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An Evaluation of Mixed, Fixed, and No Delays to Reinforcement on Problem Behavior, Preference, and Task Engagement

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An Evaluation of Mixed, Fixed, and No Delays to Reinforcement on Problem Behavior, Preference, and Task Engagement

by

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Dedication

This work is dedicated to the participants from this study and their families. Thank you for inspiring me to be a better clinician, researcher, and person each day. Thank you for allowing me to be a part of your lives, trusting my work, and for bringing me joy throughout this project. To all persons with disabilities and their families, thank you for teaching me acceptance and being a true inspiration of perseverance.

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Andrea Ramirez-Cristoforo

Abstract

An Evaluation of Mixed, Fixed, and No Delays to Reinforcement on Problem Behavior, Preference, and Task Engagement

By

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The University of Texas at Austin, 2022

Supervisor: Terry S. Falcomata

The proposed study aimed to replicate and extend basic and applied literature pertaining to functional communication training (FCT), delays to reinforcement, concurrent schedules of reinforcement, problem behavior (e.g., escape maintained), and task engagement in individuals with autism. Specifically, we evaluated the effects of presenting a 0-s delay, a mixed delay (0, 30-s) and a fixed delay (15-s) within a concurrent schedule arrangement on problem behavior, preference, and task engagement among three individuals with ASD. An ABAB reversal single-case design was conducted during the current study. During this evaluation, the quality of the reinforcement was manipulated. Selecting the 0-s delay led to lower quality reinforcement (i.e., low preferred items for 30-s), whereas selecting the mixed or fixed delay led to higher quality reinforcement (i.e., access to preferred items for 30-s). Results indicated that two out of three participants preferred the mixed delay over the fixed delay and the 0-s delay to reinforcement alternatives. One participant preferred the mixed and fixed delay equally. None of the participants preferred the 0-s delay to reinforcement. Presenting these three delays to reinforcement alternatives concurrently at the beginning of treatment resulted in low levels of problem behavior for all participants and task engagement levels remained at high levels. Potential implications for practice and possible areas of future research on delays to reinforcement, especially regarding mixed delays to reinforcement are discussed.

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Chapter 1: Introduction

Impairments in verbal and non-verbal communication are commonly found in individuals with autism spectrum disorder (ASD; DSM-5). These communication impairments can hinder the ability of individuals with ASD to effectively communicate their needs. Consequently, individuals with ASD have a higher probability of engaging in high levels of problem behavior (Boonen et al., 2014; Marcus & Vollmer, 1995). The presence of problem behavior can negatively affect how individuals with ASD respond to instruction and their daily functioning, which hinders their ability to acquire skills (Boonen et al., 2014). The presence of problem behavior not only affects individuals with ASD but also their families. Parents of individuals with ASD who engage in problem behavior can possibly experience high levels of parenting stress. These high levels of stress can affect the family dynamic and their well-being (Boonen et al., 2014; Estes et al., 2013). Due to these negative consequences, research on decreasing problem behavior and increasing communication skills among individuals with ASD is still warranted.

Problem behavior can be maintained by either positive or negative reinforcement. Positive reinforcement can include access to attention or a preferred activity (i.e., tangible); whereas negative reinforcement is the avoidance of negative stimuli or removal of an aversive stimuli. Negatively reinforced problem behavior, or escape-maintained problem behavior, can include engagement in disruptive or non-compliant behaviors such as aggression, elopement, or self-injurious behaviors. Consequently, the individual avoids completing non-preferred tasks or delays the presentation of the task.

One of the most common functions of problem behavior in individuals with developmental disabilities (DD) has been shown to be negative reinforcement (i.e., escape; Iwata et al., 1982/1994). More recently, Love et al. (2009) found that escape was the second most common function of problem behavior identified with 50% of children with ASD. The presence of escape-maintained problem behavior presents a great challenge for teachers and caregivers because task engagement, and following instructions and requests, are important components for skill acquisition (Carr et al., 1980; Marcus & Volmer, 1995).

Functional communication training (FCT; Carr & Durand, 1985) is an empirically validated and often recommended intervention to replace problem behavior. Numerous studies have been conducted on FCT. These studies can be categorized into first- and second-generation FCT studies. First-generation studies have demonstrated the effectiveness of FCT as a function-based treatment for the treatment of problem behavior among individuals with ASD and DD across different topographies of behaviors and behavior functions including those that serve escape functions (Bird et al., 1989; Durand, 1990; Durand & Carr, 1991; Durand & Kishi, 1987).

During FCT, the individual is taught to emit an appropriate functional communication response (FCR; e.g., verbalization, picture card, or manual sign) as a means to access the same reinforcer that was maintaining problem behavior (Tiger et al., 2008). FCT begins with the identification of a motivation operation (MO) for problem behavior that is then systematically introduced. The implementation of FCT for the treatment of escape-maintained problem behavior usually consists of presenting the demand or the aversive stimulus and teaching the individual to request for a “break” or “help” using an alternative communication modality (e.g., picture card, speech generating device, or sign) as the FCR and reinforcing the FCR immediately (i.e., continuous schedule of reinforcement).

Through consistent reinforcement of the FCR, the individual learns that emitting the FCR results in a break and engaging in problem behavior is no longer reinforced. Therefore, asking for a “break” increases, which in turns decreases problem behavior. However, task engagement may remain low (Hagopian et al., 2011), especially among individuals whose requests to escape the task are emitted at high rates. The consistent use and continuous reinforcement of the FCR to escape tasks and not complete academic or daily living routines is not feasible in the long term because needed skills will not be acquired. Therefore, the use of continuous schedules of reinforcement to strengthen the FCR to escape tasks can lead to common concerns regarding the long-term success, social validity, generalizability, and maintenance of FCT for escape-maintained problem behavior (Hagopian et al., 2011).

As a result, ways of thinning the schedules of reinforcement to practical levels and tolerating delays to reinforcement while maintaining near-zero rates of problem behavior have been investigated as second-generation studies (e.g., Escobar & Bruner, 2007; Fisher et al., 1993; Hanley et al., 2001; Lalli et al., 1995; Roane et al., 2004). One of the most common procedural variations for scheduling thinning during FCT for the treatment of escape-maintained problem behavior is chain schedules of reinforcement, or demand fading (Hagopian et al., 2011). Demand fading consists of gradually increasing the number of tasks that have to be completed before the individual’s request for a “break” is reinforced. The use of a chain schedule of reinforcement facilitates task engagement, emitting the FCR at practical levels, and decreasing problem behavior (e.g., Davis et al., 2018; Lalli et al., 1995).

The use of delays to reinforcement, in addition to demand fading, as a schedule thinning procedure, has also been investigated in basic and applied studies (i.e., delay fading; Hanley et al., 2001). Delays to reinforcement consist of systematically increasing the tolerance between the FCR and the delivery of reinforcement. However, there is some evidence that increasing the delay to reinforcement may weaken the contingencies between the FCR and the delivery of the reinforcement, leading to resurgence of problem behavior (Hanley et al., 2001; Volkert et al., 2009; Hagopian et al., 2011). For this reason, most studies that have investigated the use of delays to reinforcement within FCT have begun with a short delay and progressively increased the delay until a terminal criterion has been met. Hagopian et al. (2005) progressively increased the delays to reinforcement within FCT with extinction from five seconds up to the terminal criteria of five minutes. During the delays, Hagopian et al. provided access to stimuli that competed with problem behavior (i.e., competing stimuli) non-contingently. Results from the current study suggested that problem behavior was less likely to occur when competing stimuli were provided during the delays compared to when no competing stimuli were available. Austin and Tiger (2015) extended Hagopian et al. by evaluating the effects of providing access to alternative reinforcers during schedule thinning within FCT. Delay fading with the alternative reinforcers was effective at decreasing problem behavior while maintaining FCR at stable and efficient levels.

The main research focus over the past years has been the evaluation of additional components within the delay to reinforcement procedures and other schedule thinning procedures used during FCT (Austin & Tiger, 2015; Fisher et al., 2000; Hagopian et al., 1998; Hagopian et al., 2005). Less attention has been provided to investigating specific delay arrangement procedures that can influence FCT practicality and effectiveness. Evaluating the potential effect of delay arrangement procedures within FCT is necessary.

The evaluation of specific delay arrangement procedures is scarce in the translational and applied literature. However, a few translational studies have examined these delay arrangements. Hagopian et al. (2004) compared the effects of a dense to lean (DTL) versus fixed lean (FL) schedule for thinning alternative reinforcement using FCT or non-contingent reinforcement

(NCR) for the treatment of problem behavior across three participants. Problem behavior was placed on extinction during this evaluation. During the DTL condition, reinforcement was provided in a continuous schedule of reinforcement (e.g., FR-1) followed by progressively thinning the schedule of reinforcement to the terminal delay criterion. The FL condition consisted of the use of a fixed schedule of reinforcement throughout sessions that was equivalent to the terminal reinforcement schedule. For two out of the three participants, the terminal delay criterion was attained more rapidly during the FL condition than during the DTL condition. During the DTL condition, a more significant reduction of problem behavior was observed when compared to the FL condition across all three participants. However, recovery of problem behavior occurred in some instances during schedule thinning.

