# Contingencies are necessary for promoting delay tolerance

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# Contingencies are Necessary for Promoting Delay Tolerance

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## Abstract

The effectiveness of functional communication training as treatment for problem behavior depends on the extent to which treatment can be successfully extended to typical environments that include unavoidable and unpredictable reinforcement delays. Time-based progressive delay (TBPD) often results in the loss of acquired communication responses and the resurgence of problem behavior whereas contingency-based delay (CBPD) appears effective for increasing tolerance for delayed reinforcement. No direct comparison of TBPD and CBPD has, however, been conducted. Relying on single-subject designs, we compared the relative efficacy of TBPD and CBPD. Four individuals who engaged in problem behavior (e.g., aggression, vocal and motor disruptions, self-injury) participated. Results were consistent across all participants showing lower rates of problem behavior and collateral responses during CBPD than TBPD. The generality of CBPD treatment effects, including optimal rates of communication and compliance with demands, was demonstrated across a small but heterogeneous group of participants, reinforcement contingencies, and contexts.


*Keywords:* contingency-based delay, delayed reinforcement, functional communication training, generality, schedule thinning, severe problem behavior

# Contingencies are Necessary in Promoting Delay Tolerance

Function-based differential reinforcement, commonly referred to as functional communication training (FCT[1]; e.g., Carr & Durand, 1985), has been shown to reduce problem behavior by teaching the individual an appropriate alternative behavior that serves the same function as problem behavior. In fact, FCT combined with extinction has been shown to be an efficacious treatment for a variety of problem behaviors that differ both functionally and topographically (Kurtz, Boelter, Jarmolowicz, Chin, & Hagopian, 2011; Tiger, Hanley, & Bruzek, 2008). Problems arise, however, because requests cannot always be immediately reinforced by caregivers, and these periods of non-reinforcement for appropriate communication can lead to the resurgence of problem behavior (Hanley, Iwata, & Thompson, 2001).

In order to increase the generality of effects, thinning the schedule of reinforcement for the functional communication response (FCR) is often listed as an essential component of FCT when treatment is extended to the typical environment (e.g., Durand & Moskowitz, 2015; Kurtz et al., 2011). Various procedures for increasing tolerance for delays to reinforcement (here defined as near zero levels of problem behavior and manding during extensive non-reinforcement periods and the resumption of manding when appropriate) have been evaluated (see Hagopian et al., 2011, for a review). One common procedure involves programing gradually increasing delays between the FCR and the delivery of the reinforcer, often indicated with a brief signal such as “wait.” This procedure has been referred to as a delay schedule (Hagopian et al.). Using delay schedules has an intuitive appeal as the arrangement best emulates the typical situations experienced in the natural environment (i.e., when parents cannot provide requested items or interactions, they tell the child to wait and then provide that which was requested when it is possible to do so). This procedure, however, frequently results in the loss of the newly

[1] See Table 1 for a list of acronyms used in this paper.

acquired FCR and a resurgence of problem behavior, usually within the first 16 s of delay (Fisher et al., 2000; Hagopian et al., 2011; Hanley et al., 2001). Delayed reinforcement could also elicit negative emotional responses as well as evoke an excessive amount of manding (Fisher et al.) prior to the resurgence of problem behavior, and these collateral responses may be as disruptive as the original problem behavior.

The apparent obstacle to achieving general effects of FCT may be partly due to the extinction-like periods created by the long delays that could result in the resurgence of the previously reinforced problem behavior (Lieving & Lattal, 2003) and agitated or emotional responding (Lerman and Iwata, 1996). Lieving and Lattal showed that as schedules of intermittent reinforcement are thinned, longer periods of non-reinforcement are created that are functionally equivalent to conventional extinction and can lead to the resurgence of the previously reinforced response. Volkert, Lerman, Call, and Trosclair-Lasserre (2009), further, demonstrated that problem behavior may resurge when the newly acquired FCR is placed on an intermittent schedule of reinforcement during generalization attempts with FCT. In fact, deterioration of FCT treatment effects during implementation in more typical environments has often been reported (Fisher et al., 2000; Hagopian et al, 1998; Hagopian et al, 2011; Hanley et al., 2001; Rooker, Jessel, Kurtz, & Hagopian, 2013). For instance, Hagopian et al. (1998) found that when delays-to-reinforcement and demand fading were introduced, the efficacy of FCT with extinction was maintained in less than one half of the applications (i.e., clinically acceptable outcomes were not achieved). In most of their cases, the addition of punishment was necessary to attain a 90% reduction in problem behavior. Wacker et al. (2011) also showed that long periods of FCT treatment (an average of 14 months) are required before treatment effects would persist during 5 min periods of extinction, and even longer periods of treatment were required when a

15 min extinction period was used. In addition, although problem behavior was reduced during repeated extinction exposures, after nearly two years of treatment, problem behavior was not eliminated for half of the children.

The negative side effects observed with delayed schedules may also be attributed to a contingency weakening effect that occurs under this arrangement (Hanley et al., 2001). Positive contingency strength may be defined as the probability of obtaining reinforcement given a response being greater than the probability given no response (Hammond, 1980). Luczynski and Hanley (2014) found that delivering reinforcement after a delay resulted in a contingency strength of -1 (the weakest possible contingency) because no reinforcers were ever delivered within close temporal proximity to the communication response. As such, the delay schedule created a context that was probably aversive to the participating children as they preferred a context with no reinforcement at all to one in which delayed reinforcement was programmed.

In order to mitigate the contingency weakening effects associated with delay, multiple schedules (e.g., Fisher, Kuhn, & Thompson, 1998; Hanley et al., 2001), chained schedules (e.g., Fisher et al., 1993; Lalli, Casey, & Kates, 1995), or a combination of the two (e.g., Falcomata, Muething, Gainey, Hoffman, & Fragale, 2013) have been adopted and have successfully maintained zero or near-zero rates of problem behavior during long periods of non-reinforcement. Multiple schedules involve a time-based alternation between reinforcement and extinction components, both of which are correlated with distinct stimuli (e.g., colored cards). Chained schedules incorporate a response requirement, either a specific number of demands or a specific duration of time engaged in work activity, to be completed following which the first instance of FCR results in reinforcement. Neither multiple nor chained schedules, however, precisely emulate the unplanned and therefore unpredictable delays that are often experienced in homes and schools.

Chained and multiple schedules require parents and teachers to plan periods of non-reinforcement or demand time, during which children's FCRs are ignored. Once these periods are completed (either when a time criterion has been met or through completion of required demands), an interval of reinforcement then sets in, and parents are advised to immediately reinforce requests. Delays in the typical environment, however, do not emulate this arrangement. Delays are often sudden, unexpected, and unplanned. Children can request a variety of items at a given time, and in these cases, parents and teachers may not know whether the reinforcer is available until the specific request has been made, making it hard to plan for immediate reinforcement. A person must also be able to tolerate periods in which their reinforcing activities are suddenly interrupted and their requests are not granted, in the absence of clear stimuli signaling the unavailability of reinforcement, and even under stimulus conditions that would normally signal immediate reinforcement (e.g., a toy is available but the battery runs out). In such cases, the only naturally occurring stimuli may be brief verbal responses of "wait," "not right now," or "in a minute" to the request. The individual is, then, expected to wait for their request to be granted without engaging in repeated manding, problem behavior, and negative emotional responses. In addition, the individual will often be required to comply with an adult's requests or acquiesce to someone else's preferences during the delay. At other times, the individual might need to scan the environment and find other alternative activities to engage in while waiting for their preferred items and others' attention. Delay schedules are structurally ideal for teaching the behavioral expectations in these situations; however, strategies for mitigating the extensive negative side-effects associated with their application have not yet been articulated.

One change to typical delay procedures that may reduce the commonly reported negative side effects is the addition of probabilistic immediate reinforcement of the communication response. The addition of immediate reinforcement of some FCRs would increase the FCR-reinforcer positive contingency strength. This change may also increase the ecological validity of this procedure because requests in the typical environment are also immediately granted sometimes. The second change that may improve the effectiveness of delay schedules involves the addition of a response requirement during the delay interval. In other words, the negative side effects may be mitigated by changing from a time-based delay to a contingency-based delay in which a chain of responses following the FCR will result in the delivery of reinforcement. A contingency-based delay would increase the FCR-reinforcer positive contingency strength by building a chain of responses that ultimately contacts reinforcement, thereby minimizing the creation of long delays that emulate conventional extinction.

These procedural changes to the delay schedule were described in a study by Hanley, Jin, Vanselow, and Hanratty (2014) in which probabilistic immediate reinforcement and contingency-based delay were used to effectively treat problem behaviors maintained by positive reinforcement for one child and a synthesis of positive and negative reinforcement for other children. During contingency-based delay, following the cue to wait, the children were initially required to engage in a tolerance response (e.g., saying “okay”); progressively more difficult response chains were then prompted before reinforcers would be delivered. In this way, the authors were able to extend the delay to practical levels that included completion of age-appropriate demands and engagement with appropriate leisure items during the delay, without the resurgence of problem behavior.

Given that Hanley et al. (2014) implemented multiple changes to the way delays are traditionally scheduled, the extent to which each of the changes is necessary for the success of this treatment remains unclear. For example, the addition of probabilistic reinforcement to increase the contingency strength of FCRs may be sufficient to produce the same results with time-based delay. Also, the mere presence of, and redirection to an alternative activity may be sufficient to maintain zero levels of problem behavior during delay. For instance, Fisher et al. (2000) showed that in one case the addition of an alternative work activity, without a contingency, was enough to reduce positively-maintained problem behavior and collateral responses during non-reinforcement intervals. These authors, however, did not report on the rate of excessive manding or compliance with demands during these intervals. The extent to which the mere presence of an alternative activity during delays to reinforcement, without a response contingency, will be sufficient to reliably eliminate severe problem behavior without the emergence of other collateral responses remains to be investigated.

