicates a possible extinction burst of the recently taught terminal FCR. In addition, other manding during the first extinction test was near or above 1 for all participants, while initial FCRs and analogue problem behavior did not reemerge. During the FCT-S treatment, we observed a similar possible extinction burst pattern, with three of the four participants exhibiting proportions of the single FCR above 1. While other mands did occur as well during the FCT-S, all three participants who exhibited other mands exhibited those mands at proportions less than 1. Lastly, three of the four participants experienced some resurgence of the analogue problem behavior, albeit at lower proportions than baseline rates of that same analogue problem behavior. Interestingly, although bursts of the recently taught communication forms and emergence of other untaught mand forms were observed in both the FCT-M and FCT-S treatment conditions, proportions were always lower in the FCT-S treatment. This is important to point out because the FCT-S treatment was always experienced second for the participants, suggesting the lower proportions of responding

were a function of repeated exposure to extinction. This is juxtaposed with problem behavior that was not observed during the FCT-M treatment and only observed during the FCT-S treatment.

Social Validity

All caregivers rated both FCT-M and FCT-S treatments as being highly acceptable (7 of 7) and helpful (6.75 of 7). All caregivers also indicated that they were very satisfied with the improvements in the communication skills of their respective children (7 of 7). Although there was no difference between ratings of the two conditions, all caregivers indicated a preference for the FCT-M condition over FCT-S or no treatment when given the opportunity to choose. Furthermore, one caregiver reported that, "the variety of communication is very important because it gives them more comfort for expressing their thoughts." Thus, both variations of FCT may be found to be generally acceptable, but caregivers would largely prefer that the procedures extend to teaching more complex and varied communication skills.

Discussion

Overall, we found less resurgence of the pre-existing mand serving as an analogue problem behavior during FCT teaching multiple forms of communication as compared to FCT teaching a single response for the majority of participants. For the remaining participant, we observed no resurgence of any behaviors (analogue problem behavior or target FCRs). We did observe an increase in the other untargeted mands during extinction when multiple FCRs were taught. We observed no problem behavior for these participants throughout the duration of the study. On social validity follow-up measures, caregivers indicated that both types of treatment were acceptable but, when asked which they preferred, they selected the FCT-M condition.

The results of our study provide evidence for the recency effect when resurgence occurred across participants. That is, when the terminal FCRs were placed on extinction, the

majority of participants returned to allocating responding to the more recently reinforced initial FCR instead of the analogue problem behavior, while the final participant did not demonstrate resurgence at all. The recency effect was observed even though the FCRs were novel and did not have a history of reinforcement, whereas the analogue problem behavior was selected specifically because of its likelihood of long history of reinforcement. This effect was also demonstrated despite the presence of two systematic confounds. First, the item assigned to the FCT-M condition was more preferred than the item assigned to the FCT-S condition. We would expect higher rates of manding during resurgence for the item that is more highly preferred, but that did not occur. Second, repeated extinction dampens the rate of responding. We would expect the rate of responding during extinction to be higher during the second administration of extinction in the FCT-S condition, but this did not occur either. These outcomes have clinical significance in that caregivers are likely to have additional opportunities to reinforce other appropriate mands, redirect individuals away from unavailable reinforcers, or put protective strategies into place before problem behaviors occur. Without the teaching of multiple FCRs, the individual may be more likely to immediately return to problem behavior (primacy effect) when presented with extinction-like conditions.

Resurgence of problem behavior following FCT teaching a single FCR is potentially a problem even after long-term exposure to the FCT treatment. For example, Wacker et al. (2011) conducted FCT with a single response across a mean of 14 months for eight participants who exhibited problem behavior. The authors repeatedly exposed the participants to extinction including an initial phase before treatment and repeated extinction blocks interspersed across multiple months during the treatment. Wacker et al. found that problem behavior continued to occur during the exposure to extinction well within three of the repeated blocks of five of the

eight participants. It is possible that teaching increasingly varied or complex FCRs during FCT may not only improve the social acceptability of the treatment but also its overall efficacy.

It is important to point out that this was a translational study and it is difficult to unequivocally compare a history of reinforcement for pre-existing mands to problem behavior. Problem behavior may be more likely to have a longer history of reinforcement than mands considering that language delays are a defining feature of the diagnosis of ASD. In fact, Matson et al. (2009) found that problem behavior including topographies such as aggression, disruption, and SIB were exhibited in children with ASD as young as 17 to 36 months old. Furthermore, in the sample of 168 participants, problem behavior was negatively correlated with levels of expressive and receptive communication skills. In our study, we did include analogue problem behavior with a history of reinforcement, but this history for a pre-existing mand is unlikely to be as extensive as a history of chronic problem behavior.

The inclusion of free operants (i.e., vocal FCRs) allowed us to evaluate resurgence in a natural context with unrestricted availability to communication responses. In addition, the measurement of "other" untargeted mands made it clear that the repertoires of the participants were not limited in any way. In fact, other mands from that which were reinforced in this study were found to occur frequently in extinction conditions. These outcomes are somewhat juxtaposed with Diaz-Salvat et al. (2020), who suggested that resurgence is more likely to be influenced by the size of the available responses rather than the training of multiple responses. This is not to say that number of response options is not necessarily a factor: the distinction between type of training (multiple versus single) and number of available response options (e.g., number of PECS icons) may be an important distinction for non-vocal modalities such as picture exchanges or across-modality treatments (e.g., that include both pictures and an iPad), but may

be an arbitrary distinction for within-modality vocal response options. For vocal responses, all possible options are available at all times. For those with vocal abilities, the type of training and the number of available response options may both potentially serve to reduce resurgence. In FCT, teaching multiple vocal responses may benefit individuals both in terms of increased availability of responses and also increased repertoire within the same response class. Therefore, it seems of practical value to capitalize on both procedures of teaching multiple forms of communication that expand the participant's repertoire.

Teaching multiple FCRs proved to be successful in reducing resurgence of analogue problem behavior because the participants allocated responding to other available appropriate behavior before ceasing to respond altogether. This increase in variability before the elimination of behavior has been demonstrated with problem behavior (e.g., Sullivan et al., 2020), collateral responses such as excessive manding (e.g., Ghaemmaghami et al., 2016), and variability of mand topography (e.g., Falcomata et al., 2018). For example, Greer et al., (2016) investigated schedule thinning following FCT using three different procedures, one of which was response restriction, where the FCR response card was removed during the extinction components of schedule thinning procedures. While destructive behavior was reduced for the 25 applications with the inclusion of supplemental procedures in some cases, resurgence of destructive behavior continued to occur throughout the schedule thinning process, including when the FCR response card was unavailable. We could not create such an arrangement in our current study because the participants were vocal and their response modality could not be removed or restricted. In addition, contingency-based thinning procedures have been found to be effective and socially acceptable without having to remove a child's ability to communicate (e.g., Hanley et al., 2014). Therefore, we are somewhat limited in determining the effects of sequential training of multiple

FCRs when the responses are no longer available. This seems more likely to affect non-verbal individuals during situations where they may lose their communication board or the battery for a tablet dies. In that sense, extinction is not necessarily in place because the contingency is discontinued but rather because the individual's ability to communicate for the reinforcers has been obstructed. It is possible that the extended exposure to a therapeutic environment with the teaching of a growing communication repertoire may establish a general level of tolerance to extinction conditions. However, this is an area for future research and cannot be addressed in the current study.

Schedule thinning is an important and necessary extension to any behavioral treatment. This study is limited to evaluating extinction effects prior to the process of thinning access to reinforcement. Researchers may consider investigating this FCT treatment comparison with more natural extinction like conditions that are arranged during schedule thinning. For example, in a study with 25 outpatient applications, Jessel et al. (2018) conducted FCT teaching participants increasingly complex FCRs. Reinforcement was thinned following the terminal FCR by progressively increasing a (a) probabilistic number of instructions that needed to be completed following the return of the reinforcers, (b) probabilistic duration without problem behavior, or (c) both. Jessel et al. obtained at least an 80% reduction in problem behavior for all participants following reinforcement thinning without the necessity of supplemental procedures. However, this study only introduced schedule thinning following the teaching of multiple, increasingly complex FCRs. In order to compare the utility of multiple FCRs, reinforcement thinning would need to be introduced in a separate condition following the initial FCR.