Hagopian et al.'s (2004) findings raise the question about the potential effects of implementing the terminal delay criterion since the beginning of the treatment versus progressively increasing the delay across treatment sessions. Due to the study design, the processes responsible for the observed difference between these two methods of schedule thinning were not able to be concluded. The authors suggested investigating schedule thinning methods, such as moderate dense schedules of reinforcement, because the response allocation may shift from the alternative response to problem behavior (e.g., from the FCR to problem behavior in the context of FCT) during schedule thinning. Moderate dense schedules of reinforcement could potentially maintain the alternative communicative response at practical levels and increase the likelihood of problem behavior contacting extinction, which in turn could help maintain low levels of problem behavior during the delay (Hagopian et al., 2004).

Response allocation can also be influenced through four variables: response effort, quality of the reinforcement, rate, and immediacy of reinforcement (McDowell, 1988; Stromer et al., 2000). Manipulating these four variables to favor one particular response can shift response allocation from problem behavior to the alternative response (e.g., FCR, task engagement, etc.) and vice versa in the context of FCT. Response allocation has been evaluated in basic and applied studies, using concurrent schedules of reinforcement and manipulating these four variables (Davis et al., 2012; Davis et al., 2018; Horner & Day 1991; Peck et al., 1996; Peterson et al., 2009). In Davis et al. (2012), problem behavior produced non-contingent escape (NCE), but engaging in the FCR produced NCE plus access to a preferred item. For all three participants, their response allocation shifted from problem behavior to the FCR. However, a schedule thinning procedure in the form of a delay to reinforcement was needed for task engagement to increase and for the FCR to occur at practical levels.

A few applied studies have addressed these limitations by manipulating the quality and duration of reinforcement on problem behavior, mands for breaks and mands for work (Peck Peterson et al., 2005; Peterson et al., 2009; Davis et al., 2018). In these studies, higher quality (e.g., access to preferred toys) and longer duration of reinforcement was provided contingent upon task completion and the FCR. A shorter and lower-quality break was provided contingent upon emitting the FCR before task completion or engaging in problem behavior. The manipulation of these variables and the presence of concurrent schedules of reinforcement produced task completion, emission of the FCR at acceptable rates, and lower levels of problem behavior for all participants. The results from these studies suggested that concurrent schedules of reinforcement and varying the parameters of reinforcement can manipulate response allocation and increase FCT effectiveness and efficacy.

Fewer applied studies have used concurrent schedules of reinforcement to investigate the effects of delays to reinforcement on response allocation (Vollmer et al., 1999). The arrangement of the delay interval may influence response allocation within concurrent schedules of reinforcement and maintain steady rates of the alternative response (Stromer et al., 2000). For instance, basic research on pigeons has demonstrated that pigeons show greater allocation to keys associated with variable delays than those associated with constant delays (Tobin & Logue, 1994; Cicerone, 1976). Constant delays appear to weaken resistance to extinction whereas intermittent or partial delays appear to increase resistance to extinction (Crum et al., 1951).

Fixed or constant delays versus variable delays to reinforcement has been investigated in the literature regarding self-control (i.e., risk sensitivity). Self-control literature has contributed to the literature in delays to reinforcement because in a self-control procedure a choice is given between a small immediate reinforcer or a larger delayed reinforcer (Mazur & Logue, 1978). Displaying self-control entails engaging in behaviors that do not produce immediate access to the reinforcer and choosing to engage in behaviors that produce delayed reinforcement.

When given a choice between a fixed reinforcement delay and a variable reinforcement delay that average to the same value as the fixed delay, the non-human subjects consistently preferred the variable delay (Mazur, 1984; Mazur, 2004). Herrnstein (1964b) used concurrent schedules of reinforcement to assess this preference with pigeons. In this study, responses on one key produced food reinforcement in a fixed interval and responses on the other key produced food reinforcement on a variable schedule. The results from this study suggested that the pigeons emitted a higher rate of responding (e.g., preference) on the key that delivered food in a variable-interval schedule when the mean of this schedule was equal to the schedule of the fixed interval.

Within the delay to reinforcement literature and the self-control literature, mixed delays to reinforcement have a smaller empirical base. Mixed delays consist of a bi-valued variable schedule (e.g., variable ratio or variable interval) of a short and a long value (i.e., smaller or larger), which are presented with equal probability. The two values that compose the mixed delay interval or ratio can vary but the mean of the two values must equal the scheduled value.

Preference between fixed or constant delays and mixed delays to reinforcement have been investigated mainly in basic studies. Cicerone (1976) studied preference using a free-operant procedure with four pigeons. During this study, pecking on one key was reinforced following a mixed interval delay (i.e., 6 or 10 s and 2 or 14 s) while pecking on the second key was reinforced following a constant delay (i.e., 0, 8, 16, and 32 s). Preference was examined across a variety of delays intervals in this study. The results from this study suggested that pigeons preferred mixed delays over the constant delay to reinforcement. Also, as the interval increased preference for the mixed delays increased.

Another basic study that extended the literature on preference for mixed delays to reinforcement was Rider (1983). Preference for mixed versus constant delays to reinforcement was studied with rats. Within the mixed delay arrangement, Rider (1983) investigated the effects of different probabilities of the short delay. Preference for mixed delays was observed in all rats. When the proportion of the short delay (i.e., 0 s) was presented 25% of the time, all five rats preferred the mixed delay. When the short delay was presented only 10% of the time, only three out of five rats preferred the mixed delay. Results from this study suggested that intermittent small delays to reinforcement can affect preference.

A few human operant studies have investigated these findings (Kohn et al., 1992; Locey et al., 2009). Locey et al. (2009) examined preference between viewing 30-s video clips on either a fixed time (15-s, 30-s, or 60-s) schedule versus a mixed time schedule of the same average delay (1s-59s) with four adult males. Three out of the four participants showed preference for the mixed time schedule across all delay values. Participants who preferred the mixed time schedule were given the choice of responding across different pairs of mixed time schedules with different distribution of reinforcer delays that contained increasingly smaller proportions of the smaller value (e.g., 1s). All three participants chose the distribution that had the higher percentage of the small 1s delay. These studies replicate Rider et al.'s (1983) findings and show preliminary evidence of the effects of intermittent small delays to reinforcement on preference and responding.

Most recently, Mullane et al. (2017) evaluated preference for mixed versus fixed ratio schedules of reinforcement with four fourth grade students. The students were given the choice to complete addition problems on a fixed ratio 5 schedule (i.e., FR5) or on one of three mixed-ratio schedules. The three mixed-ratio schedules consisted of an equivalent mixed ratio (e.g., 1, 9), a schedule with a 20% larger ratio requirement (e.g., 1,11) and an equally lean mixed ratio without a small fixed-ratio component of 1 (5, 7). Results from this study suggested that all children preferred the equivalent mixed-ratio of (1, 9) over the equivalent fixed ratio 5 schedule.

When the equally lean mixed ratio (e.g., 5,7) was presented, one participant switched to the FR5 alternative while the other three participants showed a pattern of indifference. The participant who shifted his preference for the FR5 alternative was completing more effortful level math problems, whereas the participants who were indifferent were completing instructional level materials. There is the possibility that the level of difficulty made the contrast between the fixed schedule over the (5,7) mixed ratio schedules more salient. The possibility of having to complete two additional problems at the mixed ratio schedule may have been meaningful as it required a higher level of effort. These results suggested that response effort may have a potential effect on preference. The results from this study also brings to light the possibility that under certain conditions, children's preference for variable schedules to reinforcement can be evoked in order to increase academic responding especially when the small

FR1 component is present in the mixed schedule. Mullane et al.'s (2017) results highlight the importance of a small FR1 component in the emergence of preference for mixed ratio schedules.

More recently, Mullane et al. (2020) extended the literature and assessed whether preschool age children with a developmental disability chose to engage in problem behavior or the FCR when concurrent variable and fixed reinforcement delays were programmed for each response. A preference for the variable reinforcement delay over the fixed delay was observed across phases for both participants. The participants also altered their response allocation between FCR and problem behavior to favor the response that was reinforced in a mixed delay schedule of reinforcement. An extinction phase was added to decrease problem behavior to zero. The results from this study replicated previous findings in regard to manipulating the delay arrangement (e.g., contingencies) to alter response allocation. Individuals commonly experience different contingencies and delays to reinforcement in the natural environment. These contingencies can influence the individual's behavior and his or her response allocation. For this reason, Mullane et al. advised for additional research on humans' choices and self-control to better understand the factors that can influence an individual's choices and response allocation. This would aid designing more effective behavioral interventions. For instance, it would support the use of a variable rather than a fixed schedule during reinforcement schedule thinning within FCT for participants who have shown a preference for mixed delays to reinforcement.