The main purpose of this study was to evaluate the direct effects of a response contingency during delayed reinforcement. Although, contingency-based delay has been used as the main treatment (Hanley et al., 2014) or a component of treatment (e.g., Carr & Carlson, 1993), the effects of a response contingency alone have not been evaluated. We therefore conducted a comparative analysis of time-based versus contingency-based delay tolerance training. In order to isolate the effects of a response contingency alone, we included both probabilistic reinforcement and alternative activities in both time-based and contingency-based delay conditions. The second purpose of this study was to evaluate the direct effects of contingency-based delay on collateral responses (e.g., excessive manding, negative emotional responding) and compliance with adult instructions, so multiple measures were collected across all participants. The third purpose of this study was to assess the generality of delay tolerance trainings. In addition to the systematic replication of the comparison across a wide range of participant characteristics and different reinforcement contingencies, we also evaluated the extent to which behavior changes occurring as a function of experiences with either delay procedures would generalize to a second context in which problem behavior during delay would be reinforced (i.e., a context emulating typical environments with no extinction during delays).

# Method

## Participants and Settings

Four individuals, ranging in age from 21-months to 30-years, who were referred to our university-based outpatient services, participated in this study. Participant characteristics including specific diagnoses, language abilities, and imitation, motor, and play skills are summarized in Table 2. Nico was a 23-month old boy who reportedly had difficulty waiting for preferred items and activities. Nico's parents reported that he would often repeat his requests multiple times, say "no" when told to wait, and would sometimes have a meltdown that included crying and flopping if his requests were not granted. Nico attended a center-based daycare.

Will was a 30-year old man with a long history of severe self-injurious behavior (SIB), primarily hand-to-head hitting which often led to open wounds on his forehead as well as finger biting. Will reportedly engaged in SIB throughout the day at his rehabilitation center, his group home, as well as during transport to and from the center. Staff reported that they often gave Will food and drinks to calm him down. Will could walk independently and feed himself, but was not toilet trained. Will attended the day habilitation center five days a week, and spent the majority of his time eating, taking walks, or sleeping.

Jack was a 21-month old boy who engaged in severe problem behavior multiple times each day. His problem behavior included motor disruptions and aggression toward peers and adults (usually toward his mother) when preferred activities were interrupted and when an item he requested was not available. These episodes usually led to the family leaving social settings or providing Jack with the requested item or other preferred items as well as physical and verbal attention (e.g., hugs, squeezes, reprimands). He received early intervention services at home that included early intensive behavioral intervention, speech language services, and occupational therapy. He also attended a home-based daycare.

Alex was a 6-year old boy who engaged in daily episodes of severe problem behavior that included meltdowns, vocal and physical disruptions, and aggression toward adults and peers. Alex reportedly became highly emotional and aggressive at home, school, and other community outings, when his preferred activities were interrupted or not available, and when asked to comply with demands. These episodes usually led to adults complying with Alex's requests and providing access to preferred items in order to calm him down, as well as physical and verbal attention (e.g., hugs, squeezes, reprimands). Alex attended a public school in which he spent the majority of his time in a resource room that included the support of paraprofessionals, and had an individualized educational plan.

All sessions for Nico, Jack, and Alex were conducted in small treatment rooms (4 m by 3 m) at a university setting, with a one-way observation mirror, audio/video equipment, child-sized tables, two chairs and academic and play materials as needed. All sessions for Will were conducted in an open area within the day rehabilitation center that contained cafeteria style tables and adult-size chairs. Sessions were conducted 2 to 4 days per week, 2 to 8 times each day. Sessions were 3 to 5 min throughout the functional analyses and mand analysis. Sessions lasted 3 to 5 min (Nico and Jack) or 5 evocative trials (Will and Alex) during FCT. Sessions lasted for 5 evocative trials throughout the comparative analyses unless the time-based session termination criteria were met (20 min session for Nico and 10 min of crying for Jack).

**Data Collection, Response Definitions, and Interobserver Agreement**

Trained observers recorded data using pencil and paper during the functional and preference analyses for Will. Otherwise, trained observers collected data via computers that provided a second-by-second account of participant's responses and relevant contextual features.

Counts of participants' communication and tolerance responses, problem behavior, and *discrete* collateral responses (i.e., excessive manding, grabbing and motor disruptions, and attempts to control) were collected and converted to a rate for all analyses. Duration data were collected on *continuous* collateral responses (e.g., crying), scheduled and experienced delay intervals (the interval of time between the delivery of the delay cue, e.g., "wait", to the delivery of reinforcement), and engagement in the alternative activity during delays. The percentage of session engaged in negative emotional responding was calculated by dividing the duration of negative emotional responding by the session duration. The percentage of delay interval engaged in alternative activity was calculated by dividing the duration of alternative activity engagement by the delay duration.

Target problem behavior for Nico, Jack, and Alex included *aggression* (defined as hitting, biting, kicking, hair pulling, head-butting, and pushing) and *disruptions* (defined as both physical disruptions such as throwing, ripping, swiping and pushing items, and banging items together, and vocal disruptions such as a high pitch scream). Will's problem behavior was *self-injurious behavior* in the form of hand to head hits and knuckle biting.

Nico's collateral responses were in the form of *excessive mands* (defined as any additional requests other than the target FCR during the delay). Will's collateral responses included *motor disruptions* and *grabbing others*. Jack's collateral responses were in the form of *negative emotional responding* (defined as crying, pouting, and saying “no”). Alex’s collateral responses included *attempts to control* during the delay (defined as negotiating to change the qualitative features of the task or the amount, vocally refusing or completing the task in a manner different than what the analyst indicated, and making additional requests).

Nico’s initial FCR was a single-word mand (e.g., “music,” “dance”) identified via the mand analysis. His target FCR was a fully framed mand (e.g., “I want [item] please,” “More [activity] please”). Will’s target FCR consisted of handing a food icon to the analyst. Jack’s target FCR consisted of a hand gesture to his chest or a vocal response of “my way.” Given Jack’s limited vocal imitation repertoire, a novel hand gesture was added to supplement the vocal response and allow for immediate prompting. Alex’s initial FCR was “my way, please.” His target FCR consisted of saying “Excuse me” then waiting for acknowledgement before saying “May I have my way please?” The tolerance response (TR) for Nico, Jack, and Alex consisted of saying “Okay,” in an appropriate tone and volume, in response to the delay cue.

*Alternative activity engagement* was defined as actively manipulating, responding to (e.g., dancing to music), and/or orienting towards materials (e.g., neutral toys, beads) as instructed by the analyst, without problem behavior or collateral responses, for Nico, Will, and Jack. For Alex, counts were collected on each verbal and gestural instruction issued by the adult, and his compliance with each instruction. *Compliance* was defined as orienting towards the materials within 5 s of the instruction and completing the task correctly without any collateral responses or problem behavior, and without any need for a physical prompt from the adult.

Interobserver agreement (IOA) was assessed by having a second observer collect data on all target behaviors simultaneously but independently during at least 20% (range, 20% to 60%) of the sessions in each condition for each participant. Each session’s data were divided into 10-s intervals, and compared on an interval-by-interval basis. Agreement percentages were calculated by dividing the smaller number of responses or duration (in seconds) in each interval by the larger number, averaging the fractions and multiplying it by 100%. IOA averaged 95% (range, 76% to 100%) for Nico, 93% (range, 76% to 100%) for Jack, 92% (range, 74% to 100%) for Alex, and 96% (range, 80% to 100%) for Will.

**Buffet Style Preference Assessment**

For Jack, Alex, and Nico, highly preferred and neutral items and activities nominated by caregivers during an open-ended interview along with other age-appropriate toys and academic activities (10-20 items) were arbitrarily arranged on two half-circle-shaped tables prior to sessions. The items included in the buffet varied for each child but remained the same throughout all assessment and treatment analyses for each child. During the assessment, the analyst directed the child to the tables and reviewed the items that were available by touching and naming each activity. She then allowed the child to walk around the table and manipulate the items briefly before prompting the child to choose 3-5 preferred items to bring into the session room. The analyst, then, selected 1-3 items that the child had not chosen during the previous two selection opportunities and used those as the neutral items for the alternative activity or demands. Access to the buffet was typically provided after two to four sessions.

## Part I: Functional Assessment

**Procedures**

**Open-ended functional assessment interview and brief observation.** An open-ended interview, as described by Hanley (2012), was conducted with the participants' caregivers to discover (a) the individual's language ability and types of problem behavior, (b) potential reinforcers influencing the individual's problem behavior and contexts in which problem behavior was most likely, and (c) the individual's preferred as well as non-preferred items and activities. The interview lasted 45 to 60 min and was followed by a 20-min informal observation of the participant interacting with parents (Nico, Jack, and Alex) or staff (Will), in which play preferences, language skills, topographies of problem behavior, fine and motor skills, and other unique characteristics described by caregivers during the interview were directly observed to individualize and prepare for analyses.

**Mand analysis.** The open-ended interview with Nico's parents revealed that concerns centered exclusively on situations when an item or activity or their attention was not immediately available and Nico was asked to wait, during which Nico would mostly engage in excessive manding, whining, and crying, but seldom any problem behavior. Therefore, a mand analysis was designed to identify Nico's predominant response form that functioned as a mand for tangible items. The analysis involved rapidly alternating between two conditions. The test consisted of differential reinforcement of mild problem behavior, gestures, single-word, and framed mands (DRA); whereas the control consisted of continuous noncontingent reinforcement (NCR). During NCR, the preferred toys, DVDs, and activities were made available freely and continuously. During DRA, the preferred items were placed on a table but Nico's access was blocked by the analyst. Access to items was provided for 30 s contingent on any target response (e.g., reaching and pointing, single-word mands, and fully- or partially-framed mands).

**Functional analyses.** Following open-ended interviews, functional analyses were designed for Will's, Jack's, and Alex's problem behavior. The analyses involved rapidly alternating between test and control sessions: (a) presenting the reported evocative situation (e.g., presenting writing tasks, taking away toys/iPad, removing attention, etc.) in test sessions and allowing 30-s access to the reported consequence(s) immediately following problem behavior, and (b) withholding the same evocative situations in control sessions by presenting the putative reinforcers continuously. Events not suspected of maintaining problem behavior (e.g., escape from demands for Jack, analyst's attention and escape from demands for Will) were freely available in both the test and control conditions, ensuring that the only difference between test and control conditions was the programmed reinforcement contingency.