Although resurgence of analogue problem behavior did occur during the FCT condition teaching a single response, the rates of problem behavior were far lower during the extinction

condition in comparison to the baseline response rates. Therefore, from a quantitative perspective, FCT teaching multiple responses did improve treatment outcomes but we are unable to determine if these improvements are socially meaningful. The limited reemergence of the analogue problem behavior could have also been influenced by the repeated exposure to extinction. It may be that if the FCT-S condition been implemented first, extinction effects such as resurgence or bursts would have been magnified. Such an effect was observed with the greater extinction bursts of the terminal FCRs in the FCT-M condition. It seems that obtaining even the slightest reemergence of problem behavior in our arrangement may be indicative of a much larger concern in that resurgence of problem behavior occurred even after repeated exposure to extinction. In addition, because we limited our measures to analogue problem behavior in this translational arrangement we are unable to identify other inappropriate collateral behavior (i.e., negative emotional responses) that could have emerged. In fact, collateral responding such as excessive manding or crying could be as disruptive to a therapeutic environment as problem behavior in some cases (Ghaemmaghami et al., 2016). Future researchers may want to extend this research to an applied setting with participants who exhibit problem behavior and measure potential collateral behavior while incorporating teachers and caregivers throughout the process to understand outcomes of social relevance. Furthermore, caregivers in the current study provided little distinction in their rating of the FCT-M and FCT-S procedures; however, more pronounced differences in acceptability and approval may be obtained when actual problem behavior is targeted.

Table 1

Interobserver Agreement and Treatment Fidelity

	PA	Mand Analysis					Treatment Comparison			
	Select	1	2	3	4	5	Analogue PB	Initial FCR	Terminal FCR	Other FCR
Ali	100%	100 (100)	100 (100)	100 (100)	96 (N/A)	100 (N/A)	100 (100)	100 (100)	100 (N/A)	100 (100)
Yaritza	100%	94 (97)	97 (92)	100 (97)	100 (94)	100 (N/A)	100 (100)	100 (97)	99 (N/A)	98 (100)
Lev	100%	94 (100)	98 (100)	94 (100)	100 (N/A)	100 (N/A)	100 (100)	100 (98)	99 (N/A)	99 (100)
Robin	100%	100 (96)	100 (99)	100 (93)	100 (94)	N/A (99)	100 (100)	98 (99)	100 (N/A)	99 (100)
Mean	*100%*	*97 (98)*	*99 (98)*	*99 (98)*	*99 (94)*	*100 (99)*	*100 (100)*	*100 (98)*	*100 (N/A)*	*99 (100)*

Note. PA refers to preference assessment. Select refers to selections. Numbers in parentheses refer to the mean representative of the FCT-S condition.

Table 2

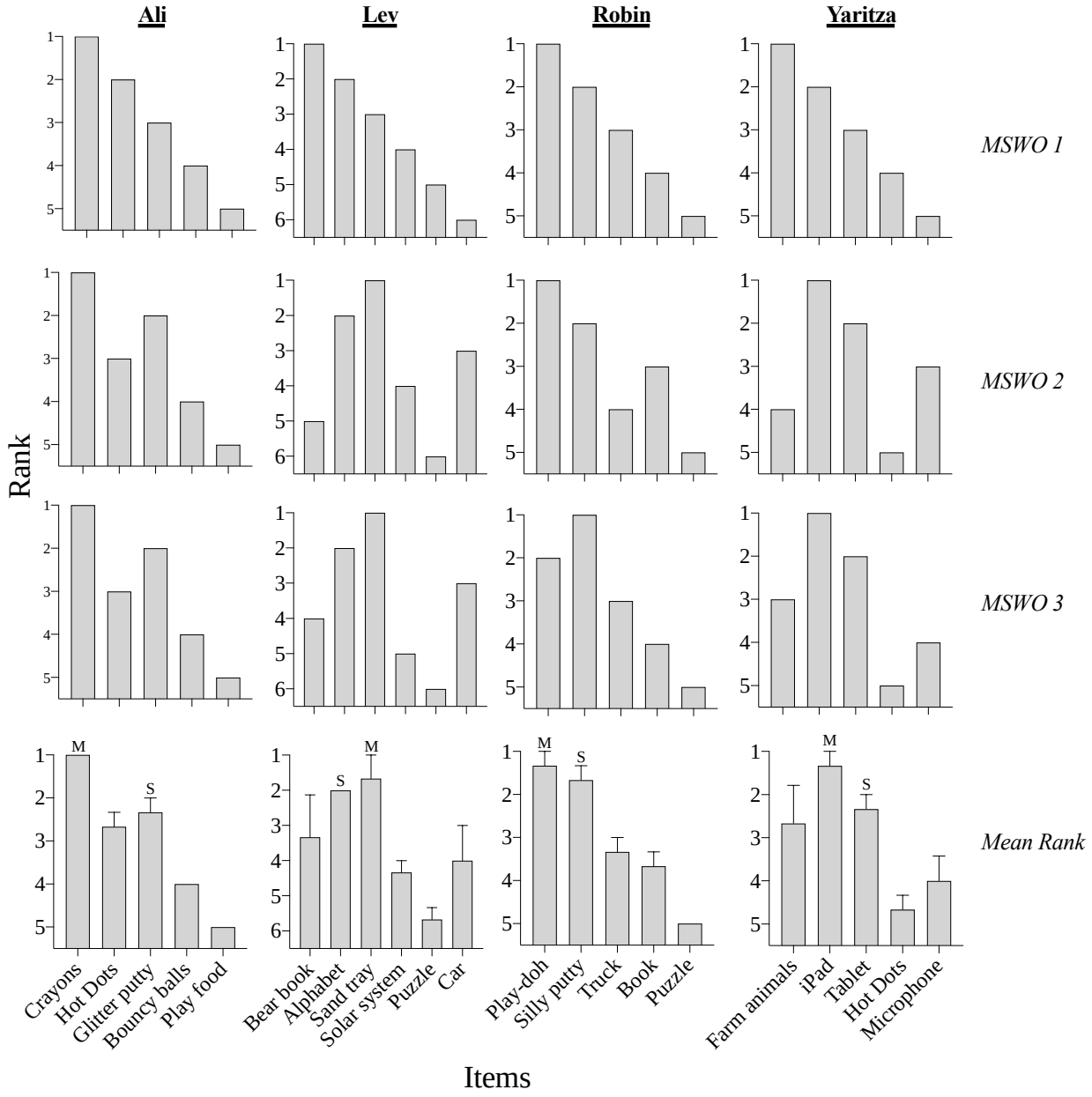
Mand Topographies across Phases

	Mand Analysis		Treatment Comparison	
	FCT-M	FCT-S	Initial FCR	Terminal FCR
Ali	*Can I have the crayons please; Can I draw now; Can I have it; Can I have them please; Can I draw please	*Can I have it now; putty please; I want	Please may I draw now (M); Glitter putty please (S)	Time to make pictures (M)
Yaritza	*Watch it again; I can play more games; I want to sit right here; let's count by ones; let's make a try	*I need a video; I want videos; I want to see the video of dancing; I want to dance it; I want to stand on the chair	Videos please (M); Cat movie please (S)	I want videos please (M)
Lev	*I love to play with this too; Can I play with the sand please; Can I play with these; Can I play please	*Could I have those please; Could I have them back please; Could I have that please	May I have the sand please? (M); Letters please (S)	I would like to play now (M)
Robin	*Blue again, neigh, please have, cactus	*Play-doh please, I want the silly putty please, blue please, I want the play-doh please, Grandpaa please	Putty please (M); Clay (S)	I want putty please (M)

Note. Asterisks indicate the pre-existing mand used to represent the analogue problem behavior in the treatment comparison. (M) refers to the FCR reinforced in the FCT-M condition. (S) refers to the FCR reinforced in in the FCT-S condition.