Overall, these studies support that concurrent conditions can be created to influence response allocation from problem behavior to a FCR and task engagement by manipulating the delays to reinforcement. To date, there is limited research on the efficacy of fixed versus mixed delays to reinforcement during schedule thinning within FCT (Mullane et al., 2020; Van Camp et al., 2000). The potential use of mixed delays to reinforcement within FCT or other behavioral treatment interventions must be further evaluated to understand the parameters needed for effective implementation.

The current study aims to expand the empirical research on delays to reinforcement, FCT, and concurrent schedules of reinforcement on negative problem behavior in individuals with autism. The current study has two main purposes. One is to extend and replicate findings from previous basic and applied studies examining preference between a 0-s delay, fixed delay, and mixed delay to reinforcement when the quality of the reinforcement is manipulated, and problem behavior is on extinction. The second is to evaluate the effects of presenting three concurrent choices, each correlated to a different delay to reinforcement [e.g., 0-s delay, mixed delay (0-30-s) and fixed schedule (15-s)] on problem behavior, preference, and task engagement in individuals with ASD. This research will help inform alternative methods for using delays to reinforcement within behavioral treatment interventions and applied settings.

CHAPTER 2: An Evaluation of Functional Communication Training to Treat Escape-Maintained Problem Behavior: A Systematic Review of the Literature

Many individuals with an autism spectrum disorder (ASD) or a developmental disability (DD) engage in problem behavior (Marcus & Vollmer, 1995). One of the most common functions of problem behavior in individuals with DD has been shown to be negative reinforcement (i.e., escape; Iwata et al, 1994). Iwata et al. (1994) analyzed the function of self-injurious behavior (SIB) of 152 individuals with DD. The results showed that 35% of the individuals' SIB was maintained by escape from instruction compared to 23% and 26% of individuals whose SIB was maintained by attention or automatic reinforcement respectively. More recently, Love et al. (2009), found that escape was the second most common function of problem behavior identified for 16 out of 32 children with ASD. The presence of escape-maintained problem behavior presents a great challenge for teachers and caregivers because compliance, in the form of completing academic work, following instructions and requests, and doing chores, is an important component for skill acquisition (Carr et al., 1980; Marcus & Volmer, 1995).

Escape-maintained problem behavior may include engagement in disruptive or non-complaint behaviors (e.g., aggression, self-injurious behaviors, and eloping or avoidant behaviors). Engagement in escape-maintained problem behaviors, often times, terminate an aversive stimulus (e.g., non-preferred activity, person, noise, or physical space). When the behavior prevents or terminates the presence of the aversive stimulus, the behavior is said to be negatively reinforced (Butler & Luiselli, 2007; Iwata,1987). A number of antecedent and consequence-based interventions have been empirically supported for the treatment of escape-maintained behaviors (i.e., negative reinforced behaviors).

Task modification is an antecedent intervention that has been empirically validated and consists of modifying the establishing operation (EO) for the escape behavior (Michael, 1982). When implementing task modification, the therapist alters "easy" tasks and "difficult" tasks, during training sessions, to reduce problem behavior (Pace et al., 1993). Weeks and Gaylord-Ross (1981) conducted a study in which tasks were modified to different levels of difficulty. Weeks and Gaylord-Ross observed low levels of behavior problems during the "no demands", "easy tasks", and "errorless learning" conditions in comparison to the "difficult demand" condition. Horner et al. (1991) incorporated interspersed simple demands or high probability tasks (i.e., high-probability instructional sequence) among instructional trials, with three individuals with severe intellectual disabilities. The interspersed demands increased the probability of the individual completing the new and difficult task instead of engaging in problem behavior.

Other antecedent interventions that have been effective at reducing escape-maintained problem behavior are stimulus fading and noncontingent reinforcement (NCR). Stimulus fading consists of modifying one or more features of the aversive stimulus that produces problem behavior (Iwata, 1982). Stimulus fading for the treatment of escape-maintained problem behavior begins with the identification and alteration of the aversive stimulus such as the task or demand. For example, at the beginning of Heidorn and Jensen (1984) study, the number of demands presented to the participant was decreased. Contingent upon a reduction of SIB, the number of demands presented gradually increased. Other ways to implement stimulus fading consists of increasing the complexity and task duration as problem behavior reduces (Peterson et al., 2017; Shieltz et al., 2011). NCR has also been effective at decreasing problem behavior (Vollmer et al., 1995; Vollmer et al., 1998; Coleman & Holmes, 1998). NCR involves delivering the functional reinforcer on a response-independent schedule (Vollmer et al., 1995). When NCR is implemented for escape-maintained behaviors, NCR is often referred to as noncontingent escape (NCE). Through the implementation of NCE, the EO for the escape-maintained problem behavior is removed (Vollmer et al., 1995). For instance, Vollmer et al. (1995) provided access to a break from demands, on a fixed time schedule, regardless of the presence or absence of SIB (i.e., escape-maintained problem behavior).

One benefit of NCE or NCR procedures is that they are easier to implement because the caregiver or teacher can set a timer and deliver reinforcement regardless of the presence or absence of the target behavior (Carr et al., 2000). In comparison to other differential reinforcement procedures, higher rates of reinforcer delivery are observed with NCE or NCR (Vollmer et al., 1993). When NCR or NCE procedures are implemented, less extinction bursts have been observed (Vollmer et al., 1995; Tucker et al., 1998). Some potential limitations of NCE or NCR have also been identified (Carr et al., 2000). For example, (a) there is no alternative appropriate response that is taught and reinforced to replace the problem behavior (Carr et al., 2000; Tucker et al., 1998); (b) adventitious reinforcement of problem behavior may also occur because reinforcement is provided regardless of the occurrence or non-occurrence of problem behavior (Vollmer et al., 1997).

Other empirically validated interventions for escape-maintained problem behavior include the use of extinction alone or in conjunction with other interventions. During an extinction alone procedure, the aversive stimulus continues to be present (e.g., demands) despite the occurrence of problem behavior (Iwata, 1987). The individual escapes from the demand contingent upon the non-occurrence of problem behavior or when compliance is observed in addition to the non-occurrence of problem behavior. Carr et al. (1980) implemented an extinction alone (i.e., escape extinction) procedure with one of their participants who exhibited aggression to escape demands. The extinction procedure consisted of preventing the participant from escaping the instruction area and not presenting demands until the aggressive behavior had significantly decreased. Extinction procedures have also been conducted in conjunction with other interventions such as, differential reinforcement procedures.

Carr et al. (1980) conducted another experiment which consisted of comparing two different conditions: a demand only condition versus a demand plus toys and edibles condition. In the demand only condition, a demand was placed, and prompts were delivered if the participant did not emit a response. Praise was delivered contingent upon a correct response. The demand plus toys and edibles condition, was similar to the demand only condition with the exception that access to toys and edibles were used as reinforcers for correct responses (e.g., compliance with demands). Lower levels of problem behavior were observed in the demand plus toys and edibles condition when compared to the demand only condition (Carr et al., 1980). The use of differential reinforcement, extinction, and positive reinforcement showed to be effective at reducing escape-maintained problem behavior.

In some cases, the implementation of extinction might not be feasible (Iwata, 1982). For instance, when individuals with a disability engage in SIB, extinction might not be the best course of treatment because problem behavior may increase (i.e., extinction burst). Because an extinction procedure involves the aversive stimulus (e.g., demands) to continue to be present, regardless of the occurrence of problem behavior, these procedures might resemble the procedures that are used during non-contingent aversive stimulation (Iwata, 1982). As a consequence, for some caregivers extinction procedures may not be an acceptable practice (Iwata, 1982). Thus, the application of extinction alone does not involve teaching an alternative response to replace the target problem behavior (Iwata, 1982). In addition to extinction, punishment has also been used to treat problem behavior displayed in individuals with disabilities.

The use of punishment for escape-maintained problem behavior has been used in conjunction with other procedures such as differential reinforcement. For example, Heidorn and Jensen (1984) implemented graduated physical guidance to complete the requested demand when the individual engaged in SIB. Differential reinforcement of incompatible behavior (DRI; e.g., task completion) was also utilized which consisted of providing edibles, verbal praise, and physical contact upon task completion and removing the demand.