***Will.*** Staff reported that whenever Will appeared agitated or started to engage in self-injury, they would provide him with snack items that were typically available in the cupboards in Will's habilitation center. Based on the results of this interview and the brief observation, a social positive reinforcement contingency using available food items was analyzed. Foods that were used as snacks for Will throughout the day included raisins, crackers, peanuts, cheese, apple sauce, and cookies. Two to three of these snack items were visible but slightly out of reach in both test and control conditions. During the control condition, very small bites of each of the snacks were placed on a plate, and the plate was presented to Will about every 10 s independent of his behavior. Following his selection, the plate was removed. By contrast, the plate with the snack items was presented during the test sessions only following instances of head hitting or finger biting; each instance resulted in the plate being presented and a snack bite obtained.

***Jack.*** Based on the interview results and observation with Jack's mother, a synthesized contingency of attention and tangibles was analyzed in one context conducted by his mother (Context 1) and in another by the analyst (Context 2). Two analyses were conducted in order to create two baselines from which the direct and general effects of the delay procedures could be evaluated. Preferred items including a hair brush, cooking spoons, broom and dust pan, DVDs, and laptop computers identified by Jack's Mom during the interview, and some additional age-appropriate toys and activities were placed in the activity buffet. Many of these preferred items were items that Jack's parents, in particular his mother, would use when her attention was diverted. Given Mom's report that in order to calm Jack down she would often attend to him and provide him with brief access to the items she was using, a synthesized attention and tangible reinforcement contingency was tested in the analysis. During the control condition, Jack had continuous and noncontingent access to his Mom's (or analyst's) attention (e.g., sitting in her lap, pretend cooking with her) and access to preferred items. During the test condition, the adult pretended to be busy with one of the items, and also blocked access to all other preferred items. Contingent on any instance of problem behavior, the adult immediately attended to Jack (e.g., comforted and played with him) and allowed him access to the preferred items for 30 s.

***Alex.*** During the interview, Alex's Mom reported that dinosaurs were Alex's favorite topic. He was very knowledgeable in this topic, and spent hours with dinosaur-themed toys and activities. He often engaged in imaginative play and constructed elaborate dinosaur theme sets that "had to remain untouched" in the family home. He would demand that his parents and younger brother play along with the very specific roles he would assign to them. Any movement of these items by others, interruption of Alex's play, or failure to adequately assume the assigned role resulted in severe tantrums that included aggression and could last up to 30 min. Alex's specific requests extended to other activities in the home and school. For example, he would often request that family members exit the house in a particular order, he demanded that his peers play in the gym in a particular manner, he insisted on doing academic worksheets, drawing, and writing tasks in a specific manner regardless of the teacher's instructions (e.g., writing a lower case "a" rather than an upper case when writing his name, writing underneath the line rather than on the line). Any interruption or redirection of Alex's preferred activities resulted in severe tantrums. Alex's Mom reported that when these tantrums occurred, she would often attend to Alex and tell him to calm down and take a breath. She would help Alex calm down by removing her demands, allowing Alex to tell her what he wants including the resumption of his preferred activity, and complying with these requests (e.g., the family would then play the game the way Alex preferred). The results of the open-ended interview suggested that Alex's problem behavior was evoked when adults stopped complying with Alex's requests (see Bowman, Fisher, Thompson, & Piazza, 1997, for a similar functional relation) and interrupted his preferred activities to place demands to engage in other tasks. Given that problem behavior would often result in the simultaneous delivery of attention, removal of demands, and adult compliance with Alex's mands, a synthesized contingency of positive and negative reinforcement was tested in two analyses conducted by the same analyst but in two different contexts. Context 1 contained materials selected from the activity buffet which did not include any dinosaur related items. Instead, items in the activity buffet included other activities reported as highly preferred by Alex's mother (e.g., drawing activity, Lego, tablet), and other age-appropriate toys and activities, and demand materials. Context 2 included only Alex's most preferred activity which was dinosaur figure sets along with dinosaur-themed books and stickers. During the control condition, Alex was given uninterrupted access to his preferred activity and the analyst complied with all of Alex's reasonable requests (i.e., those that could be granted in the session room safely) and presented no demands. Alex did not make any unreasonable requests during the analysis. During the test condition, the analyst interrupted Alex's play, denied his requests, and presented a demand (e.g., the therapist deviated from the play as instructed by Alex and told him to do something else, the therapist interrupted Alex's drawing and asked him to draw or write something different). Three-step prompting was used to ensure compliance with demands. Contingent on any instance of problem behavior, the analyst removed demands, allowed Alex to resume his activity in the manner which he preferred, and honored Alex's requests for 30 s.

**Results**

**Nico.** Single-word mands emerged as Nico's predominant response (Figure 1). The rate of single-word responses was consistently higher in the DRA sessions, and Nico engaged exclusively in single-word mands during the last test-control dyad. The results suggested that Nico's predominant response for preferred tangibles and adult attention was a single-word mand.

**Will.** Problem behavior was observed exclusively in test sessions in which Will's problem behavior resulted in snack items (Figure 1). The result of the functional assessment process showed that Will's problem behavior was maintained by access to food.

**Jack.** Problem behavior was observed exclusively in test sessions in which Jack's problem behavior yielded access to preferred items and adult attention, irrespective of whether his mother or the analyst implemented the contingency (Figure 1). The result of the functional assessment process suggested that Jack's problem behavior was maintained by a combination of social positive reinforcers.

**Alex.** Problem behavior was observed exclusively in the test conditions when Alex's problem behavior terminated adult instruction and allowed him access to preferred activities, adult attention, and having his requests granted (Figure 1). The result of the functional assessment process suggested that Alex's problem behavior was sensitive to a combination of social positive and negative reinforcers.

## Part II: Functional Communication Training

**Procedures**

Once reinforcers were identified for problem behavior or predominant mand forms, we attempted to replace problem behavior and simple mand forms with more socially acceptable and developmentally appropriate mand forms via FCT plus extinction. The effects of FCT plus extinction were demonstrated in a concurrent operants AB design for Nico and Will, and a concurrent operants within a multiple baseline across contexts design for Jack and Alex. The test sessions of the mand or functional analysis served as the baselines for all FCT evaluations.

During FCT, access to reinforcers was provided for approximately 1 min prior to each session, and the session started by the removal of all reinforcers and the presentation of an evocative situation for each participant (e.g., the analyst would pause the DVD player and turn away from Jack, the analyst would place a bite of food on a plate visible to Will but out of his reach). A target FCR was selected and reinforced on a fixed ratio (FR) 1 schedule whereby each instance of the FCR would result in 30 s of reinforcement. All problem behavior was placed on extinction. A small number of pre-session training trials (up to 5) were conducted prior to the introduction of FCT. These trials included a brief instructional statement, modeling of the FCR, role-play of emitting the FCR and accessing reinforcement and praise or correction of the FCR. During sessions, a most-to-least prompting hierarchy was used to teach the target FCR until 80% of FCRs were independent, following which, prompts were faded to a vocal prompt every 60 to 90 s as needed. For one participant (Alex), the complexity of the communication response was increased. Once problem behavior was eliminated in both contexts, and initial FCRs were emitted independently for two consecutive sessions, the analyst increased the complexity of the response required via prompting and differential reinforcement. The specific communication responses of each participant and associated reinforcement are noted in Table 3.

**Results**

Figure 2 depicts the results of FCT. There was a reduction in initial FCRs and variable rates of the target FCR observed with Nico, but after a period of variability, the target FCR was emitted exclusively and at an optimal rate. FCT resulted in an immediate elimination of problem behavior for Will and the acquisition of the target FCR. Despite some variability in problem behavior, FCT resulted in an eventual elimination of problem behavior and acquisition of the FCR with Jack in both contexts. FCT resulted in an immediate reduction of problem behavior for Alex and the acquisition of the initial FCR in both contexts. Independent and complex FCRs eventually occurred to the exclusion of both initial FCRs and problem behavior in both contexts. By the end of FCT, all participants emitted the target FCR at an efficient rate, maximizing reinforcement to near continuous access, in the absence of problem behavior (or initial FCRs).

## Part III: Comparative Analysis of Tolerance Training

### General Procedures

Following 1-min access to all reinforcers, every session started with the removal of all reinforcers and the presentation of the participant-specific evocative situation (e.g., taking away toys/iPad, removing attention, presenting writing tasks, etc.). Sessions were as long as necessary to allow for five presentations of the evocative situations and all the scheduled delays and reinforcement periods; henceforth referred to as trials. This resulted in session durations ranging from 2.5 to 40 min depending on the delay level. During time-based progressive delay (TBPD), contingency-based progressive delay (CBPD), and terminal delay baseline probes (Jack and Alex only), FCRs were reinforced immediately on 2 of 5 randomly selected trials. On the remaining 3 trials, the FCR resulted in one of several brief verbal delay signals (e.g., “wait,” “not yet,” “in a minute”) which were rotated within participants, and reinforcement was provided either following the scheduled amount of time (TBPD) or the scheduled response requirement (CBPD). The contingency in CBPD was either a DRA in that a specific set of responses such as compliance or play were required, a differential reinforcement of other behavior (DRO) in that a period of time without problem or collateral behavior was required, or a DRA/DRO in which both a specific set of behaviors were required in the absence of problem or collateral behavior.

The experienced duration of each delay interval within a TBPD session was either determined according to the scheduled delay level (Will, Jack, Alex), or was yoked to the experienced duration of the delay interval in the CBPD session (Nico). Scheduled delay intervals were increased according to a geometric progression starting at 1s (i.e., 1, 2, 4, 8,…, 600), while reinforcement intervals were increased from 30 s to 120 s (30 s for delays of 0 to 32 s, 60 s for delays of 64 to 128 s, and 120 s for delays of 256 to 600 s). A geometric progression was used to reach the terminal delay interval in an efficient manner and perhaps allow for differences in the procedures to be revealed more readily than with a less rapid progression. See Table 4 for criteria to increase delays.

**No delay baseline.** These sessions were identical to the final sessions of FCT. Reinforcement was withheld until the target communication response was emitted. In all trials, the FCR was immediately reinforced and neither problem behavior nor collateral responses resulted in programmed consequences.

**Time-based progressive delay (TBPD).** On the 3 delay trials, the FCR resulted in a delay signal and either no additional prompts (Nico), a single prompt (Jack and Will), or multiple prompts (Alex) to engage in the alternative activity or comply with demands. Although the alternative activity or instructional materials were present and freely available during these sessions, there was no requirement for the participant to engage these materials (i.e., the delay ended based on time alone). At the end of the scheduled delay interval, the reinforcer(s) were delivered with a verbal statement (e.g., "Now you can have ______," "Here you go"). Problem and collateral behavior resulted in no programmed consequences throughout the session.