Figure 1

MSWO Results for All Participants



Note. M refers to the item selected for use in the FCT-M treatment. S refers to the item selected for use in the FCT-S treatment. Error bars represent standard error measurement.

Figure 2

Ali Mand Analysis Results

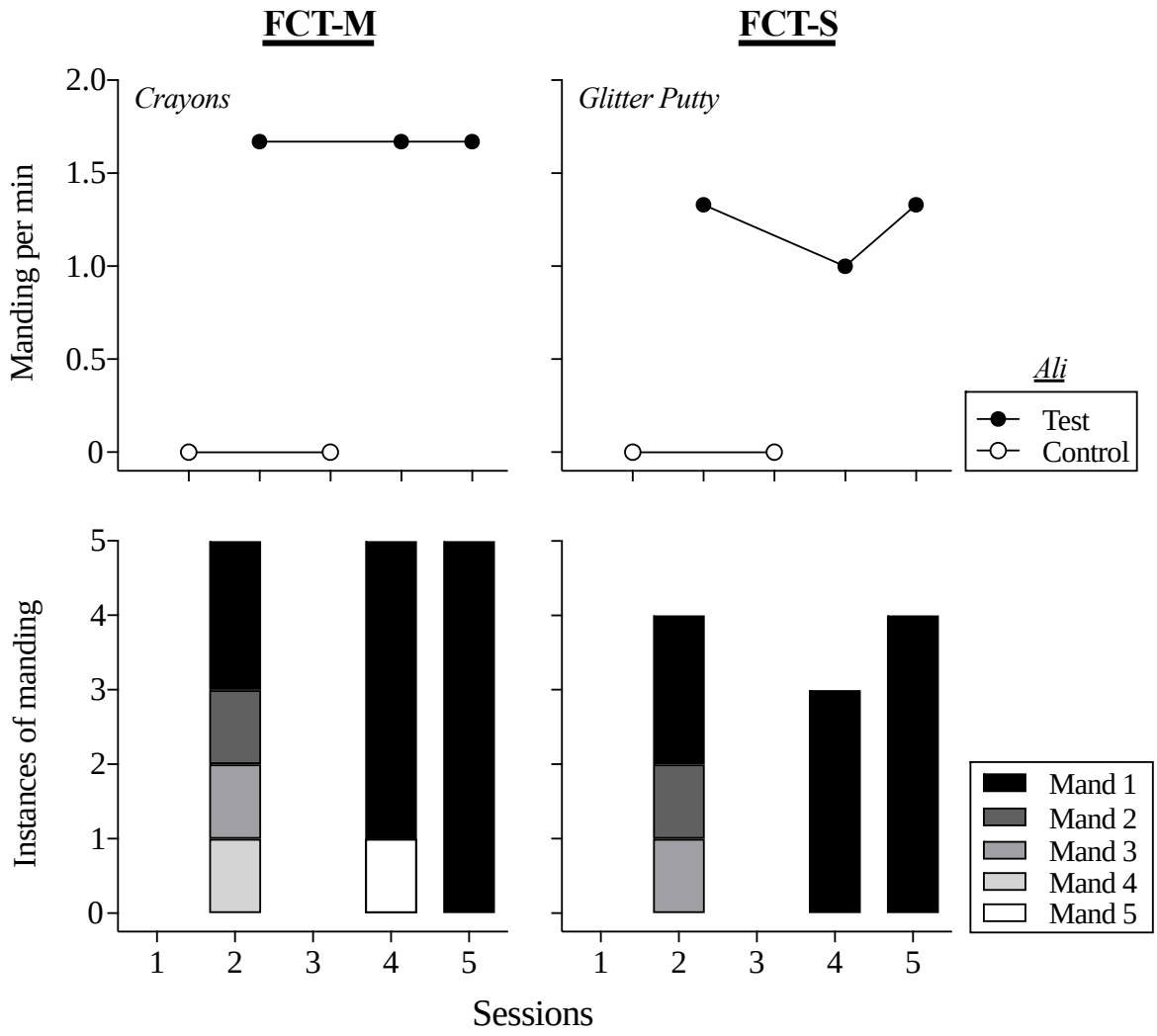


Figure 3

Yaritza Mand Analysis Results

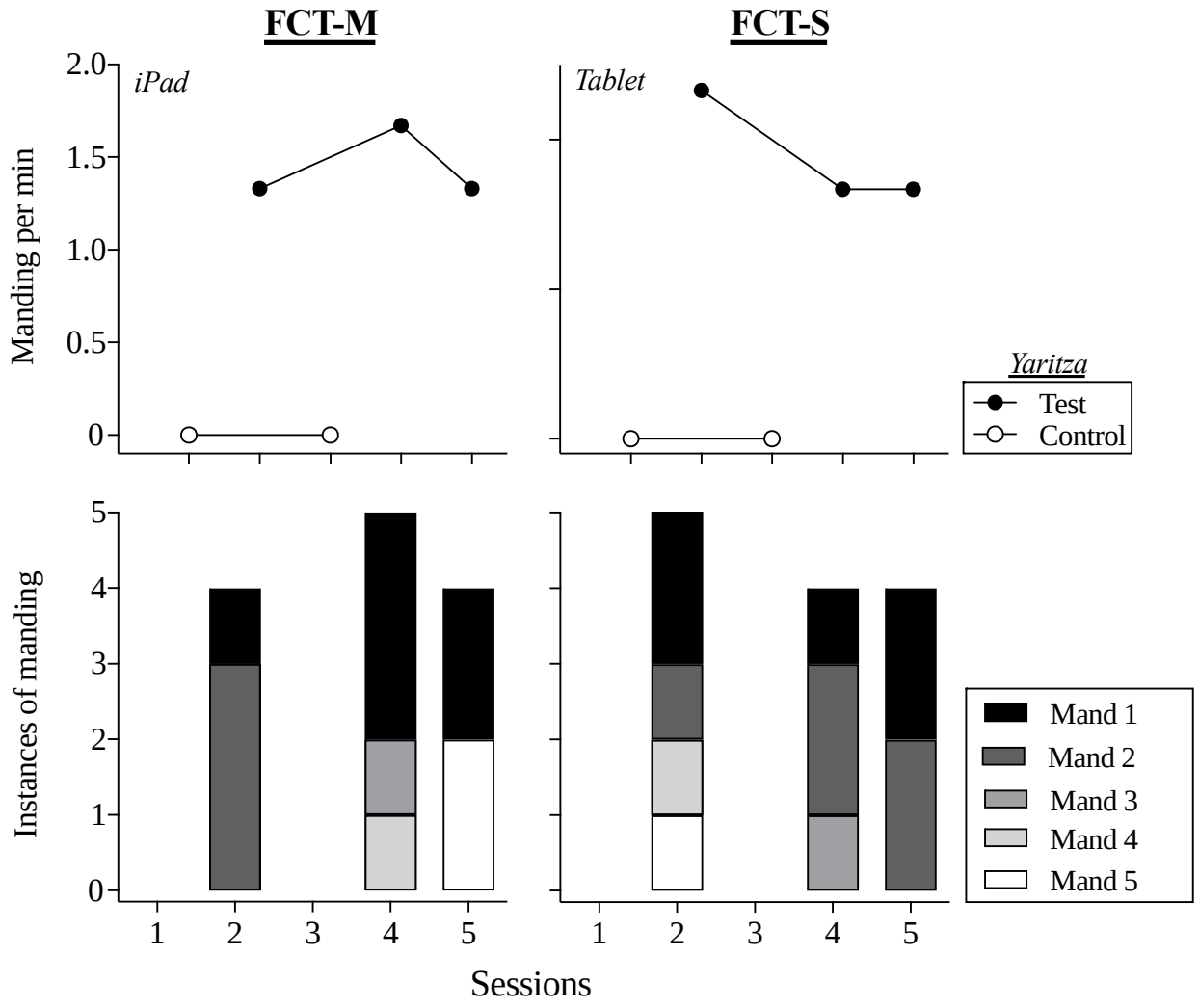


Figure 4

Lev Mand Analysis Results

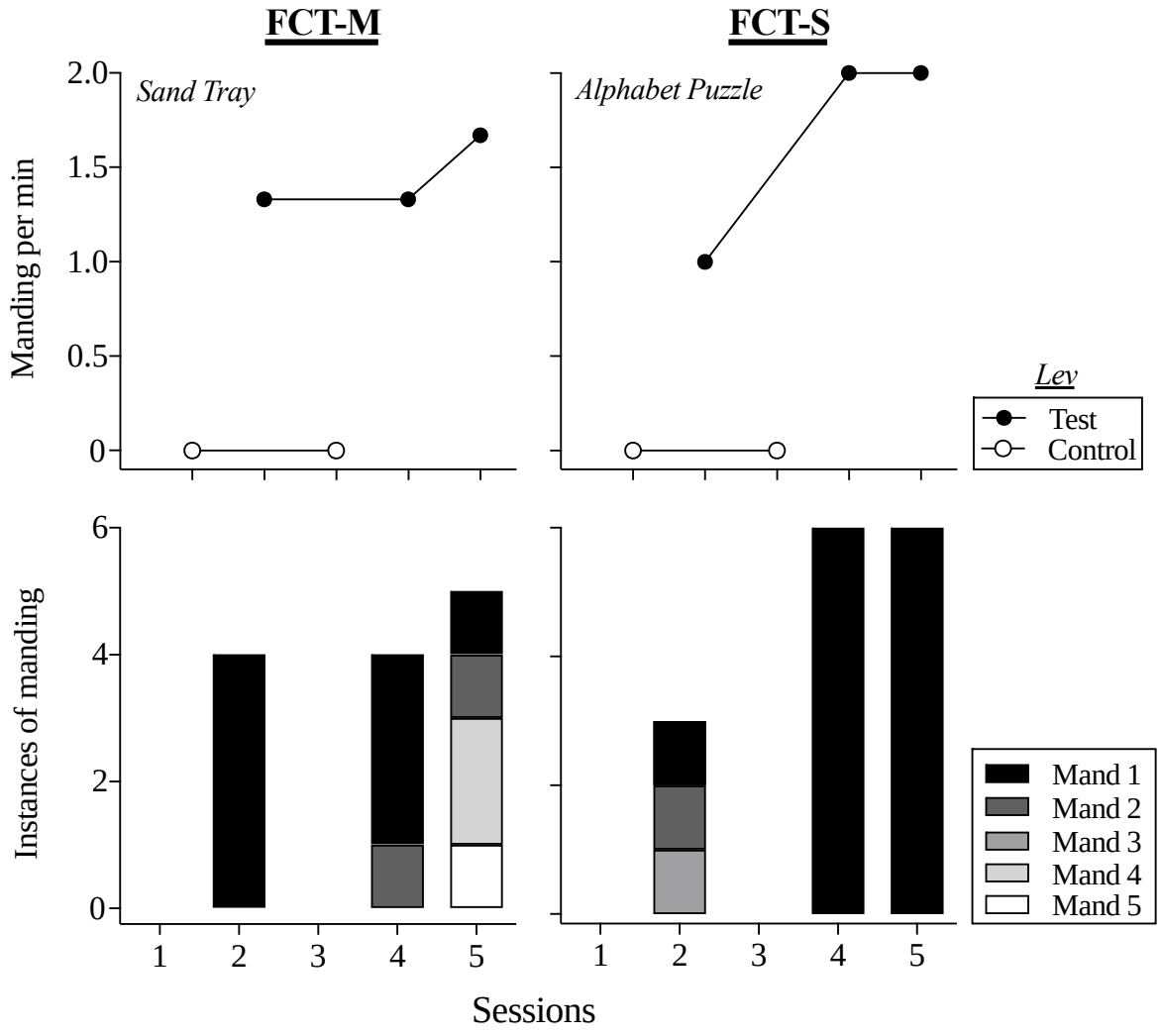


Figure 5

Robin Mand Analysis Results