Punishment of negatively reinforced behavior or escape-maintained problem behavior presents important limitations. For instance, punishment involves the use of an aversive stimulus contingent upon problem behavior. However, an aversive stimulus is already playing an important role at eliciting the problem behavior that has resulted in escaping the aversive stimulus (Iwata, 1982). Punishment that uses the same stimulus that is being used during escape or avoidance training may acquire discriminative properties and may occasion problem behavior (Iwata, 1982). Punishment intensity and the presence or absence of avoidance contingencies are important factors that have to also be considered. Researchers have found that "mildly" aversive stimuli may lead to higher problem behavior suppression than more intense aversive stimuli (Iwata, 1982; Sandler et al., 1966). Punishment procedures also have to be implemented with high treatment fidelity and using a continuous schedule of punishment to decrease problem behavior effectively and prevent adventitious reinforcement (Iwata, 1982; McKearney, 1972). For this reason, punishment alone, sometimes, is not the best treatment option and other treatments should be considered to treat problem behavior in individuals with disabilities.

A well-documented and empirically validated treatment procedure is the use of differential reinforcement procedures to decrease problem behavior (Iwata, 1982). Differential reinforcement has been used alone or in conjunction with punishment and extinction procedures to treat escape-maintained problem behaviors (McCord et al., 2001). There are different types of differential reinforcement procedures that include differential reinforcement of: other behavior (DRO), DRI, and differential reinforcement of alternative behavior (DRA). Differential reinforcement of other behavior (DRO) to treat escape-maintained problem behaviors is referred as differential negative reinforcement of other behavior (DNRO). DRO focusing on negatively reinforced behaviors, or differential negative reinforcement of other behavior (DNRO), consists of delivering a consequence contingent on the non-occurrence of problem behavior to reduce the future occurrence of the targeted problem behavior (Vollmer & Iwata, 1992; Weston et al., 2017). Buckley and Newchok (2006) used DNRO to reduce problem behavior, in a child with a DD, evoked by auditory stimulation (e.g., music tape). The auditory stimulation was removed contingent upon the participant sitting quietly with his hands down for 30 s without engaging in disruptive behavior. During DNRO, disruptive behavior decreased when compared to the levels observed in baseline. Cook et al. (2015) increased compliance with wearing a medical alert bracelet for a child with autism through the use of a DNRO procedure. The DNRO procedure consisted of removing the bracelet contingent upon the participant wearing the bracelet for a specified interval without engaging in problem behavior.

DRI is an additional differential reinforcement procedure consisting of reinforcing behaviors that are incompatible with the target problem. Heidorn and Jensen (1984) implemented a DRI procedure within their treatment package in which the participant was allowed to continue to have free time as long as incompatible behaviors with SIB were emitted. These incompatible behaviors consisted of sitting on his hands in a bean bag or walking or lying quietly. Despite the benefits of DNRO and DRI, for the treatment of escape-maintained behavior, there are some limitations that are worth noting. Poling and Ryan (1982) reviewed 19 studies that used DRO procedures and they noticed that across the studies there was some confusion with the operational characteristics of DRO. The results from their literature review suggested that DRO procedures may be more challenging to implement than other behavior reduction procedures (Poling & Ryan, 1982). Another potential limitation with DRO is that individuals with severe to profound intellectual disabilities, often times, require additional exposure to the contingencies before reduction in problem behavior is observed (Whitaker, 1996; Weston et al., 2017). Another limitation with DRO procedures and DRI procedures is that an alternative response is not taught to replace problem behavior (Iwata, 1982). A differential reinforcement procedure that addresses this limitation is DRA.

DRA is one of the most common empirically supported intervention used to decrease problem behavior in individuals with DD (Petscher et al., 2008; Bailey et al., 2002; Carr & Durand, 1985; Fisher et al., 1993; Hagopian et al., 1998; Wacker et al., 1990). DRA involves withholding reinforcement for the target problem behavior and reinforcing a specific, alternative response (Cooper et al., 2007; Vollmer et al., 1999). Functional communication training (FCT) is a type of intervention that uses differential reinforcement of alternative behavior for the treatment of problem behavior (Carr & Durand, 1985). FCT differs from other differential reinforcement procedures in that the individual is taught to emit an appropriate functional communicative response (FCR; e.g., verbalization, a gesture, or a manual sign) as a mean to access the same reinforcer that was maintaining problem behavior (Tiger et al., 2008). FCT begins with the identification of a motivation operation (MO) for problem behavior that is then systematically introduced. In the case of escape-maintained problem behavior, this would be the introduction of an aversive stimulus (e.g., demand). Once the aversive stimulus is introduced, the MO to escape the aversive stimulus is in place and mand training is implemented. Mand training involves teaching the participant a functional communication response (FCR) and delivering reinforcement contingent on the FCR while reinforcement for problem behavior is placed on extinction.

Durand (1999) evaluated the effectiveness of FCT for the treatment of problem behavior among five individuals with severe disabilities. For two out of the five individuals, their problem behavior was identified to be escaped-maintained. When a task was presented, they were taught to use their assistive devices, using a combination of fading techniques including delayed prompting, to emit their FCR. Their FCR consisted of requesting for help by pressing the pad to emit “I need help”. FCT using assistive devices was successful at decreasing problem behavior and increasing the communication skills across all participants (Durand, 1999).

Since the Carr and Durand (1985) article, numerous studies have been conducted on FCT. These studies can be categorized into first and second generation FCT studies. First generation studies have demonstrated the effectiveness of FCT as a function-based treatment for the treatment of problem behavior among individuals with DD (Bird et al., 1989; Durand, 1990; Durand & Carr, 1991; Durand & Kishi, 1987). When the effectiveness of FCT was empirically validated, second generation studies have focused on identifying components of FCT that are responsible for its continued effectiveness (Tiger et al., 2008; Hagopian et al., 2011). As well as, procedural variations within FCT that are likely to affect FCT effectiveness (Tiger et al., 2008).

Due to the extensive amount of literature that exists to support FCT as an intervention for problem behavior, an array of systematics reviews on FCT have been conducted (Chezan et al., 2017; Tiger et al., 2008; Hagopian et al., 2011; Walker et al., 2015).

Previous literature reviews

Tiger et al. (2008), summarized the procedural variations at each stage of FCT to systematically evaluate the effectiveness of the FCT variations that were present in the literature. Based on the reviewed literature, Tiger et al. provided some guidelines for best FCT practices. For instance, for FCT to be effective, the communicative response must be followed by the same reinforcer maintaining problem behavior. When selecting the functional communicative response (i.e., alternative response), response effort and response acquisition must also be considered. Across all the FCT studies, it was noted that a continuous reinforcement schedule (CRF) for the FCR was in place initially. However, in the natural environment reinforcing a behavior in a CRF schedule may not always be plausible. When this happens, the maintenance and generalization of the effects of FCT in the natural environment may be affected (Fisher et al., 1993; Hanley et al., 2001; Tiger et al., 2008). Therefore, planning for generalization and maintenance is essential for the social validity of FCT. For this reason, different procedures have been investigated to systematically thin the CRF schedule to a more manageable schedule that will promote the generalization and maintenance of the treatment effects of FCT (Tiger et al., 2008).

In 2011, Hagopian et al. extended Tiger et al. (2008) review of the literature. In this review, the most commonly used procedures for schedule thinning in FCT were systematically identified. These procedures included (a) the use of time delays between the FCR and reinforcement (delays of reinforcement; e.g., Fisher et al., 2000; Hagopian et al., 2005; Muething et al., 2018), (b) multiple schedules of reinforcement (e.g., Hanley et al., 2001), (c) chain schedules of reinforcement (e.g., Fisher et al., 1993), and (d) response restriction (RR; e.g., Roane et al., 2004; Falcomata et al., 2010).

Two meta-analyses in FCT were also recently published. Walker et al.'s (2015) meta-analysis summarized FCT studies that involved the use of augmentative and alternative communication devices (AAC) in school settings. Their findings suggested that FCT involving AAC was effective in reducing problem behavior and promoted AAC use among the participants across their studies. On the other hand, Chezan et al.'s (2017) meta-analysis evaluated the published literature using the What Works Clearinghouse (WWC) and calculated effect sizes. Their results showed that more than half of the studies that were included in their meta-analysis met the WWC standards and furthered validated the effectiveness of FCT at decreasing problem behavior and increasing the alternative communication response (i.e., FCR).

To date, the reviews or meta-analyses that have been conducted in FCT have explored the effectiveness of FCT and identified components of FCT that are essential to increase the generalizability and maintenance of the FCT outcomes across all behavior functions (e.g., attention, tangible, escape, and automatic). No review or meta-analyses has systematically evaluated the effectiveness of FCT alone and/or in conjunction with other interventions to treat, exclusively, negatively reinforced problem behaviors. In addition, no review has identified and summarized the factors that may influence the effectiveness of such interventions for the treatment of escape-maintained problem behavior. Therefore, the purpose of the current synthesis was to review and summarize the factors or components that may influence the effectiveness of FCT for the treatment of escape-maintained problem behavior.