**Tolerance response (TR) training**. Training sessions of 10 trials, 60% of which were delay trials, were used to teach a specific TR (“Okay”) to the adult’s delay cues. A minimum of two sessions with 80% independent FCRs and TRs were conducted prior to the start of CBPD. The training sessions started with a brief instructional statement, modeling of the FCR followed by the delay cue and the TR, role-play of emitting both the FCR and the TR to access reinforcement, followed by praise or any necessary corrections. A most to least prompting procedure was then used during each trial.

**Contingency-based progressive delay (CBPD).** On the 3 delay trials, the FCR resulted in a delay signal and either a single prompt (Jack, Will in DRO) or multiple prompts (Nico, Alex, and Will in DRA) to engage in the alternative activity or comply with demands. The participant was required to emit the TR and/or either engage in additional specific responses or refrain from engaging in problem behavior or collateral responses to terminate the delay. In other words, reinforcement was withheld until the participant completed the response requirements.

**Terminal delay probes (generality test).** This condition was arranged with Jack and Alex to evaluate the extent to which treatment effects would generalize to a context in which problem behavior during the delay would be reinforced (i.e., no extinction during delay). Context 2 (the analyst context for Jack, and the dinosaur context for Alex) was designated as the generalization context. The terminal delay durations of approximately 5 min for Jack and 10 min for Alex were used during these probes. All problem behavior prior to the emission of FCR was placed on extinction. However, any instances of problem behavior following the delivery of the denial cue terminated the delay and resulted in the immediate delivery of the reinforcer(s). The alternative activity or demands were available throughout this condition; there was, however, no engagement or compliance requirement. If no problem behavior was emitted during the delay, the reinforcer(s) were delivered at the end of the scheduled terminal delay. This condition served as a rigorous test of the generality of delay treatments given that direct reinforcement of problem behavior was programmed.

**Specific Procedures**

**Nico.** The relative efficacy of CBPD and TBPD was evaluated with Nico in a multielement design. The two conditions were presented as a dyad in a random order. During both delay conditions, the highly preferred toys were placed on a table where Nico and the analyst sat, while the neutral toys used as the alternative activity were placed on foam mats. Green (TBPD) and red (CBPD) plastic sheets on the wall and the table of the session room were correlated with each condition. In addition, the positions of the table and foam mats were flipped during TBPD versus CBPD. A DRA/DRO was used during CBPD with the delay being restarted if any problem behavior or collateral responses occurred.

**Will.** We systematically replicated the comparison between CBPD and TBPD using a slightly modified contingency in an ABAC design to allow for a more independent evaluation of the presence of a response contingency during delay. TBPD was introduced first. Following a return to the no delay baseline, CBPD was introduced. A DRA was used during CBPD.

Among other factors, the pace of the progression may have contributed to the persistence of Will's problem behavior and collateral responses during the first comparative analysis. A second analysis relying on a multielement design was conducted with Will to simultaneously evaluate the effects of two versions of CBPD, DRA only and DRO only, against TBPD with a slower programmed progression of the delay. The three conditions were presented in a random and counterbalanced order. The conditions were signaled using color-correlated stimuli (table clothes, plates, and beads). The comparison was started at a 64 s delay, which was the point at which problem behavior and collateral responses emerged during the previous analysis, and was continued at 90 s, 120 s, and finally 180 s of delay.

**Jack and Alex.** Although the multielement designs used previously provided a clear demonstration of the relative efficacy of each condition, there was some apparent carry over across conditions (e.g., the TR generalized to the TBPD context with Nico). Therefore, to better isolate the effects of each condition, a multiple baseline across participants design was used with Jack and Alex to evaluate the direct and general effects of a response contingency during the delay interval. During both CBPD and TBPD, highly preferred toys were placed on a table where the children and the adult sat, while the neutral toys used as the alternative activity were placed in the corner of the room for Jack or the instructional materials were placed on the table for Alex. The direct effects of TBPD and CBPD were evaluated in Context 1, while general effects were evaluated in Context 2. TBPD was introduced first followed by the no delay baseline, TR training, and finally CBPD. During both TBPD and CBPD conditions in Context 1, terminal delay baseline probes were conducted on every fifth session in Context 2. Finally, CBPD was implemented in Context 2. A DRA/DRO (Jack) and a DRA (Alex) was used during CBPD.

## Results

For all participants, an optimal rate of FCR was calculated for each session using the minimum number of FCRs required to obtain reinforcement. In other words, the optimal rate of FCR for each session was calculated by dividing the number of evocative trials presented by the total duration of that session. For Nico, an optimal rate of TR was also calculated for each session by dividing the total number of opportunities (i.e., the total number of delay trials) by the total duration of that session. The optimal rates are depicted in each figure as a dotted data path.

**Nico.** The no delay baseline showed target FCRs occurring at an optimal rate, problem behavior at zero, and no TRs occurring (Figure 3). Following TR training, and with the introduction of progressive delay, target FCRs slowly decreased but remained near the optimal in both conditions. The TR was observed in both conditions; however, TRs occurred at an optimal rate in CBPD whereas an excessive amount of TRs were emitted during TBPD. After a few sessions of CBPD, Nico spent approximately 80% of the delay interval engaging in the alternative activity (third panel). Engagement in the alternative activity did not occur much for several sessions in TBPD and then never reached above 75%. Collateral responses and problem behavior were highly variable but occurred almost exclusively in TBPD, despite the fact that the experienced delays were similar across CBPD and TBPD. Overall, it appeared that CBPD was more effective than TBPD at increasing Nico’s tolerance for delayed reinforcement. CBPD treatment effects maintained as the delay interval was extended to an average of 5 min and implemented by Nico’s parents (data available upon request).

**Will.** During the no-delay baseline in Will’s initial analysis (Figure 4), target FCRs occurred at an optimal rate, while problem behavior (i.e., SIB) and collateral responses were at zero or near-zero levels. FCRs decreased but maintained at an optimal rate and problem behavior remained low initially in TBPD. As the delays increased collateral responses such as grabbing others and swiping materials emerged and maintained and SIB resurged. Will did not engage in the alternative activity during TBPD. The return to the no-delay baseline resulted in an immediate reduction of SIB and collateral responses while FCRs persisted. The introduction of CBPD resulted in a gradual reduction of FCRs toward an optimal rate, high and variable engagement in the alternative activity, and zero levels of SIB and collateral responses, but these latter behaviors resurged as the demand requirements were increased. Due primarily to the resurgence of SIB and collateral responses as the delays were increased, neither CBPD nor

TBPD proved to be effective in developing tolerance for delayed reinforcement with Will.

Will's limited fine-motor repertoire and independent play skills may have contributed to the only moderate level of engagement in the alternative activity, which in turn may have contributed to the resurgence of problem behavior. He also may have required a slower progression of the response requirement during delay to allow him to acquire the beading skills relevant to the alternative activity. These considerations informed the second analysis, the results of which are depicted in Figure 5. The optimal number of FCRs per reinforcer in each condition was 1; this was obtained during most DRA sessions. By contrast, Will emitted twice that many FCRs during TBPD and DRO. Alternative activity engagement was exclusively observed during DRA. Both SIB and collateral responses occurred at higher rates during TBPD and DRO than during DRA. These patterns persisted as the delay interval increased to 180 s. Overall, CBPD using a DRA contingency was more effective for increasing Will's tolerance for delayed reinforcement than a time-based or DRO-based contingency.

**Jack.** During the no delay baseline in both contexts, FCRs occurred at an optimal rate, and problem behavior and collateral responses were at zero (Figure 6). With TBPD in Context 1, there was an increase in the rate of FCRs with a spike at the 16 s delay. Although some engagement in the alternative activity was observed as the delay interval was increased to 256 s, target FCRs were emitted at a higher than optimal rate during the majority of TBPD sessions. Problem behavior occurred at high and variable rates throughout TBPD and collateral responses such as crying increased as the delay was increased. Problem behavior also remained at strength in Context 2. Overall, TBPD did not produce tolerance for delayed reinforcement. The return to the no-delay baseline in both contexts resulted in the elimination of problem behavior and collateral responses, and optimal rates of FCRs.

Following TR training, the introduction of CBPD in Context 1 resulted in near optimal rates of FCRs and TRs, low but persistent engagement in the alternative activity, and continued zero rates of problem behavior and collateral responses as the delay interval was increased to 5 min. The DRA/DRO contingency during delay for Jack required him to emit the TR then refrain from engaging in any problem behavior or collateral responses for the required amount of time (i.e., there was no requirement to engage with the alternative activity). In addition, the data from Context 2 provide evidence of the generality of CBPD training. While experiencing TBPD in Context 1, Jack consistently experienced a very short delay interval than that scheduled in context 2 because he terminated the delay through problem behavior. Despite the presence of the same “inappropriate” contingency in Context 2, Jack tolerated the scheduled delay when CBPD was programmed in Context 1, even though the delays in Context 2 could have been terminated at any point by engaging in problem behavior. The TR of “okay” as well as other appropriate play responses generalized, and presumably as a result, lower rates of problem behavior and lower rates of FCR were observed in this second context. There were, however, some residual collateral responses; these were eliminated following the implementation of CBPD in Context 2. In summary, CBPD was an effective treatment for increasing Jack’s tolerance for delayed reinforcement. These treatment effects maintained when treatment was extended and implemented by Jack’s father (data available upon request).