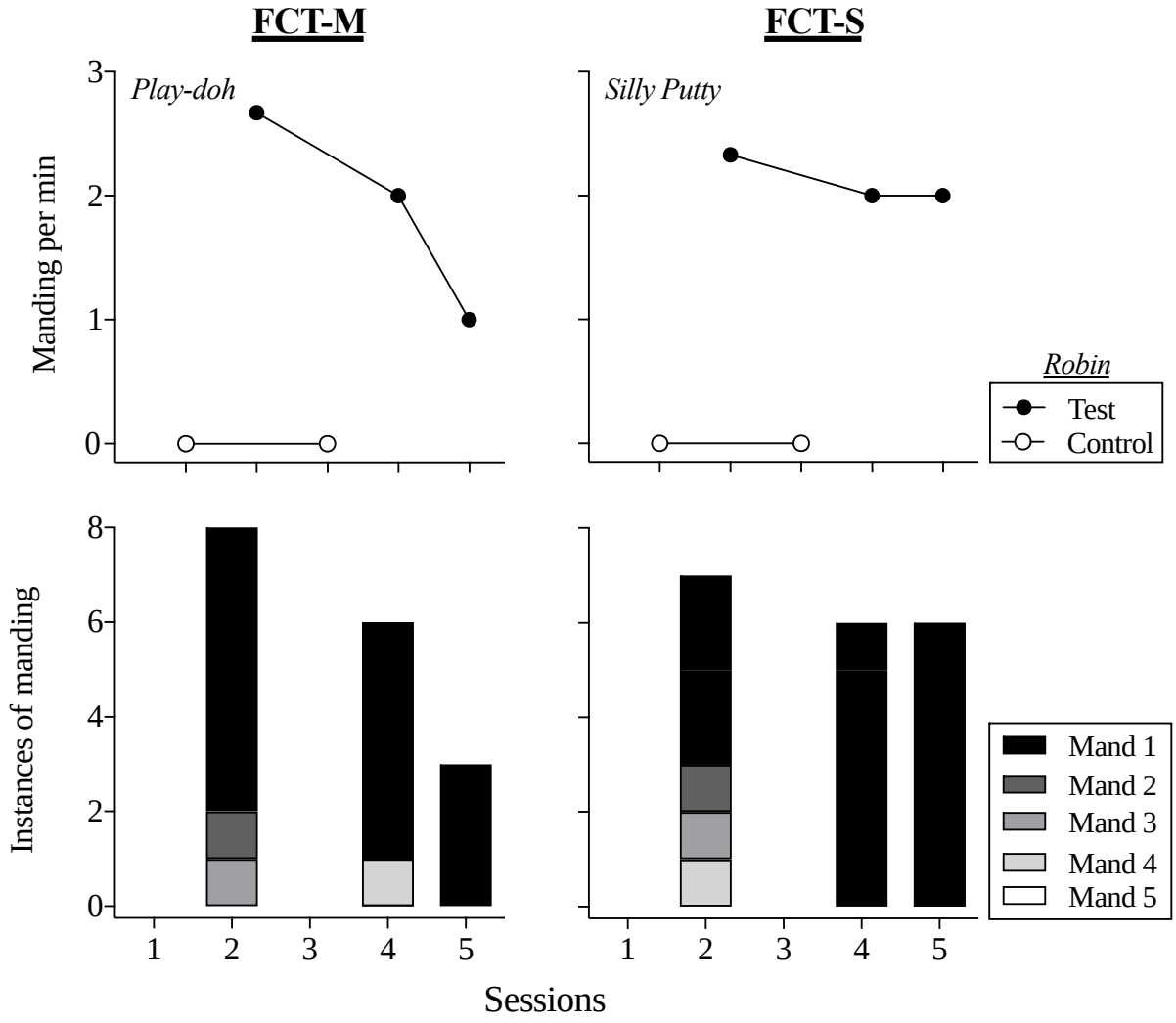
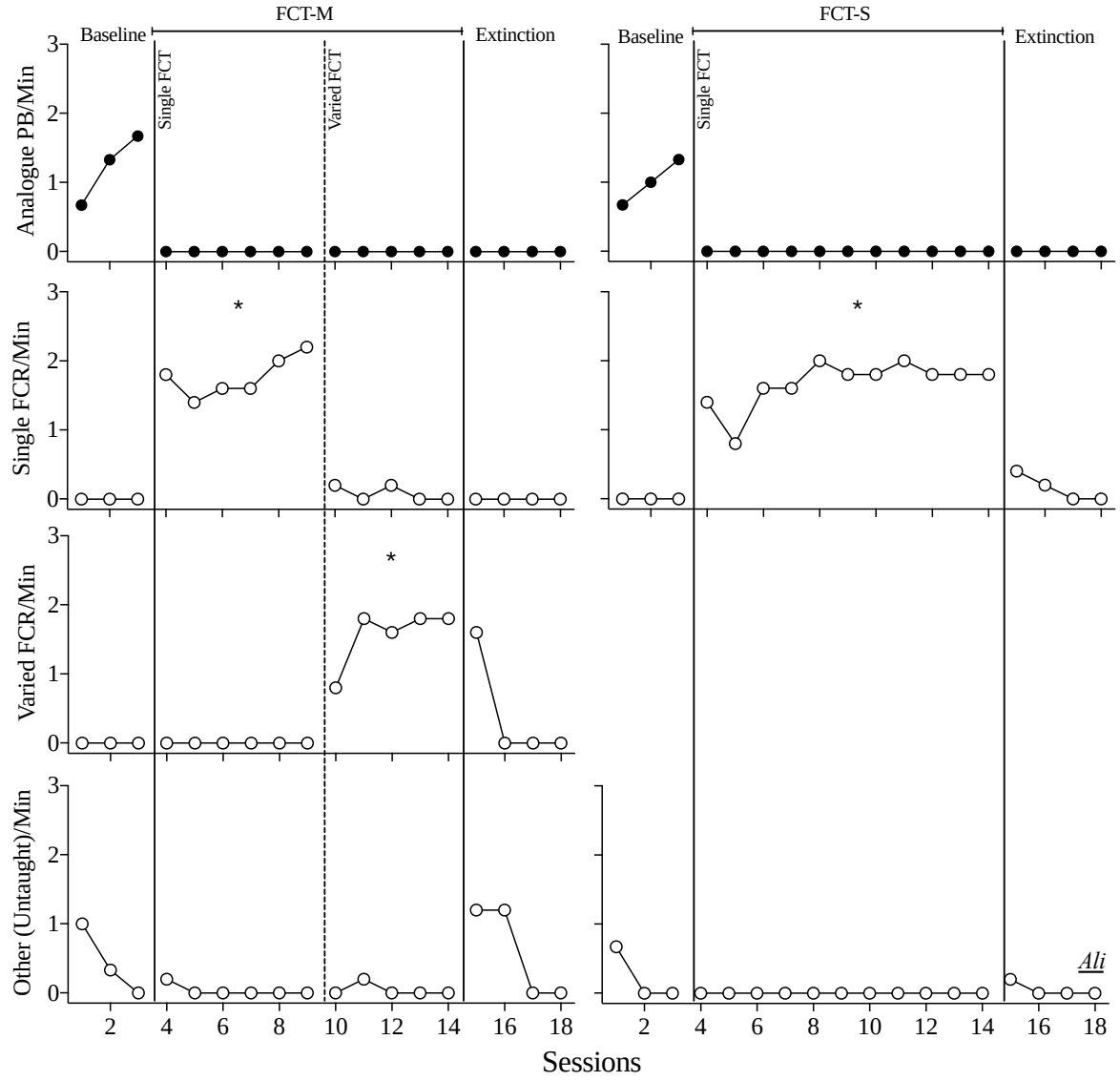


Figure 6

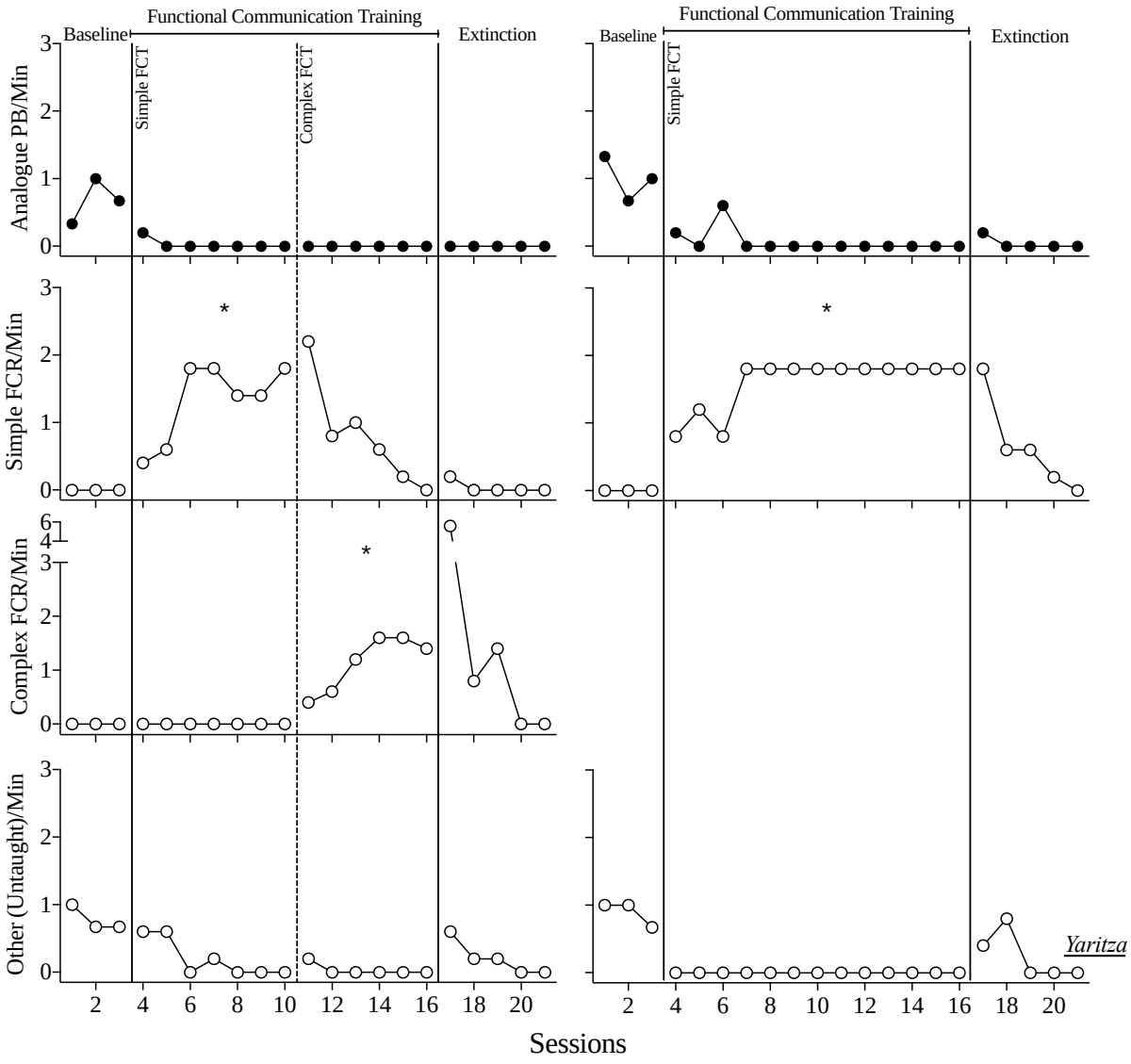
Results of Ali's FCT Treatment Comparison



Note. The asterisk denotes the FCR that was reinforced per phase.