Method

Search Procedures

Systematic searches were conducted in the following electronic databases: *EBSCOhost, Academic Search Complete, CINAHL, Communication & Mass Media Complete, Education Source, Education Resource Information Center (ERIC), Psychology and Behavioral Sciences Collection, PsycINFO,* and *Medline*. The purpose of the systematic searches was to identify peer-reviewed and empirical-based single subject studies examining the use of FCT to treat problem behavior. There was a restriction on search years. The search years were 1985 to 2019. The searched terms or keywords that were used were: functional communication training or functional equivalence training. This initial search revealed 1, 324 studies. When duplicates were removed a total of 449 studies were identified. From these 449 studies, dissertations, theses, literature reviews, studies that were written in another language, and book chapters were removed. The titles and abstracts were then evaluated, and 247 articles were identified as potential studies. These 247 articles were reviewed based on the inclusion and exclusion criteria.

Inclusion and Exclusion Criteria

For studies to be included in this review, they had to be published in a peer-review journal and be single case design (i.e., single subject). The studies were also included if (a) FCT was implemented alone or in conjunction with other interventions (b) participants had a diagnosed developmental disability or autism, and (c) the function of the problem behavior was empirically identified through a functional analysis (FA) to be escape-maintained (e.g., analogue FA; pairwise FA; brief FA). If the study included other participants whose problem behavior was not escaped-maintained, only the data and procedures used for the participants with the escape-maintained problem behavior were extracted. If the participants problem behavior was multiply maintained, the study was included if researchers treated the escape function alone or each function separately. The study was excluded from the review if the treatment procedures, results, and data were not separated for each participant by function. Additionally, if the baseline procedures were not similar to the escape condition of the FA (e.g., analogue FA, pairwise FA, or modified FA) or did not use the results from the escape-condition of the FA, the study was also excluded. Of the 247 articles, 47 met the inclusion criteria for this review.

Data Extraction

The included studies were summarized in terms of (a) single subject design(s), (b) participants' characteristics, and (c) investigated factors (e.g., generalization, schedule of reinforcement, schedule thinning procedures, FCT component analysis, and FCT alone versus other treatments).

Results

Forty-seven single case design articles met the inclusion criteria (results are summarized in Table 1).

Single Subject Design(s)

Of the 47 studies reviewed, 32 studies used one type of single subject design (e.g., reversal design, multielement, and multiple baseline; Adami et al., 2017; Briggs et al., 2018; Brown et al., 2000) and 14 used a combined design (e.g., multiple baseline design within a reversal design, multiple baseline within a probe design, multiple baseline within a multielement design, reversal design within a multielement design, and reversal design within a probe design; Campos et al., 2017; Dalmau et al., 2011; Derosa et al., 2015). One study evaluated the efficacy of FCT for treating escape-maintained problem behavior in 11 participants (Hagopian et al., 1998). 10 of the 11 applications of FCT were a reversal design and 1 was a multiple baseline design.

Table 1

Results Overview

Study	Single Subject Design(s)	Participants Pseudonym Ages Genders Diagnoses	Participant's Communication skills Intellectual functioning	Investigated factor(s)	Results
Adami et al. (2017)	Reversal Design	Fred, 10 Male ASD	Unintelligible or nonfunctional verbal responses Not reported	Lag schedules of reinf. Mand or FCR Variability	Lag 1 increased mand variability and problem bx remained low
Briggs et al. (2018)	Reversal Design	Samantha 12 Female Comorbid Diagnosis	Not reported Mild ID	Schedule thinning (chain schedules or demand fading) Preference between chain schedules and mult. schedules of reinf.	Change in response requirement altered preference Matching law
Brown et al. (2000)	Multielement Design	Theresa; Corey 13; 5 Female; Male Comorbid Diagnoses	Gestures; signs Severe/Profound ID; Moderate ID	Establishing operation (EO) FCT effectiveness Functional equivalence	Relevant mands and problem bx varied as a function of the EO
Call & Lomas Mevers (2014)	Multielement Design	Jett 6 Male Comorbid Diagnosis	Not reported Developmental Delay ID	FCT effectiveness positive and negative reinf.	Positive and negative reinf. reduced problem bx Demands that interrupt access to preferred activities may produce problem bx

Table 1 *(continued)*

Study	Single Subject Design(s)	Participants Pseudonym Ages Genders Diagnoses	Participant's Communication skills Intellectual functioning	Investigated factor(s)	Results
Campos et al. (2017)	Multiple Baseline within a Reversal Design	Mike; Bruno 11; 22 Males ASD diagnosis; ID diagnosis	Not reported Not reported	Schedule thinning (mult. schedules)	Mult. schedules alone-lack of mands discrimination
Casey & Merical, (2006)	Multiple Baseline Design	Karl 11 Male ASD diagnosis	Not reported Normal Intelligence Range	FCT effectiveness alone (no ext. and no punishment)	FCT alone was effective at reducing problem bx and increasing the FCR
Davis et al. (2012)	Reversal Design	Todd; Tony; Mary; Eli 17; 12; 8; 18 Male; Male; Female; Female Comorbid Diagnoses	Limited verbal skills; Nonverbal; Not reported; Not reported Moderate ID; Severe/Profound ID; Moderate ID; Mild ID	Concurrent schedules of reinf.	Quality of reinf. can influence response allocation Time-delay was needed for task completion
Davis et al. (2018)	Reversal Design	Noah 7 Male Comorbid Diagnosis	Full sentences (no speech impairments) Not Reported	Schedule thinning (chain schedule or demand fading) Concurrent schedules of reinf. FCT effectiveness (Ext.)	Higher quality of reinf. for FCR and task completion reduced problem bx and increase task completion Response allocation shifted

Table 1 *(continued)*

Study	Single Subject Design(s)	Participants Pseudonym Ages Genders Diagnoses	Participant's Communication skills Intellectual functioning	Investigated factor(s)	Results
Dalmau et al. (2011)	Reversal Design within a Multiple Baseline Design	Sofia; Javier 5; 6 Female; Male Comorbid Diagnoses	Limited verbal skills; Not reported Developmental Delay ID; Mild ID	Generalization of FCT Effects and Preference of manding across languages	FCT effects generalized No identified Preference of manding
Day & Horner (1994)	Multielement Design	Brandi; Dawn; Jamie 9; 34; 18 Female; Male; Male ASD diagnosis; Comorbid Diagnosis; Comorbid Diagnosis	Gestures/signs; Low adaptive level (IQ) Vineland	FCT effectiveness Functional Equivalence	FCR has to be functional equivalent to the Problem bx
Derosa et al. (2015)	Reversal Design within a Multiple Baseline Design	John 4 Male Comorbid Diagnosis	Single mands and 3 to 4-word utterances; Not reported	EO (Limited EO exposure versus Extended EO Exposure within FCT)	Limited exposure to EO lead to rapid reductions of problem bx, faster acquisition of the FCR, and less extinction bursts
Durand (1999)	Multiple Baseline Design	Matt; David 5; 11 Males Comorbid Diagnosis	Gestures; Unintelligible or nonfunctional verbal responses Moderate ID; Severe/Profound ID	Generalization	The use of assistive device to emit the FCR was generalized to the community and across untrained adults

Table 1 *(continued)*

Study	Single Subject Design(s)	Participants Pseudonym Ages Genders Diagnoses	Participant's Communication skills Intellectual functioning	Investigated factor(s)	Results
Falcomata et al. (2018)	Reversal Design	Petyr 10 Male Developmental Disability	Unintelligible or nonfunctional verbal responses Not reported	Schedule thinning (Lag schedules of reinf.) Mand/FCR variability	Mand variability remained high throughout the increasing Lag schedules and problem bx remained low
Fisher et al. (1998)	Reversal Design within a Multiple Baseline Design	Ike, Tina 13; 14 Male; Female Comorbid Diagnoses	Full to short sentences; Limited verbal skills Mild to Moderate ID; Severe/Profound ID	FCT effectiveness Positive and negative reinf.	Demands that interrupt on-going preferred activities may lead to problem bx
Fisher et al. (2005)	Reversal Design within a Multiple Baseline Design	Betty; Kim 13; 14 Females Comorbid Diagnoses	Gestures; Moderate to Severe ID; Not Reported	FCT effectiveness Positive and negative reinf.	Mixed results Positive reinf. availability may alter the MO to escape
Fisher et al. (2018)	Reversal Design	Alan 3 Male ASD Diagnosis	Gestures and PECS Not Reported	EO (Limited EO Exposure versus Extended EO Exposure within FCT)	Limited exposure to the EO lead to more rapid reductions in problem bx, faster acquisition of the target mand, and lower extinction bursts