**Alex.** During the no delay baseline in both contexts, FCRs occurred at an optimal rate, and problem behavior and collateral responses were at zero (Figure 7). With the introduction of TBPD in Context 1, there was a gradual decrease in the rate of FCRs corresponding to the optimal rate, but an immediate increase in the rate of problem behavior with a spike at the delay level of 16 s, at which point TBPD was terminated. Collateral responses also increased starting at the delay level of 4 s, and compliance with demands remained at zero throughout this condition. Overall, TBPD was not an effective treatment for increasing tolerance for delay reinforcement with Alex. The return to the no-delay baseline in both contexts resulted in the elimination of problem behavior while FCRs persisted. Following TR training, the introduction of CBPD in Context 1 resulted in occurrences of the TR, a gradual reduction of FCRs toward an optimal rate, high but variable levels of compliance during delays, and near-zero rates of problem behavior throughout. In addition, the data from Context 2 provide evidence of the generality of CBPD training. While experiencing TBPD in Context 1, Alex complied with no demands in Context 2 and terminated the delay through problem behavior. By contrast, while experiencing CBPD in Context 1 and despite the presence of the same "inappropriate" contingency in Context 2, Alex emitted the TR and complied with almost half of the demands presented in Context 2, before engaging in problem behavior to terminate the delay and high rates of collateral responses during the delay. When CBPD was introduced in Context 2, high and stable levels of compliance were achieved while FCRs and TRs persisted, and problem behavior and collateral responses occurred at zero or near zero levels. By the end of treatment, Alex engaged in approximately 50 demands and experienced delays to reinforcement of approximately 10 minutes with CBPD.

## Discussion

Contingency-based delays were more effective than time-based delays in developing participants' tolerance for delayed reinforcement. CBPD increased alternative activity engagement and compliance while maintaining zero rates of problem behavior and collateral responses and optimal rates of communication. Our finding that TBPD is an ineffective method for increasing the generality of FCT treatment is consistent with previous research (Fisher et al., 2000; Hagopian et al., 1998; Hanley et al., 2001). In fact, despite the various procedural improvements to the manner in which TBPD is usually programmed, TBPD was still found to be ineffective in our study. For example, although, the addition of probabilistic reinforcement appeared to result in the maintenance of the communication response during TBPD, problem behavior resurged in all cases and within the first 16 s of delay for three of four. Although the recovery of problem behavior during this delayed reinforcement procedure is likely due to resurgence as suggested by Lieving and Lattal (2003) and Volkert et al. (2009), we did not arrange for the necessary controls to confidently label this recovery as resurgence instead of other extinction-related phenomenon (Bruzek, Thompson, & Peters, 2009). Furthermore, the mere presence of alternative activity and prompts to engage in these activities or comply with demands were not sufficient to mitigate the negative side-effects of TBPD. Therefore, it appears that the *response contingency* during the delay is the necessary component for the effectiveness of progressive delay tolerance training. Our finding that the presence of a contingency in addition to the alternative activity during the delay is necessary for achieving delay tolerance is consistent with the findings from translational research on self-control by Mischel, Ebbesen, and Zeissalong (1972), Dixon and Cummings (2001), and Dixon, Rehfeldt, and Randich (2003). For example, Dixon and Cummings have shown that requiring participants to engage in an alternative response during delay aids in shifting preference from the smaller immediate reinforcer to the larger delayed reinforcer while maintaining lower levels of problem behavior.

The effects of CBPD were systematically replicated across participants aged 21-months to 30-years old, with and without developmental disabilities or autism, and across both social-positive and social-negative reinforcement contexts, replicating the results of Hanley et al. (2014). In addition to the elimination of problem behavior during treatment, CBPD resulted in the acquisition of an appropriate response to a delay signal (i.e., the TR of “okay”) and a set of developmentally-appropriate responses (e.g., compliance with academic demands, functional play skills) that also generalized to a context in which extinction was not fully in place. In other words, using CBPD we were able to shape a repertoire of "waiting" that generalized to contexts with an inappropriate contingency (i.e., availability of reinforcement for problem behavior during delay). This shaping of a waiting repertoire was systematically replicated across participants with varying degrees of baseline language, adaptive, and leisure skills. Desirable patterns of behavior during extended delays were produced for all participants without the need for positive punishment (Fisher et al., 1993; Hagopian et al., 1998) or additional noncontingent or differential reinforcement procedures (Hagopian, Contrucci Kuhn, Long, & Rush, 2005; Rooker et al., 2013) during the delay.

The relative speed with which these treatment effects were obtained (2 to 8 hours distributed across 4 to 24 weeks) suggest that CBPD may be an alternative to long-term FCT treatment necessary for persistence of effects during extinction (Wacker et al., 2011). Wacker et al. noted that the antecedents and consequences surrounding the response in the natural environment often vary from the specific conditions used during treatment. They suggest that variables that enhance treatment persistence such as extensive experience with FCT (nearly 16 months) should be included in treatment. Another variable that may play a role in the persistence of treatment effects is the manner in which antecedents and consequences are arranged during treatment. Our findings suggest that alterations to the design of treatment such as those included in CBPD may be an efficient means of obtaining similar resistance in light of changing contexts.

Although FCT, by the nature of its design, exposes the child to the natural maintaining contingencies of the response, exposing the child to sufficient exemplars of antecedent conditions may also be important for ensuring generalized responding (Tiger et al., 2008). Rather than relying on the use of a single tightly controlled context with a specific task and clear discriminative stimuli for the delay, we used multiple exemplars of delay cues to signal the onset of delay, a variable array of activities and tasks based on child-selected items from the activity buffet, and adult-selected demand items that changed every two to four sessions. Within eight hours of treatment, for example, Alex was able to engage in appropriate communication and tolerance responses in the presence of a variety of evocative situations (e.g., interruption of drawing activity, removal of toys, denial of a request) and to tolerate delays of approximately 10-15 min and complete roughly 50 demands involving various academic and toy-based activities.

The specific response requirements during the delay were also closely matched to the behavioral expectations regularly experienced by the participants. The selection of the alternative activities, in addition to the specific evocative contexts and reinforcers, were guided by the results of the open-ended interviews with caregivers. For example, Jack's Mom reported that a common situation involved her preparing dinner and requiring Jack to stay away from the stove and do "something else." Given this context and Jack's lack of an independent play repertoire, a DRO contingency seemed the most suitable. It allowed Jack to engage in a variety of other responses and still satisfied Mom's request that he stay away from her cooking area for a few minutes. These considerations increased the ecological validity of treatment which may further enhance the maintenance of treatment effects. We also used delay cues that were commonly presented in the natural environment (i.e., "wait," "in a minute," "not right now") to increase the similarity of the training context and the context typically experienced by the participant. Finally, for two participants treatment was sequentially implemented in a second context, and all participants' treatment was extended to the relevant context and training was provided to the caregivers that would be responsible for the maintenance of treatment.

Other procedures have been shown to effectively maintain low levels of problem behavior during planned delay intervals of practical duration. Multiple schedules are often used in the treatment of positively maintained problem behavior (Hagopian et al., 2011), whereas chained schedules are often used to treat escape-motivated problem behavior (e.g., Hagopian et al., 1998). Multiple schedules have been shown to retain zero or low levels of problem behavior and sufficient levels of communication even when non-reinforcement periods are scheduled for up to 80% of the observation period (Betz, Fisher, Roane, Mintz, & Owen., 2013; Fisher et al., 1998; Hagopian et al., 2011; Hanley et al., 2001). Multiple schedules, however, have often been programmed using somewhat artificial stimuli (but see Kuhn, Chirighin, & Zelenka, 2010) such as different colored cards that must be programmed in the natural environment (Hagopian et al.; Hanley et al.). In addition, obtaining stimulus control over the occurrence of FCR can be difficult to achieve, sometimes resulting in high rates of FCR during the extinction component and some recovery of problem behavior as the extinction component is increased (see Hanley et al., for examples). Given the current state of evidence, a direct comparison of multiple schedules and CBPD seems warranted. In particular, it would be important to evaluate the extent to which caregivers would be able to maintain treatment integrity with each procedure and whether they would prefer one over the other. The recipient’s preference for these procedures should also be directly evaluated and considered.

Chained schedules have historically been referred to as demand fading and have been used to treat negatively reinforced problem behavior (Hagopian et al., 2011; Lalli, et al., 1995). Although supplemental strategies including punishment have often been necessary to achieve the desired outcomes with demand fading (Hagopian et al., 1998), more recent evaluations by Falcomata and colleagues have been done in which various elements of both multiple schedules (the discriminative stimuli) and chained schedules (the contingency-based alternation of the component change) were used to successfully treat problem behavior maintained by a synthesis of both positive and negative reinforcement (Falcomata, et al., 2013; Falcomata, Roane, Muething, Stephenson, & Ing, 2012). The contingency arranged in the traditional chained schedules is somewhat different than the arrangement used in CBPD. Chained schedules used by Hagopian et al. (1998), Lalli et al., and Falcomata et al. can be represented as an FRx/FR1 schedule, in which a certain number of demands are completed following which the communication response is reinforced immediately. CBPD, by contrast, can be represented as an FR1/FRx schedule, in which the communication response is followed by a chain of responses that are progressively increased to accommodate the length of delay necessary, including unplanned delays that may naturally come up. This arrangement also allows for the recursive implementation of treatment. This is important given the continuous nature of the interactions between children and their caregivers. For example, a child may request a break from work and be told to wait and finish his homework first. Once that's done, the child is provided with a break with his toys. During this break, however, they child may ask that his mom play along with him. At this point, mom can once again repeat the treatment procedure and ask the child to wait and play alone while she finished her cooking. When mom joins the play, however, the child may make another request for a drink, which mom may immediately reinforce. In this way, CBPD can be practiced continuously as it has a natural fit with life and common situations.

CBPD as described in this study is not without its limitations. Some participants' performance, in particular when demands were presented, required monitoring during the delay. For example, Will required intermittent prompting to continue beading. Alex's treatment included discrete presentation of demands and three-step prompting (instruction, model, physical). The need for continuous monitoring of children's behavior may present a barrier to implementation when parents and teachers are busy with other tasks or other children. One possible extension of this research could involve evaluating the use of product monitoring as the criteria for the contingent delivery of reinforcement. Another strategy that could improve the practicality of CBPD involves the addition of self-monitoring of performance (Connell, Carta, & Baer, 1993). Children could be taught to self-assess and to recruit reinforcement once a task is complete. This strategy could reduce the amount of continuous monitoring that caregivers must provide and increase children's independent task engagement during delays. Finally, the efficacy of a DRA-based contingency using momentary and sporadic monitoring remains to be assessed.

Some additional questions arise from the manner in which CBPD was programmed in this study. One question revolves around the predictability of the delay interval. Predictability can be defined in various ways. One aspect of predictability is related to the relative proportion of delayed and immediate reinforcement for FCRs. A second aspect relates to the extent to which the duration of each delay requirement is fixed or variable. Predictability may also involve cues that inform the participant of the ensuing delay requirement (e.g., contingency-specifying statements or visual cues such as token boards). Future research should examine the impact of predictable versus unpredictable delay termination requirements.