Figure 7

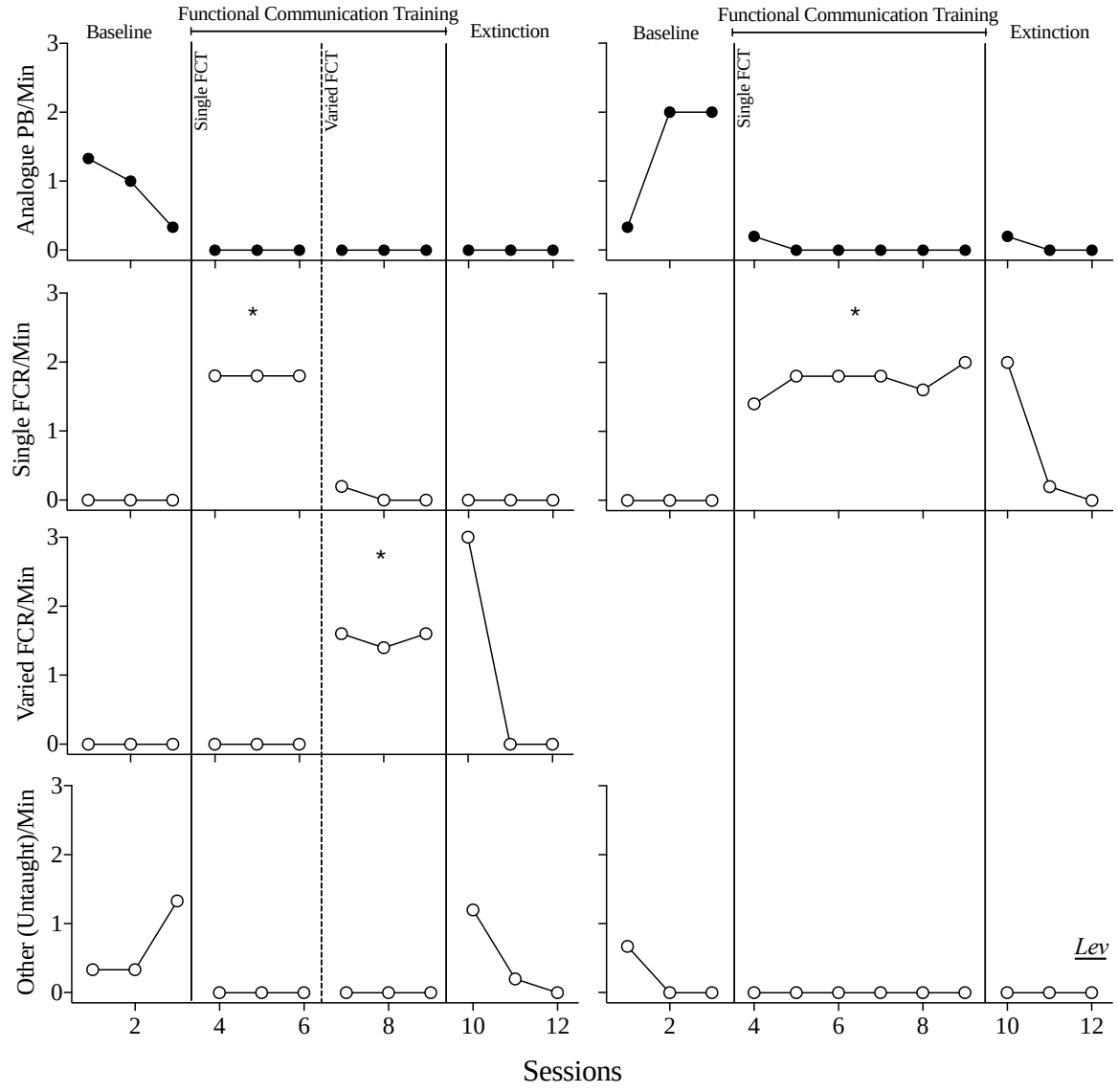
Results of Yaritza's FCT Treatment Comparison



Note. The asterisk denotes the FCR that was reinforced per phase.

Figure 8

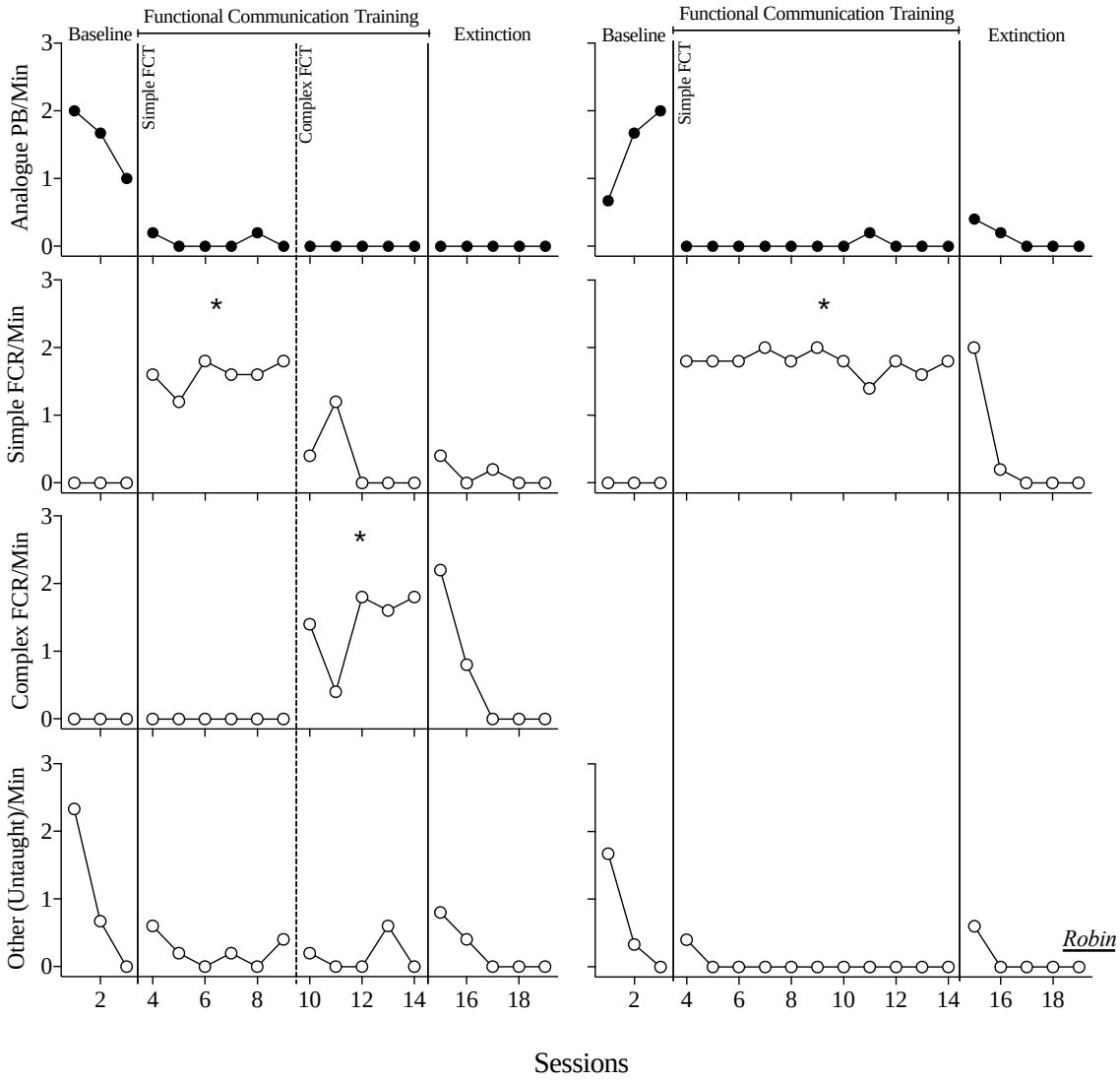
Results of Lev's FCT Treatment Comparison



Note. The asterisk denotes the FCR that was reinforced per phase.