Table 1 *(continued)*

Study	Single Subject Design(s)	Participants Pseudonym Ages Genders Diagnoses	Participant's Communication skills Intellectual functioning	Investigated factor(s)	Results
Fisher et al. (1993)	Reversal Design	Bob; Art Not Specified Not Specified ID Diagnosis	Limited verbal skills Severe/Profound ID	FCT effectiveness alone (No ext. and No punish.)	FCT alone did not produce a clinically acceptable reduction in problem bx
Fisher et al. (2019)	Multielement Design	Owen, Harvey, Tamara 4 to 11 Male; Male; Female ASD Diagnosis	AAC Device, Gestures, or 1- to 3-word utterances Not reported	Intermittent schedules of reinf. Resurgence	Denser schedules of reinf. during baseline produces higher resurgence of problem bx
Greer et al. (2019)	Multielement Design	Kari; Teddy 3; 4 Female; Males ASD Diagnosis	Not reported Not reported	Generalization from therapist to parent using schedule correlated stimuli within FCT	Schedule correlated stimuli promoted rapid transfer of the FCT treatment outcomes
Grow et al. (2008)	Reversal Design	Curtis 10 Male ASD Diagnosis	Signs and gestures Not reported	Mands variability	Response repertoires included multiple behaviors in the same response class
*Hagopian et al. (1998)	Multiple Baseline Design Reversal Design	Case 1; Case 2; Case 3; Case 4; Case 5; Case 6; Case 7; Case 8; Case 9; Case 10; Case 11 5; 8; 11; 16; 10; 15; 9; 8; 9; 5; 7	Not reported; Language age reported; Not reported	FCT effectiveness alone (No ext. and No punishment)	FCT alone did not produce a clinically acceptable reduction in problem bx.

Table 1 *(continued)*

Study	Single Subject Design(s)	Participants Pseudonym Ages Genders Diagnoses	Participant's Communication skills Intellectual functioning	Investigated factor(s)	Results
*Hagopian et al. (1998) cont.		Not specified Comorbid diagnoses	Language age reported for the other 7 cases; Severe/Profound ID; Mild to Moderate ID; Severe/Profound ID; Severe/Profound ID; Severe/Profound ID; Mild ID; Severe/Profound ID; Severe/Profound ID; Mild ID; Severe/Profound ID; Mild to Moderate ID		Implementation of FCT alone to fade punishment
Hagopian et al. (2001)	Multiple Baseline Design	Preston 6 Male Comorbid Diagnosis	Single mands or 1 to 4-word utterances Mild ID	FCT in conjunction with NCE (NCE alone versus NCE plus FCT)	NCE plus FCT lead to greater reductions in problem bx and increased in the FCR
Harding et al. (2009)	Reversal Design	Tim; Alan 4 Males	Some utterances, Single words,	FCT Effectiveness Presence of Positive Reinforcers	Enriching breaks with positive reinforcers can

Table 1 *(continued)*

Study	Single Subject Design(s)	Participants Pseudonym Ages Genders Diagnoses	Participant's Communication skills Intellectual functioning	Investigated factor(s)	Results
Harding et al. (2009) cont.		ID Diagnosis	and another mode (sign, gestures); Full to short sentences Moderate ID		produce a higher quality of reinf. and shift response allocation
Horner & Day (1991)	Reversal Design	Paul; Mary 12; 27 Male; Female Comorbid Diagnosis	Signs; single words/single mands Low adaptive level (IQ) Vineland	FCT effectiveness Response efficacy (e.g., physical effort, schedule of reinf., and delay to reinf.)	The FCR in FCT must be less effortful, produce higher rates of reinf. and be reinforced at a faster rate than problem bx
Kahng et al. (1997)	Multielement Design within a Multiple Baseline Design	Todd; Bob 50; 45 Males Comorbid Diagnosis; ID Diagnosis	Nonverbal; limited verbal skills Severe/Profound ID	FCT effectiveness response efficacy (control for reinf. delivery)	Control over reinf. does not affect FCT effectiveness
Kelley et al. (2002)	Reversal Design within a Multiple Baseline Design	Gary; Jennifer 9; 10 Male; Female ASD Diagnosis; Genetic Disorders	Not reported; Severe/Profound ID	Intermittent schedules of reinf.	Teaching the FCR while problem bx is reinforced intermittently did not increase the FCR and decrease problem bx

Table 1 *(continued)*

Study	Single Subject Design(s)	Participants Pseudonym Ages Genders Diagnoses	Participant's Communication skills Intellectual functioning	Investigated factor(s)	Results
Kunnavatana et al. (2018)	Reversal Design	Kaleb; Harry 39; 26 Males ID diagnoses	Not reported Not reported	Mand preference and proficiency within FCT	Proficiency may emerge during the acquisition phase
Lalli et al. (1995)	Multielement Design	Joe; Jen; Kim 10; 15; 13 Male; Female; Female ID Diagnosis; ID Diagnosis; Comorbid Diagnosis	1-4 utterances; 1-4 utterances; Single utterances and gestures Not reported; Moderate ID; Moderate ID	Schedule thinning (Chain schedules or demand fading)	Increased compliance FCR emitted at practical levels Maintained low levels of problem bx
Lerman et al. (2002)	Reversal Design	Timmy; Gary 4; 10 Males ID Diagnosis; Comorbid Diagnosis	Short sentences; Limited verbal skills Moderate ID; Severe/Profound ID	FCT effectiveness (Ext.) Magnitude of reinf. and response maintenance	Mixed results The effects of magnitude of reinf. may increase the post-reinforcement pause
Machalicek et al. (2016)	Multielement Design	Lily 8 Female ASD Diagnosis	Full sentences CARS Scores	Generalization (Telehealth/Parent Training)	Parents implemented FCT effectively Problem bx decreased
Marcus & Vollmer (1995)	Reversal Design	Sally 5 Female Comorbid Diagnosis	Not reported Moderate ID	FCT versus DNR for compliance	FCT may still lead to low levels of task completion

Table 1 *(continued)*

Study	Single Subject Design(s)	Participants Pseudonym Ages Genders Diagnoses	Participant's Communication skills Intellectual functioning	Investigated factor(s)	Results
Mildon et al. (2004)	Reversal Design	R 4 Male ASD Diagnosis	Unintelligible or nonfunctional verbal responses Not reported	Effectiveness of FCT plus NCE	NCE plus NCE lead to higher reduction in problem bx and increase in the FCR than NCE alone
Muething et al. (2018)	Reversal Design within a Multiple Baseline Design	Alex; Patrick 5; 12 Males ASD Diagnosis; Comorbid Diagnosis	Limited verbal skills Not reported	Schedule thinning (Delays to reinforcement) Mands variability	Mixed results Delays to reinf. may increase FCR variability
O'Neill, Sweetlander-Baker et al. (2001)	Multiple Baseline Design with a Multiple Probe Design	Randall; PJ 6; 15 Males Comorbid Diagnoses	Unintelligible or nonfunctional verbal responses Severe/Profound ID	Generalization	FCT alone effects may generalized across untrained tasks, especially with Ext. plus FCT
Peck Peterson et al. (2005)	Reversal Design	Brad; Teddy 4; 9 Males Comorbid Diagnosis; ID Diagnosis	Nonverbal; full or short Sentences Developmental Delay ID; Moderate ID	Concurrent schedules of reinf.	Higher quality of Reinf. with concurrent schedules can shift response allocation
Peterson et al. (2017)	Probe Design within a Reversal Design	Damon; Erin 7; 8 Male; Female ID Diagnosis; Comorbid Diagnosis	Unintelligible or nonfunctional verbal responses; Limited Verbal Skills Moderate to Severe ID; Not Reported	Concurrent schedules of reinf.	Higher quality of reinf. with Concurrent schedules can shift response allocation

Table 1 *(continued)*

Study	Single Subject Design(s)	Participants Pseudonym Ages Genders Diagnoses	Participant's Communication skills Intellectual functioning	Investigated factor(s)	Results
Peterson et al. (2009)	Multielement Design within a Reversal Design	Abby; Damon; Erin; Santino; Andrew; Dan; Dustin 7; 7; 8; 12; 10; 7; 10 Female; Male; Female; 4 Males	PECS and Gestures; Limited Verbal Skills Not Reported; Moderate to Severe ID; Moderate to Severe ID; Not Reported; Not Reported; Not Reported; Mild ID; ID Diagnosis; ID Diagnosis; Comorbid Diagnosis; Comorbid Diagnosis; ASD Diagnosis; ASD Diagnosis; Comorbid Diagnosis	Concurrent schedules of reinf.	Higher quality of reinf. with concurrent schedules can shift response allocation
Radstaake et al. (2013)	Reversal Design	Amy; Cody 7; 6 Female; Male Genetic Disorder	Gestures Severe/Profound ID	FCT effectiveness functional equivalence	Replacement bx were functionally equivalent to problem bx