The main advantage of CBPD lies in its ability to create desirable patterns of behavior while emulating situations that involve unplanned delay intervals and in its ability to yield generalizable patterns of behavior that appear to protect children from mismanaged contingencies (see also Luczynski & Hanley, 2013). Future investigations into the procedural variations that may enhance the efficacy of this treatment, its generality, and its social validity are still warranted.

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Table1

*List of Acronyms*

| | |
|---|---|
| FCT | Functional communication training |
| FCR | Functional communication response |
| SIB | Self-injurious behavior |
| TR | Tolerance response |
| IOA | Interobserver agreement IOA |
| DRA | Differential reinforcement of alternative behavior |
| NCR | Noncontingent reinforcement |
| FR | Fixed Ratio |
| TBPD | Time-based progressive delay |
| CBPD | Contingency-based progressive delay |
| DRO | Differential reinforcement of other behavior |

Note: The order of acronyms reflects the order in which they appear in the manuscript.

Table 2

*Participant Characteristics*

| Participants/ Age/ Gender | Diagnoses | Receptive Language | Expressive Language | Imitation Skills | Motor Skills | Play/ Leisure Skills |
|---|---|---|---|---|---|---|
| Nico 23-month old male | None | Multi-step vocal instructions | Gestures, one-word & partial frames | 2 | 2 | 2 |
| Will 30-year old male | PDD, ID, ADHD, Episodic Mood Disorder | Simple gestural prompts | Non-vocal | 0 | 1 | 0 |
| Jack 21-month old male | ASD | Simple vocal instructions | Gestures & vocal approximation/ | 1 | 1 | 0 |
| Alex 6 year-old Male | ASD | Multi-step vocal Instructions | Full Sentences | 2 | 2 | 2 |

Note: PDD = Pervasive Developmental Disorder, ID = Intellectual Disability, ADHD = Attention Deficit/Hyperactivity Disorder, ASD = Autism Spectrum Disorder, 0 = none, 1 = limited, 2 = age-appropriate

Table 3

*Participant Specific Communication Responses and Reinforcers*

| Participant | Initial/Simple FCR | Target FCR | Reinforcers |
|---|---|---|---|
| Nico | Single-word mand e.g., “show” | Fully framed mand e.g., “More show please” | Child-selected items from activity buffet and adult attention (30s to 120s) |
| Will | Handing a food icon | Handing a food icon | Food (one piece) |
| Jack | “My way” or hand gesture to chest | “My way” or hand gesture to chest | Child-selected items from activity buffet and adult attention (30s to 120s) |
| Alex | “May way please” | “Excuse me” pause “May I have my way, please?” | Escape from demand, child-selected items from activity buffet, and compliance with mands (30s to 120s) |

Note. FCR = functional communication response

Table 4

*Participant Specific Mastery Criteria and Treatment Extension Context*

| Participant | Criteria to Increase Delay | Treatment Extension Context |
|---|---|---|
| Nico | One session at 1s, 2s, 4s<br>Two sessions at 8s, 16s, 32s<br>One session at 64s | 256 s<br>Dad and Mom<br>session room* |
| Will<br>(Comp 1) | One session with no PB or CR<br>Two sessions if any PB or CR | -- |
| Will<br>(Comp 2) | Stable and desirable trends in one condition | 8 demands<br>Staff<br>typical setting |
| Jack | One session with no PB or CR<br>Two to four sessions if any PB or CR | 256 s<br>Dad<br>session room* |
| Alex | One session with no PB or CR<br>Two sessions if any PB or CR | 50 demands<br>Mom<br>session room |

*Data available upon request.

Note. Comp = comparative analysis; PB = problem behavior, CR = collateral responses

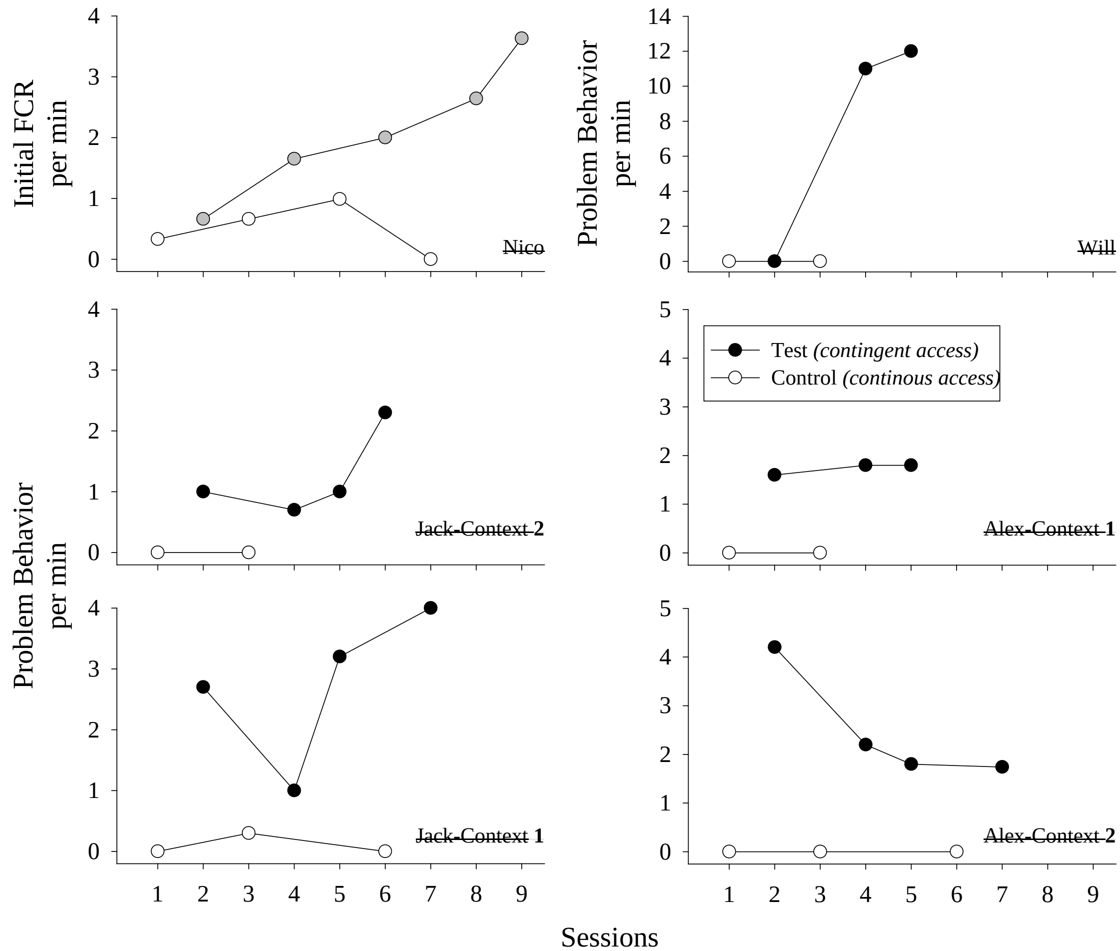


*Figure 1.* Results of the mand form analysis for Nico and the interview informed synthesized contingency analyses for Will, Jack, and Alex.

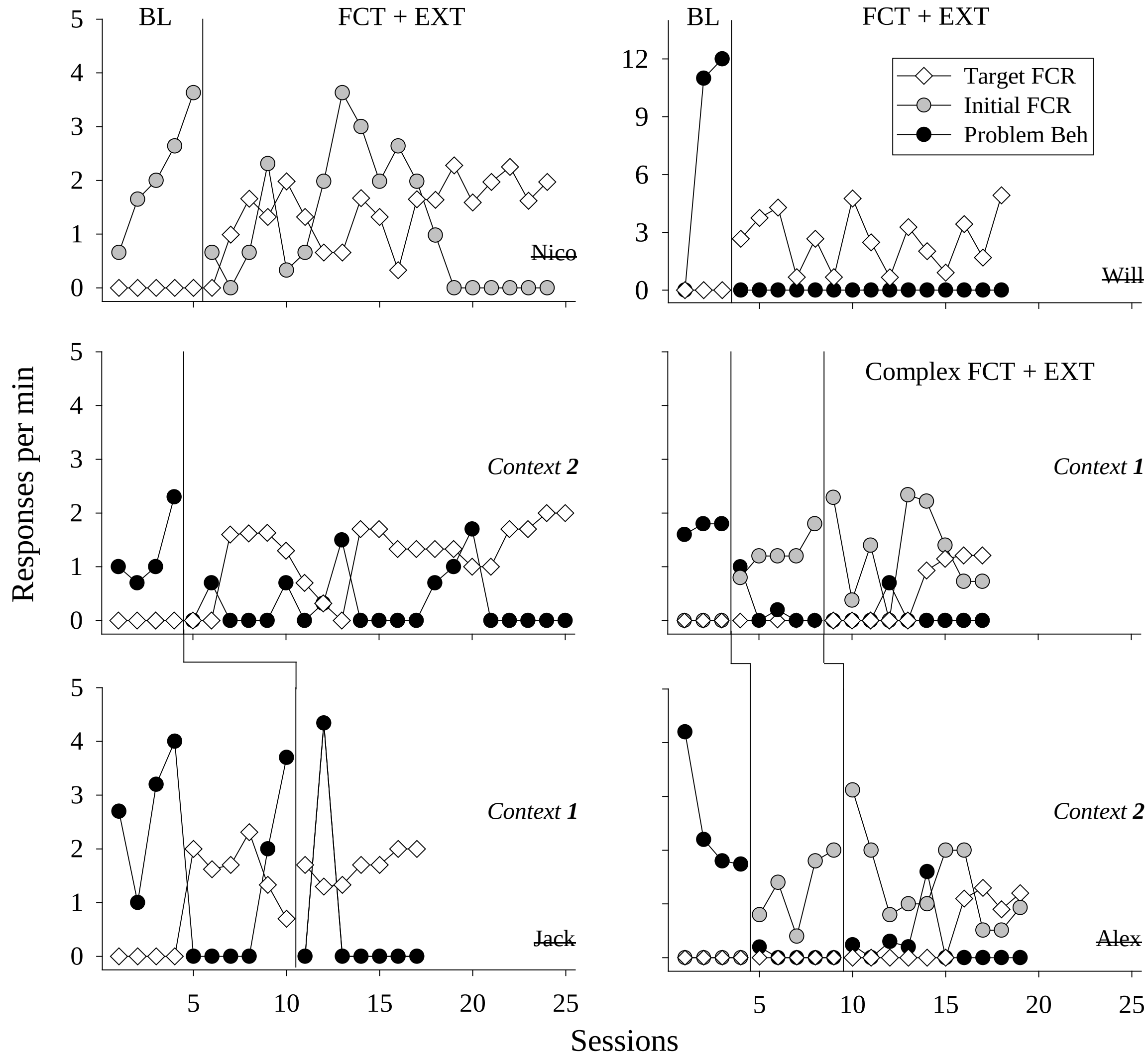


*Figure 2.* Results of the functional communication training plus extinction (FCT + EXT) for Nico, Will, Jack and Alex.