Figure 9

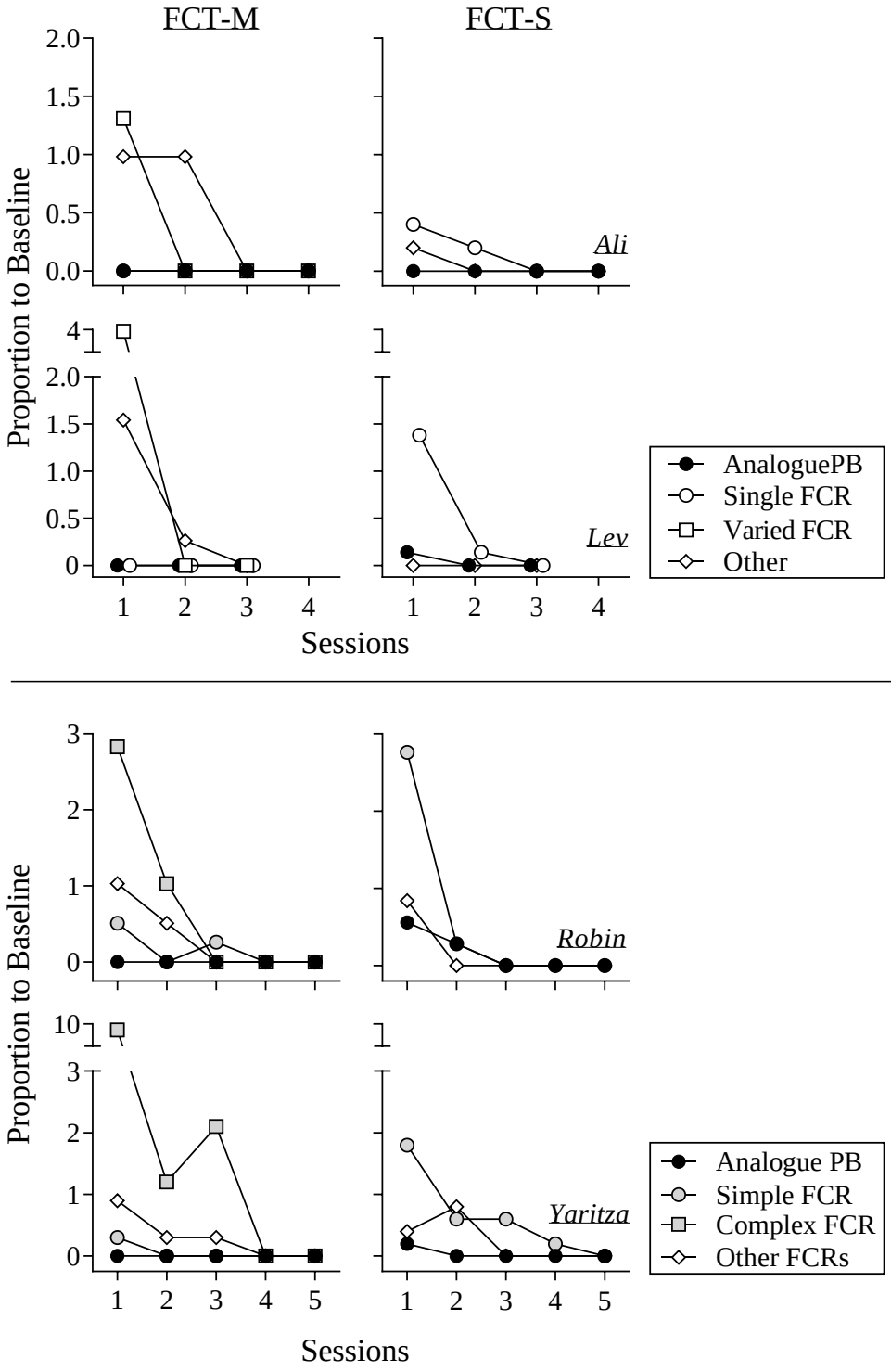
Results of Robin's FCT Treatment Comparison



Note. The asterisk denotes the FCR that was reinforced per phase.

Figure 10

Proportion of Responding in Extinction Compared to Baseline



Appendix A

Procedural Integrity: Mand Analysis

Procedures	**Trials**					
	1	**2**	**3**	**4**	**5**	**6**
Experimenter provides access to relevant reinforcers for duration of all control sessions						
Experimenter delivers the reinforcer(s) contingent on the target mand (analogue for problem behavior) within 1-3 seconds						
Experimenter removes access to reinforcer(s) after 30 seconds (+/- 5 sec)						

Appendix B

Procedural Integrity: FCT (Multiple and Single)

Procedures	**Trials**					
	1	**2**	**3**	**4**	**5**	**6**
Experimenter provides access to relevant reinforcer(s) prior to the trial for at least 30 seconds						
Experimenter provides the relevant EO at the start of the session by removing access to the reinforcers and/or attention						
Experimenter delivers the reinforcer(s) contingent on the target FCR within 1-3 seconds						
Experimenter allows access to the reinforcer(s) for the duration of 30 sec or until the reinforcer is consumed (if edible)						
Experimenter removes access to the reinforcer after the duration of the 30 sec (+/- 5 sec)						
Experimenter does not deliver the reinforcer(s) when the FCR has not occurred						
Experimenter does not deliver the reinforcer(s) when the EO is not present						

Appendix C

Procedural Integrity: Extinction (Resurgence Test)

Procedures	**Trials**					
	1	**2**	**3**	**4**	**5**	**6**
Experimenter provides access to relevant reinforcer(s) prior to the start of the session for at least 30 sec						
Experimenter presents the EO by removing access to all relevant reinforcer(s) at the start of the session						
Experimenter blocks access to all relevant reinforcer(s) for the duration of the session						
Experimenter does not respond to any mands, including analogue problem behavior, target mands, or untaught mands						

References

Adami, S., Falcomata, T. S., Muething, C. S., & Hoffman, K. (2017). An evaluation of lag schedules of reinforcement during functional communication training: Effects on varied mand responding and challenging behavior. *Behavior Analysis in Practice, 10*(3), 209–213. https://doi.org/10.1007/s40617-017-0179-7

American Psychiatric Association, American Psychiatric Association, & DSM-5 Task Force. (2013). *Diagnostic and statistical manual of mental disorders: DSM-5.* http://dsm.psychiatryonline.org/book.aspx?bookid=556

Briggs, A. M., Fisher, W. W., Greer, B. D., & Kimball, R. T. (2018). Prevalence of resurgence of destructive behavior when thinning reinforcement schedules during functional communication training. *Journal of Applied Behavior Analysis*, *51*(3), 620–633. https://doi.org/10.1002/jaba.472

Carr, J. E., Coriaty, S., & Dozier, C. L. (2000). Current issues in the function-based treatment of aberrant behavior in individuals with developmental disabilities. In J. Austin, J. E. Carr, J. Austin (Ed), & J. E. Carr (Ed) (Eds.), *Handbook of applied behavior analysis.* (2001-16421-004; pp. 91–112). Context Press.