Table 1 *(continued)*

Study	Single Subject Design(s)	Participants Pseudonym Ages Genders Diagnoses	Participant's Communication skills Intellectual functioning	Investigated factor(s)	Results
Schieltz et al. (2011)	Reversal Design	Juan; Cam; Bud; Andy; Jasper; Jose; Kevin; Kurt; Rose; Tina 3; 2; 3; 2; 1; 4; 2; 2; 3; 3 8 Males; 2 Females ASD Diagnosis; Developmental Delays; Comorbid Diagnosis; Genetic Disorders; Developmental Delays; Genetic Disorders; Developmental Delays; ID Diagnosis; ASD Diagnosis	Full Sentences; single words and signs; single mands; single words and signs; single words and signs; single words and signs; single words and signs; single mands; single mands; single words and object exchange Developmental Delay ID; Developmental Delay ID; Mild ID; Developmental Delay; ID; Developmental Delay ID; Moderate ID; Developmental Delay ID; Mild ID; Mild ID; Developmental Delay ID	Generalization (Indirect effects of FCT on non-targeted disruptive bx)	Target and non-targeted bx decreased The FCT effects generalized across topographies
Shirley et al. (1997)	Multiple Baseline Design within a Reversal Design	John 39 Male; ID Diagnosis	Unintelligible responses; Severe/Profound ID	FCT effectiveness (Ext.)	Ext. as a necessary component to reduce problem bx

Table 1 *(continued)*

Study	Single Subject Design(s)	Participants Pseudonym Ages Genders Diagnoses	Participant's Communication skills Intellectual functioning	Investigated factor(s)	Results
Simacek et al. (2017)	Multiple Probe Design within a Reversal Design	Ella; Lilly 3; 4 Females ASD Diagnosis	Limited verbal skills Low adaptive level (IQ) Vineland	Generalization (Telehealth/Parent Training)	Parents effectively implemented FCT and problem bx decreased
Torelli et al. (2016)	Multielement Design	Lucas 4 Male ASD Diagnosis	PECS and AAC device Not reported	Mand proficiency and preference within FCT	Preference may be correlated with higher rates of indep. manding
Umbreit (1996)	Reversal Design within a Multielement Design	Nate 5 Male ID Diagnosis	Not reported Mild ID	FCT effectiveness Task difficulty and assistance level	Levels of problem bx correlates to task difficulty and level of support
*Volkert et al. (2009)	Reversal Design	Ben; Max; Bella 9; 5; 8 Male; Male; Female *ASD Diagnosis or Developmental Disabilities	Nonverbal; 1 to 2-word utterances and gestures; nonverbal Not reported	Schedule thinning procedure (chain schedule or demand fading)	Thinning the schedule of reinf. too rapidly or reinforcing the FCR on a lean schedule may cause problem bx to reemerge.
Wacker et al. (1990)	Reversal Design	Jim 9 Male; ID Diagnosis	Signs Not reported	FCT effectiveness (Punish.)	FCT plus punish. suppressed problem bx

Table 1 *(continued)*

Study	Single Subject Design(s)	Participants Pseudonym Ages Genders Diagnoses	Participant's Communication skills Intellectual functioning	Investigated factor(s)	Results
Winborn-Kemmerer et al. (2010)	Reversal Design	Evan 3 Male Genetic Disorder	Single words Developmental Delay ID	Concurrent schedules of reinf (novel and existing ands)	Both mands replaced problem bx.
Winborn et al. (2002)	Multielement Design	Ike; Julie 2 Male; Female Comorbid Diagnoses	Gestures; 1 Word Utterances Developmental Delay ID	Novel vs. Existing Mands Preference within FCT	Existing mand correlated to higher levels of problem bx and lower levels of manding than novel mand Preference for existing mand

Note: FCT, functional communication training; reinf., reinforcement; bx, behavior(s); Ext., extinction; Punish., punishment; FCR, functional communication response(s); vs., versus; comm., communication; NCE, noncontingent escape; DNR, differential negative reinforcement; cont., continues; * denote studies for which some participants' characteristics were not specified.

Participants Characteristics

The participants' characteristics among the 47 studies were summarized in terms of their (a) age group and gender, (b) diagnosis and intellectual functioning, and (d) communication skills.

Age Group and Gender. There was a total of 104 participants across the 47 studies. Out of these 104 participants, 76 were children (1-year-old to 11 years old), 18 were adolescents/teenagers (12 to 20 years old), and eight were adults (21 to 50 years old). For 2 out of the 104 participants, their age was unspecified (Fisher et al., 1993). Sixty-four participants were males and 27 were females. For 2 out of the 47 included studies, their participants' gender was not reported (*n* = 13 participants; Hagopian et al., 1998 and Fisher et al., 1993).

Diagnosis and Intellectual Functioning. Across the 104 participants, 22 participants had ASD and 20 participants had an intellectual disability diagnosis. Forty-nine out of the 104 participants had a comorbid disability (e.g., autism and an intellectual disability, autism and a seizure disorder etc.). Six participants had a genetic disorder (e.g., down syndrome, Angelman syndrome) and four participants had a developmental disability or developmental delay diagnosis. For three of the 104 participants, their disability was not specified but they were included in the study if they had an autism or a developmental disability diagnosis (Volkert et al., 2009). Intellectual functioning was reported for 74 out of the 104 participants. Out of the 74 participants for whom their intellectual functioning was reported, only one participant intellectual scores fell under the normal range of intelligence **(**Clerical & Merical, 2006).

Communication Skills. Communication skills were reported for 86 out of the 104 participants. Out of the 86 participants, 17 used alternative modes of communication (e.g., picture exchange system [PECS], signs, gestures, or AAC devices) and were considered nonverbal. Of these 86 participants, eight participants emitted vocal responses that were unintelligible or non-functional, 18 participants had limited verbal skills, and five were non-verbal and no other form of communication was reported. Ten participants used single mands or one to four utterances to communicate and 12 participants communicated using single words and another mode of communication (PECS, signs, gestures, AAC etc.). Hagopian et al. (1998), reported the expressive and receptive language age for nine of their 11 participants instead of their communication skills.

Investigated Factors

The study purposes of the 47 included studies were furthered analyzed to identify the factors that were being investigated. These investigated factors were then categorized and summarized in terms of (a) generalization, (b) schedules of reinforcement, (c) schedule thinning procedures, (e) mands and FCR, (f) EO effects in FCT, (g) FCT effectiveness and component analyses, and (i) FCT versus other treatments or in conjunction with other treatments.

Generalization Factors. Eight out of 47 studies evaluated generalization of FCT outcomes across contexts, different tasks, persons (e.g., therapists or caregivers), or behaviors (e.g., Schieltz et al., 2011; Durand, 1999; Greer et al., 2019). Out of these eight studies, two studies provided parent training via telehealth and the results from these studies support that parents can implement FCT with their children effectively to reduce problem behavior (Machalicek et al., 2016; Simacek et al., 2017). Greer et al. (2019) used schedule correlated stimuli during FCT to promote the rapid transfer of the FCT treatment effects from the therapist to the parent. The programming of schedule correlated stimuli mitigated the renewal of problem behavior and no disruption was produced in the efficacy of the FCT treatment effects. Five of these eight studies supported that FCT can produce substantial response generalization, stimulus generalization, and generalization across behavior topographies (e.g., Durand, 1999; O'Neill et al., 2001; Schieltz et al., 2011; Wacker et al., 1990). Schieltz et al. (2011) implemented FCT to decrease destructive behavior and evaluated the indirect effects of FCT on non-targeted disruptive behavior. For all of their participants, their destructive behavior and the non-targeted disruptive behavior decreased. These results demonstrated the potential effect of FCT to decrease behaviors across topographies and behaviors that belong to the same response class. Durand (1999) taught their participants to emit the FCR via an assistive device in the classroom. Durand then evaluated if the use of the assistive device was generalized to the community and with untrained adults. For all their participants, using an assistive device to emit the FCR was generalized and no problem behavior was observed. O'Neill et al. (2011) results indicated that the effect of FCT alone across untrained tasks, may occur, but not across all tasks. Extinction had to be implemented in addition to FCT to observe generalizability of the decrease of disruptive behavior across all tasks.