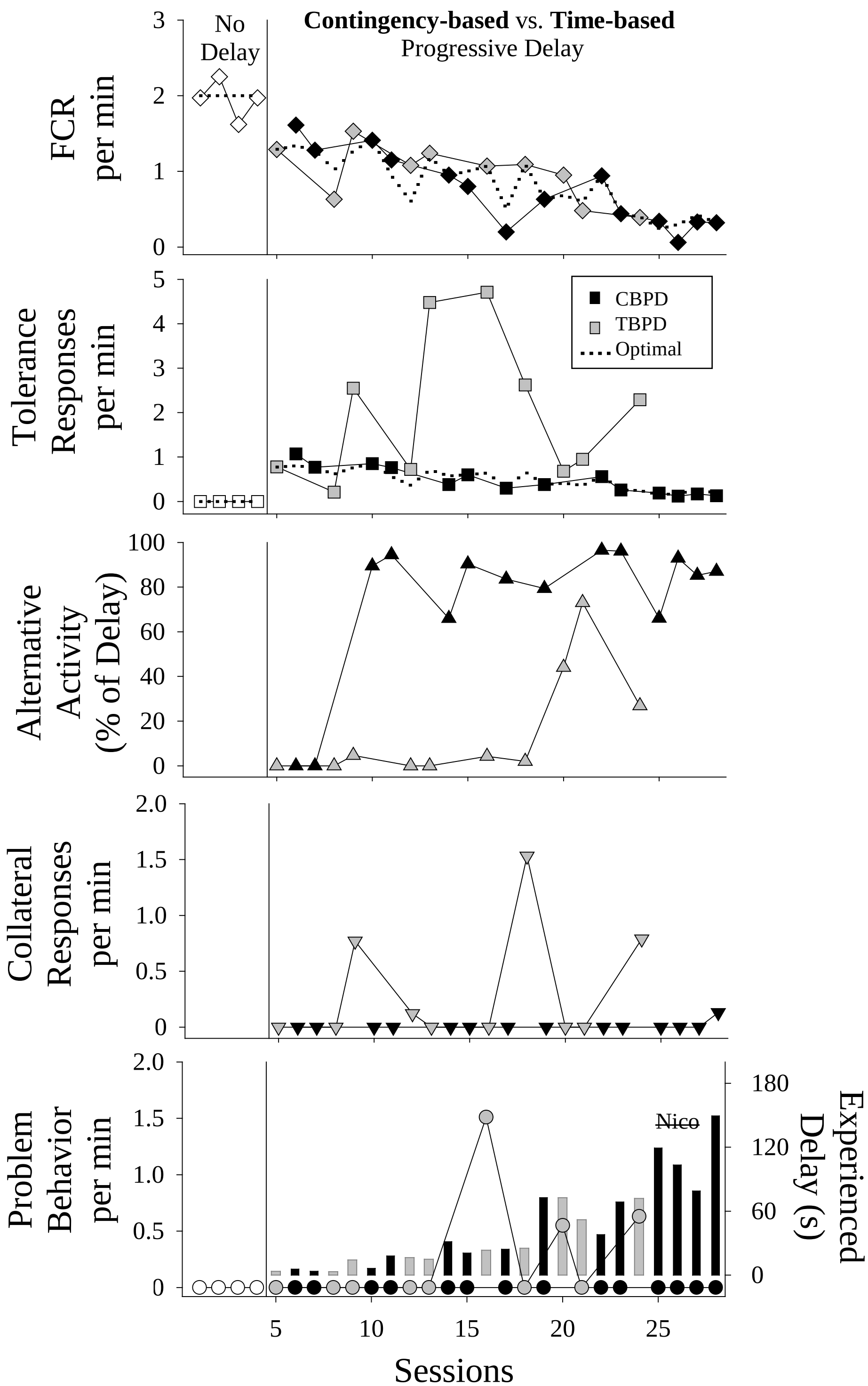


*Figure 3.* Results of the time-based versus contingency-based comparative analysis for Nico.

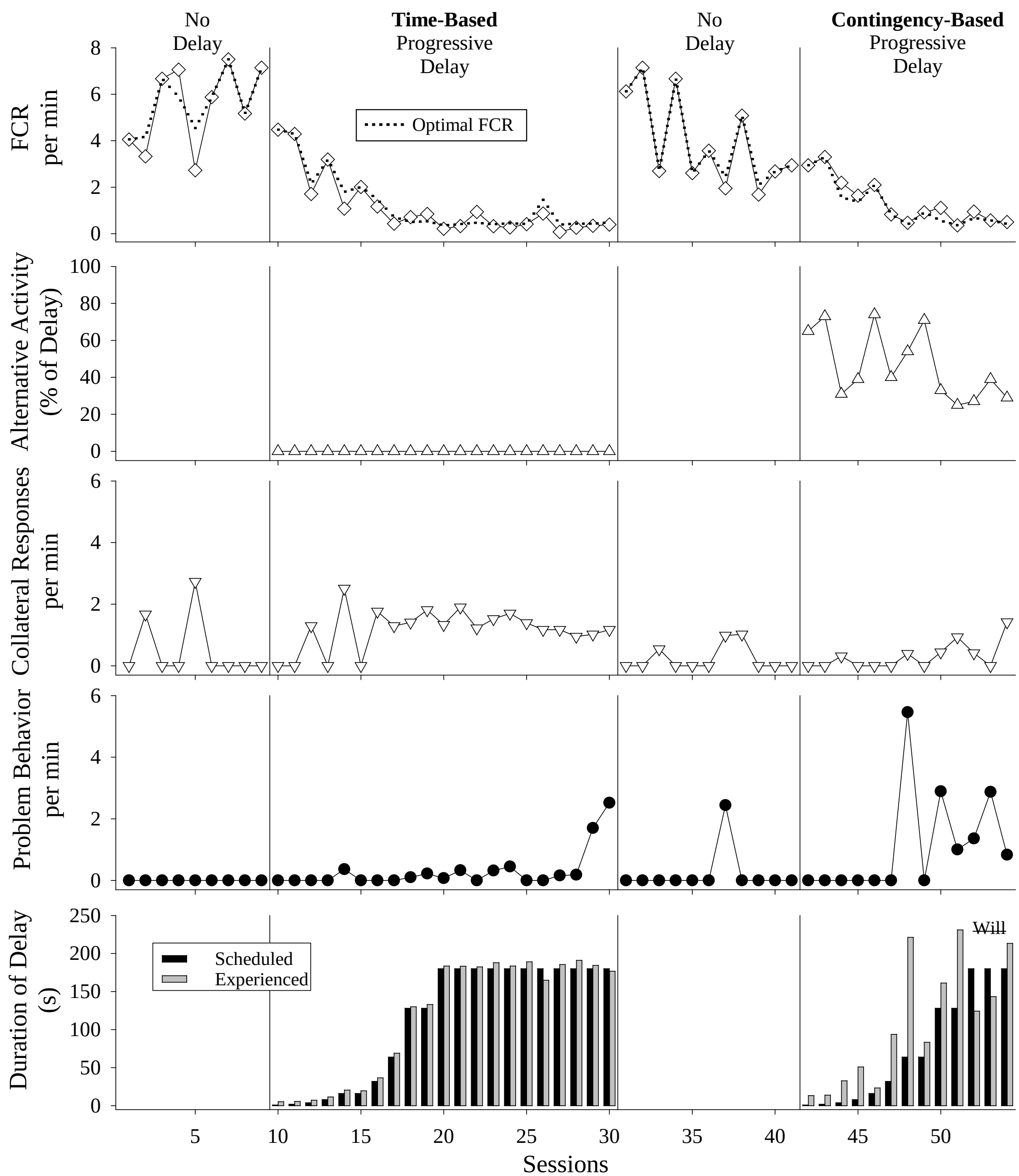


*Figure 4.* Results of the time-based versus contingency-based comparative analysis for Will.