DeLeon, I. G., & Iwata, B. A. (1996). Evaluation of a multiple-stimulus presentation format for assessing reinforcer preferences. *Journal of Applied Behavior Analysis*, *29*(4), 519–533. https://doi.org/10.1901/jaba.1996.29-519

Diaz-Salvat, C. C., St. Peter, C. C., & Shuler, N. J. (2020). Increased number of responses may account for reduced resurgence following serial training. *Journal of Applied Behavior Analysis*, 1–17.

Durand, V. M., & Merges, E. (2001). Functional communication training: A contemporary behavior analytic intervention for problem behaviors. *Focus on Autism and Other Developmental Disabilities, 16*(2), 110–119. https://doi.org/10.1177/108835760101600207

Epstein, R. (1983). Resurgence of previously reinforced behavior during extinction. *Behaviour Analysis Letters, 3*(6), 391–397.

Falcomata, T. S., Muething, C. S., Silbaugh, B. C., Adami, S., Hoffman, K., Shpall, C., & Ringdahl, J. E. (2018). Lag schedules and functional communication training: Persistence of mands and relapse of problem behavior. *Behavior Modification, 42*(3), 314–334. https://doi.org/10.1177/0145445517741475

Ghaemmaghami, M., Hanley, G. P., & Jessel, J. (2016). Contingencies promote delay tolerance. *Journal of Applied Behavior Analysis*, *49*(3), 548–575. https://doi.org/10.1002/jaba.333

Ghaemmaghami, M., Hanley, G. P., Jessel, J., & Landa, R. (2018). Shaping complex functional communication responses. *Journal of Applied Behavior Analysis*, *51*(3), 502–520. https://doi.org/10.1002/jaba.468

Gratz, O. H., Wilson, A. N., & Glassford, T. (2018). Evaluating the resurgence of problem behavior with three functionally equivalent discriminated operants. *The Psychological Record*. https://doi.org/10.1007/s40732-018-0305-0

Greer, B. D., Fisher, W. W., Saini, V., Owen, T. M., & Jones, J. K. (2016). Functional communication training during reinforcement schedule thinning: An analysis of 25 applications. *Journal of Applied Behavior Analysis, 49*(1), 105–121. https://doi.org/10.1002/jaba.265

Hagopian, L. P., Boelter, E. W., & Jarmolowicz, D. P. (2011). Reinforcement schedule thinning following functional communication training: Review and recommendations. *Behavior Analysis in Practice*, *4*(1), 4–16.

Hanley, G. P., Iwata, B. A., & Thompson, R. H. (2001). Reinforcement schedule thinning following treatment with functional communication training. *Journal of Applied Behavior Analysis*, *34*(1), 17–38. https://doi.org/10.1901/jaba.2001.34-17

Hanley, G. P., Jin, C. S., Vanselow, N. R., & Hanratty, L. A. (2014). Producing meaningful improvements in problem behavior of children with autism via synthesized analyses and treatments. *Journal of Applied Behavior Analysis*, *47*(1), 16–36. https://doi.org/10.1002/jaba.106

Jessel, J., Ingvarsson, E. T., Metras, R., Kirk, H., & Whipple, R. (2018). Achieving socially significant reductions in problem behavior following the interview-informed synthesized contingency analysis: A summary of 25 outpatient applications. *Journal of Applied Behavior Analysis*, *51*(1), 130–157. https://doi.org/10.1002/jaba.436

Kestner, K. M., Diaz-Salvat, C. C., Peter, C. C. S., & Peterson, S. M. (2018). Assessing the repeatability of resurgence in humans: Implications for the use of within-subject designs. *Journal of the Experimental Analysis of Behavior*, *110*(3), 545–552. https://doi.org/10.1002/jeab.477

Kurtz, P. F., Boelter, E. W., Jarmolowicz, D. P., Chin, M. D., & Hagopian, L. P. (2011). An analysis of functional communication training as an empirically supported treatment for problem behavior displayed by individuals with intellectual disabilities. *Research in Developmental Disabilities*, *32*(6), 2935–2942. https://doi.org/10.1016/j.ridd.2011.05.009

Lambert, J. M., Bloom, S. E., Samaha, A. L., & Dayton, E. (2017). Serial functional communication training: Extending serial DRA to mands and problem behavior. *Behavioral Interventions*, *32*(4), 311–325. https://doi.org/10.1002/bin.1493

Lambert, J. M., Bloom, S. E., Samaha, A. L., Dayton, E., & Rodewald, A. M. (2015). Serial alternative response training as intervention for target response resurgence. *Journal of Applied Behavior Analysis*, *48*(4), 765–780. https://doi.org/10.1002/jaba.253

Lieving, G. A., & Lattal, K. A. (2003). Recency, repeatability, and reinforcer retrenchment: An experimental analysis of resurgence. *Journal of the Experimental Analysis of Behavior*, *80*(2), 217–233. https://doi.org/10.1901/jeab.2003.80-217

Matson, J. L., Boisjoli, J., & Mahan, S. (2009). The relation of communication and challenging behaviors in infants and toddlers with autism spectrum disorders. *Journal of Developmental and Physical Disabilities*, *21*(4), 253–261. https://doi.org/10.1007/s10882-009-9140-1

Matson, J. L., Mahan, S., Hess, J. A., Fodstad, J. C., & Neal, D. (2010). Progression of challenging behaviors in children and adolescents with autism spectrum disorders as measured by the Autism Spectrum Disorders-Problem Behaviors for Children (ASD-PBC). *Research in Autism Spectrum Disorders*, *4*(3), 400–404. https://doi.org/10.1016/j.rasd.2009.10.010

Murphy, O., Healy, O., & Leader, G. (2009). Risk factors for challenging behaviors among 157 children with autism spectrum disorder in Ireland. *Research in Autism Spectrum Disorders*, *3*(2), 474–482. https://doi.org/10.1016/j.rasd.2008.09.008

Nevin, J. A., Craig, A. R., Cunningham, P. J., Podlesnik, C. A., Shahan, T. A., & Sweeney, M. M. (2017). Quantitative models of persistence and relapse from the perspective of

behavioral momentum theory: Fits and misfits. *Behavioural Processes, 141*, 92–99. https://doi.org/10.1016/j.beproc.2017.04.016

Peck, S. M., Wacker, D. P., Berg, W. K., Cooper, L. J., Brown, K. A., Richman, D., McComas, J. J., Frischmeyer, P., & Millard, T. (1996). Choice-making treatment of young children's severe behavior problems. *Journal of Applied Behavior Analysis, 29*(3), 263–290. https://doi.org/10.1901/jaba.1996.29-263

Reed, P., & Morgan, T. A. (2006). Resurgence of response sequences during extinction in rats shows a primacy effect. *Journal of the Experimental Analysis of Behavior*, *86*(3), 307–315. https://doi.org/10.1901/jeab.2006.20-05

Sullivan, W. E., Saini, V., DeRosa, N. M., Craig, A. R., Ringdahl, J. E., & Roane, H. S. (2020). Measurement of nontargeted problem behavior during investigations of resurgence. *Journal of Applied Behavior Analysis*, *53*(1), 249–264. https://doi.org/10.1002/jaba.589

Tiger, J. H., Hanley, G. P., & Bruzek, J. (2008). Functional communication training: A review and practical guide. *Behavior Analysis in Practice, 1*(1), 16–23. https://doi.org/10.1007/BF03391716

Volkert, V. M., Lerman, D. C., Call, N. A., & Trosclair-Lasserre, N. (2009). An evaluation of resurgence during treatment with functional communication training. *Journal of Applied Behavior Analysis*, *42*(1), 145–160. https://doi.org/10.1901/jaba.2009.42-145

Wacker, D. P., Harding, J. W., Berg, W. K., Padilla, Y. C., Schieltz, K. M., & Lee, J. F. (2011). Evaluating intervention effectiveness. In J. K. Luiselli & J. K. Luiselli (Ed) (Eds.), *Teaching and behavior support for children and adults with autism spectrum disorder: A practitioner's guide.* (2011-10159-025; pp. 195–203). Oxford University Press.