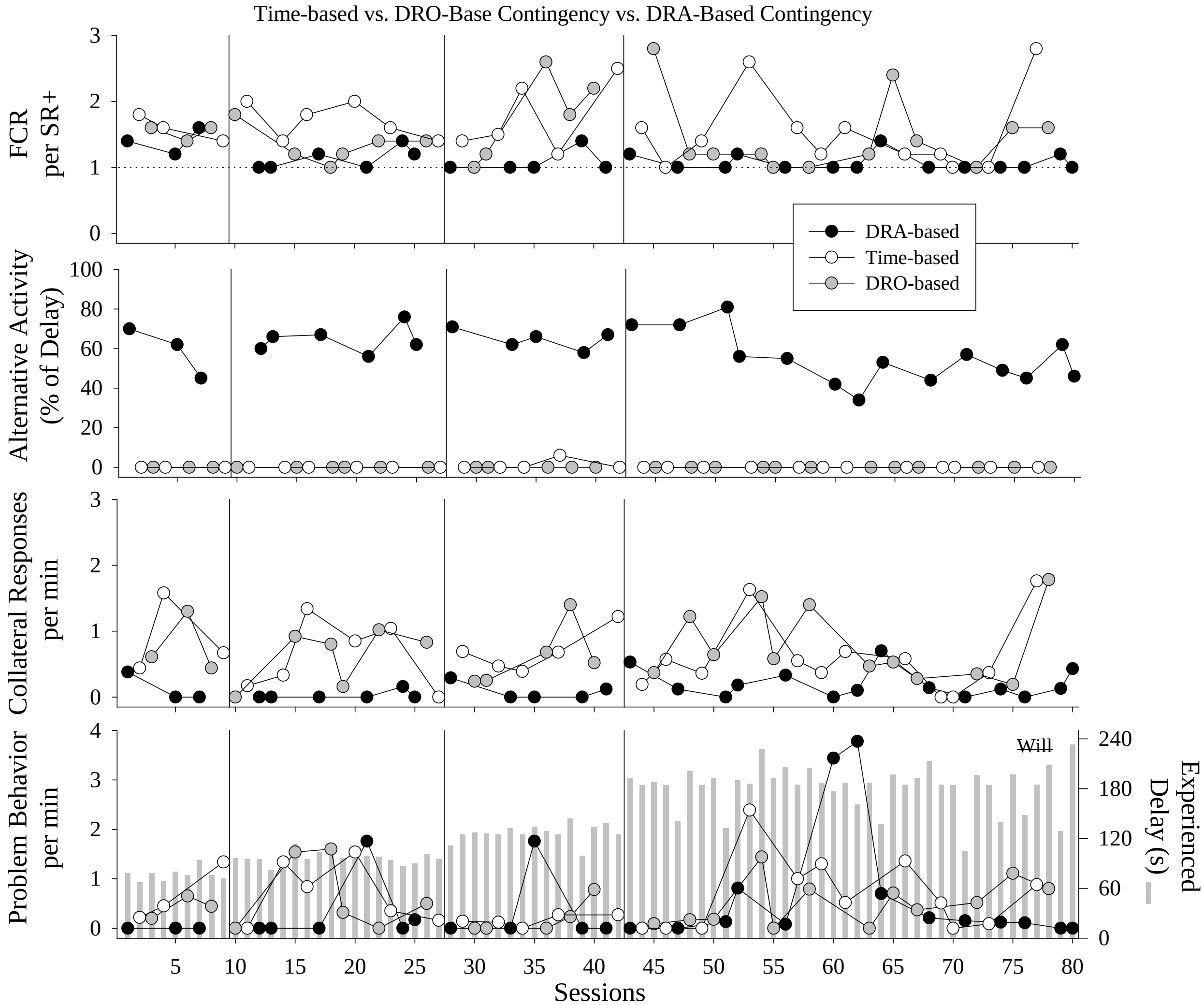


*Figure 5.* Results of the comparison between time-based versus DRO-based versus DRA-based delay for Will. Note. The scheduled delay increased at each phase line.

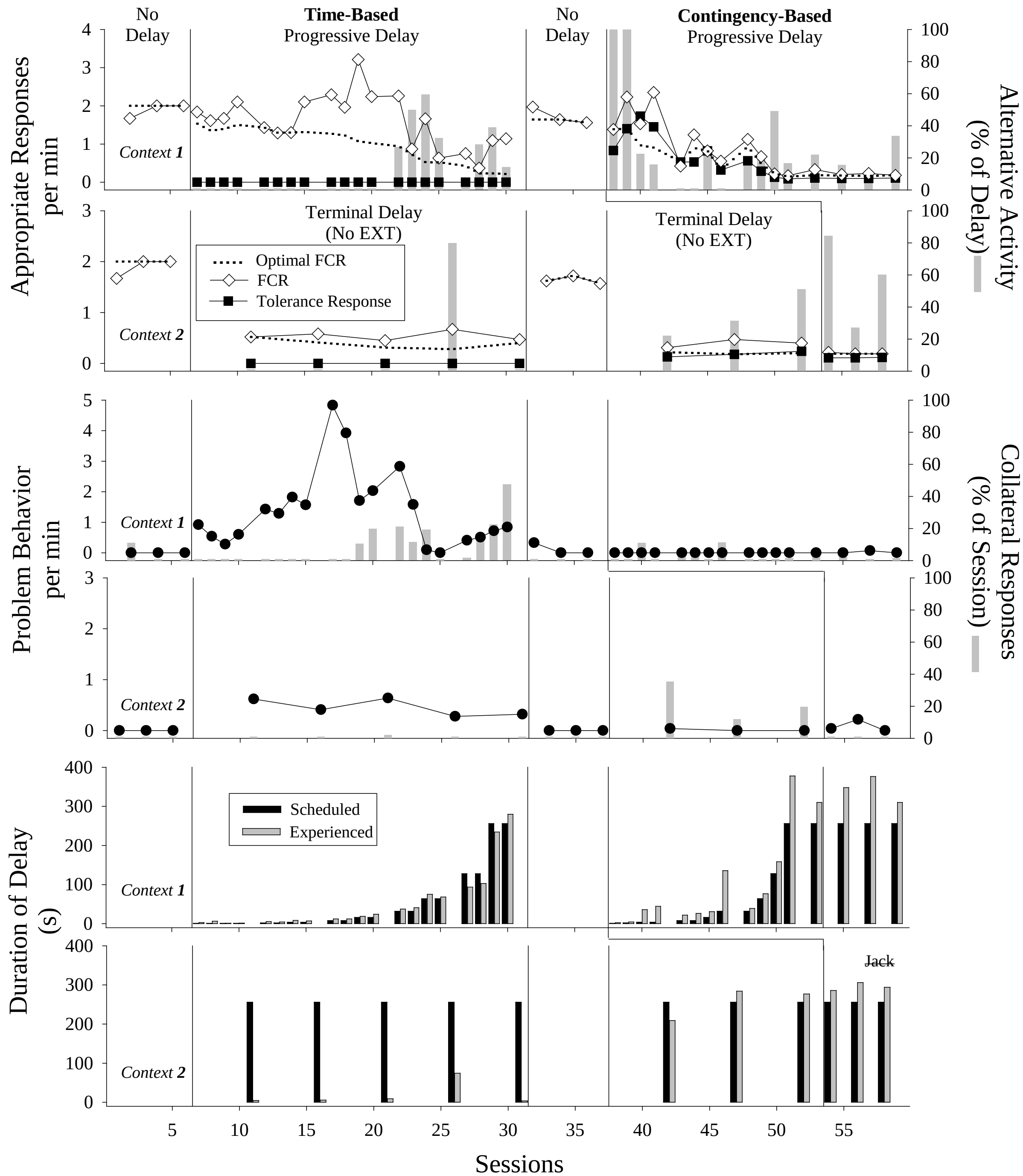


*Figure 6.* Results of the time-based versus contingency-based comparative analysis for Jack.

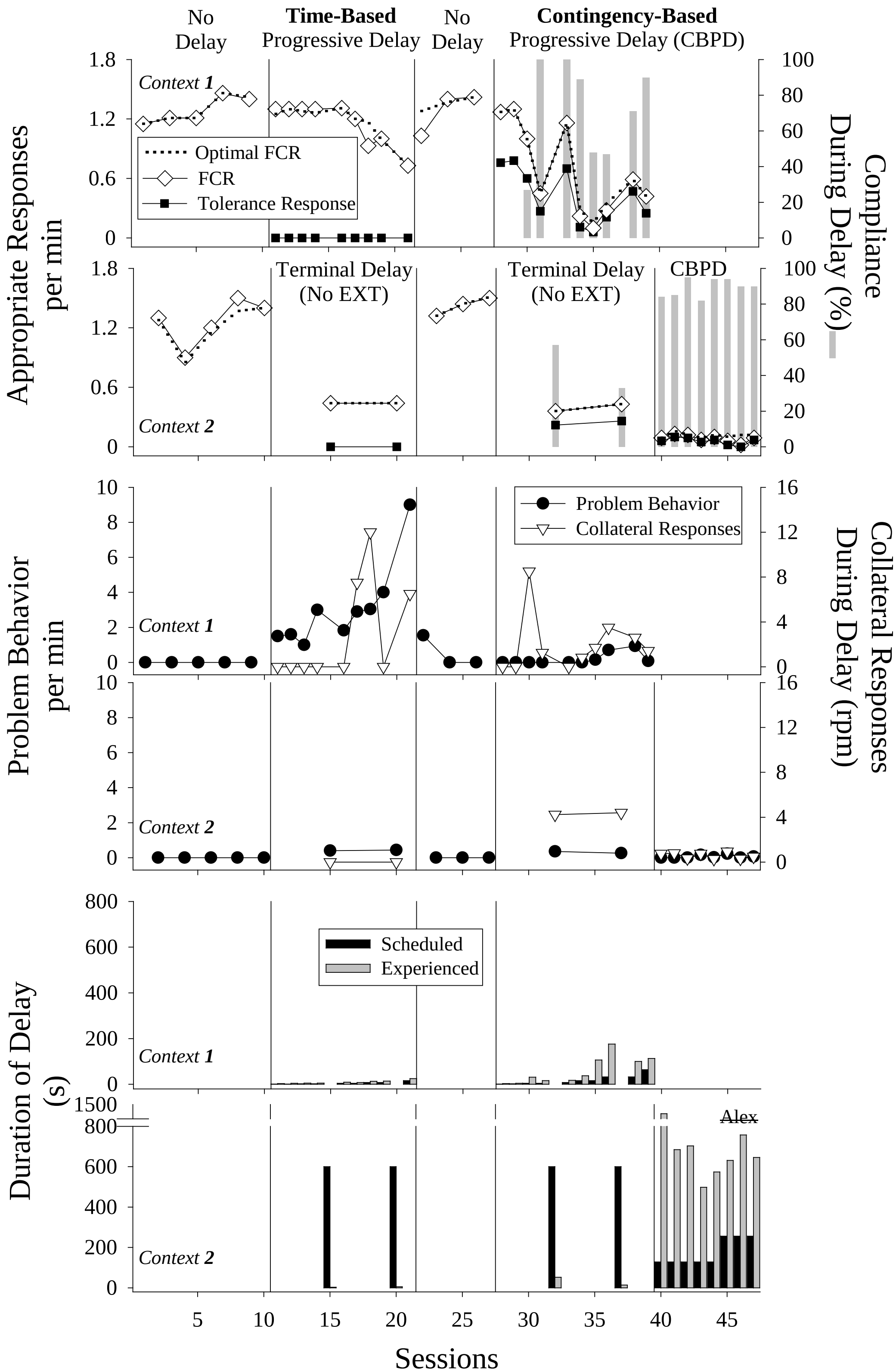


*Figure 7.* Results of the time-based versus contingency-based comparative analysis for Alex.