Schedules of Reinforcement. Nine out of the 47 studies evaluated the effects of utilizing a specific schedule of reinforcement in FCT (e.g., CRF schedule, lag schedule, concurrent schedules of reinforcement, and intermittent schedule of reinforcement; Adami et al., 2017; Fisher et al., 2019; Kelley et al., 2002; Peterson et al., 2009; Wacker et al., 1990). Wacker et al. (1990) conducted a component analysis of FCT and one of the components they evaluated was the efficacy of reinforcement being delivered immediately, on a CRF schedule, contingent upon emitting the FCR. The evaluation of this component was conducted in a reversal design. This reversal design consisted of comparing different conditions (e.g., differential reinforcement of other behavior [DRO]), an FCT treatment package that included time-out or graduated guidance for problem behavior, and an FCT alone condition). During the DRO condition, the participants received the same amount of reinforcement and on the same schedule as the two final FCT treatment package sessions and the FCR was placed on extinction. Consequently, the FCR decreased considerably in this condition and inappropriate behavior increased. These suggested that the participant having control over the delivery of reinforcement may be a critical component of FCT. Adami et al. (2017) evaluated the use of a lag 0 and lag 1 schedule of reinforcement in FCT to increase mand variability and compare levels of problem behavior across baseline and lag schedule conditions. During the lag 0 condition, problem behavior decreased to near zero levels and total manding increased when compared to baseline levels. However, varied manding remained at near zero levels. When the lag 1 condition was implemented, an increase in varied manding was observed and problem behavior remained at low levels. These findings demonstrated the utility of combining lag schedules of reinforcement within FCT for the treatment of problem behavior and increasing the communication modes of individuals with disabilities. These results also supported that lag schedules within FCT may mitigate resurgence of problem behavior when reinforcing the target mand (e.g., FCR) is not possible.

Previous research in FCT for the treatment of escape-maintained problem behavior, has shown that one of the limitations of FCT is that the FCR is emitted at such high levels resulting in continuous access to breaks and minimal task completion. Six of these 47 studies evaluated the use of concurrent schedules of reinforcement within FCT to address this limitation (e.g., Davis et al., 2018; Peterson et al., 2009; Peterson et al., 2017). Four out of these six studies used concurrent schedules of reinforcement to shift response allocation from problem behavior to emitting the FCR and/or task completion (e.g., Davis et al., 2012; Davis et al., 2018; Peterson et al., 2009). The results from these studies, suggested that modifying the reinforcement quality and duration can influence response allocation. For instance, in Davis et al. (2012), engaging in problem behavior produced NCE but engaging in the FCR produced NCE plus access to a preferred item (e.g., a higher quality reinforcement). Problem behavior decreased and FCR increased for all the participants. The researchers then implemented time-delay to thin the schedule of reinforcement. A schedule thinning procedure was still needed for task completion to occur and for the FCR to occur at socially valid rates. Peck Peterson et al. (2005), Peterson et al. (2009) and Davis et al. (2018) addressed these limitations by varying the quality and duration of reinforcement on problem behavior, mands for breaks and mands for work. For instance, contingent upon requesting for a break prior to task completion or problem behavior, the participants were provided with a shorter and lower quality of a break (e.g., no access to preferred items). Higher quality and longer breaks were provided contingent upon task completion and the FCR (e.g., access to preferred toys and longer duration). The concurrent schedule of reinforcement produced lower levels of problem behavior, task completion, and the emission of the FCR at acceptable rates for all the participants in both studies. The use of concurrent schedules of reinforcement may address the limitations of the FCR being emitted at elevated rates and minimal task completion.

Alternatively, Winborn-Kemmerer et al. (2010) evaluated the use of concurrent schedules of reinforcement within FCT in the use of existing versus novel mands as the FCR. The novel mand in this study consisted of a communication card. When the card was not available the participant engaged in the existing mand but when the card was available the participant emitted the novel mand. The novel mand being a communication card may have functioned as a discriminative stimulus for emitting a specific mand. Problem behavior remained low across both conditions.

Two out of the nine studies studied the use of intermittent schedules of reinforcement within FCT. Kelley et al. (2002) examined the role of extinction during the training of the FCR phase in FCT. They taught a new FCR while problem behavior was reinforced on the same intermittent schedule (e.g., variable ratio) prior to and during the training phase. The results suggested that teaching a FCR while problem behavior continues to be reinforced intermittently may not be effective at reducing problem behavior and increasing the FCR. More recently, Fisher et al. (2019) investigated if the rate of baseline reinforcement (e.g., behavioral momentum) contributed to the relapse of severe problem behavior. The researchers implemented FCT and compared the effects of different baseline reinforcement rates (e.g., a dense versus a lean schedule of reinforcement was compared on experiment 1 and experiment 2). Higher levels of resurgence of problem behavior was observed in the conditions associated with high-rate baseline reinforcement for four out of the seven participants. It should be noted that three out of these four participants had an escape function. The variable interval (VI) 2-s condition had higher levels of resurgence than the VI 14-s condition in Experiment 1. In Experiment 2, the FR 1 condition had higher levels of resurgence than the VI 30-s condition. A behavior that has been reinforced in a denser schedule of reinforcement during baseline may lead to higher levels of resurgence of problem behavior when reinforcement is no longer available for the FCR. It should also be noted that the denser schedule of reinforcement during baseline was also associated with more variable levels of problem behavior. When FCT is discontinued, resurgence of problem behavior can occur and presents a problem in applied settings.

For this reason, schedule thinning procedures have been developed and proven to be effective for decreasing the overall rate of reinforcement for the FCR (e.g., number of breaks provided) and maintaining low levels of problem behavior.

Schedule Thinning Procedures. Schedule thinning procedures were evaluated in eight out of 47 studies. One of the most common schedule thinning procedures used within FCT to treat escape-maintained problem behavior involves chain schedules of reinforcement, also known as a demand fading procedure. Four out of the eight studies evaluated the use of demand fading to increase task compliance within FCT (e.g., Briggs et al., 2018, Davis et al., 2018; Lalli, Casey, & Kates, 1995). Results from these studies demonstrated that the use of a chain schedule of reinforcement or demand fading within FCT facilitates increasing compliance, emitting the FCR at practical levels, and decreasing escape-maintained problem behavior (e.g., Davis et al., 2018; Lalli et al., 1995).

Chain schedules of reinforcement have also been proven to be effective when problem behavior is placed on extinction (e.g., Lalli et al., 1995) or when used with concurrent schedules of reinforcement (e.g., Davis et al., 2018). Davis et al. (2018) varied the quality of reinforcement for mands for a break before task completion, problem behavior, or mands for a break after task completion, as previously explained under the schedules of reinforcement section. Thus, they also used demand fading to increase the number of letters the participant had to write before he could request for a high-quality break. Adding the demand fading criteria increased the number of letters the participant completed before he requested for a break.

Volkert et al. (2009) used a chain schedule of reinforcement to resemble extinction periods or non-reinforcement periods that can occur during FCT treatment. For instance, parents may sometimes not be able to reinforce the alternative response immediately or the schedule of reinforcement may be thinned too quickly resulting in resurgence of problem behavior. Volkert et al. examined whether problem behavior would resurge if the chain schedule of reinforcement was thinned too quickly. The results from this study provided preliminary evidence that when an alternative response was reinforced on a thin schedule of reinforcement or thinned to rapidly during FCT, resurgence of problem behavior may occur. The use of chain schedules of reinforcement with FCT were compared to the use of multiple schedules of reinforcement with FCT in the Briggs et al. (2018) study.

Briggs et al. (2018) compared FCT that included a multiple-schedule of reinforcement (time-based) or a chained schedule of reinforcement (response-based). FCT with the multiple schedule of reinforcement was used to treat tangible maintained problem behavior in one context and the chain schedule of reinforcement was used to treat the escape-maintained problem behavior in another context. Preference was then evaluated across these two functions. The results from this study demonstrated that both schedules of reinforcement maintained low levels of problem behavior when compared to FCT and moderate levels of FCR. Preference for the FCT with a chain schedule of reinforcement was observed during session in which the response requirement was lower (e.g., FR 1 to FR 5). This preference was observed when response requirements provided a higher time in reinforcement than the multiple schedule sessions. When the response requirement increased, and a higher time of reinforcement occurred during the multiple schedule of reinforcement, preference shifted as supported by the matching law.

Multiple schedules of reinforcement and delays to reinforcement for schedule thinning in FCT were evaluated in three out of the eight articles. Campos et al. (2017) evaluated the use of a multiple schedule of reinforcement with an alternating fixed-ratio extinction (FR1/ext) component, the use of the multiple schedule alone did not lead to discrimination of manding. The participants continue to mand for a break when reinforcement was not available (also known as an S-delta condition). An extinction component to the FCR and reinforcement for compliance was added during the s-delta condition. For one participant, in addition to extinction, a punishment procedure (e.g., response blocking) was implemented to decrease the FCR to practical levels. In order to increase compliance, the researchers added reinforcement for compliance in the form of access to preferred items during the s-delta. These results demonstrated, that for some participants who had trouble differentiating across conditions additional treatment components such as extinction or punishment were needed. Thus, when using multiple schedules, a contingency for compliance may have to be in place for task completion or adherence to occur.

The use of delays to reinforcement within FCT was evaluated for schedule thinning or to increase mand variability in two out of these three studies. In addition to implementing a concurrent schedule of reinforcement, as previously mentioned, Davis et al. (2012) used a delay procedure to gradually increase the time between the mand and the delivery of reinforcement (e.g., break) to increase time on task and decrease the FCR to practical levels. Task on time was increased for all participants and the FCR decreased to moderate levels. Muething et al. (2018) implemented an FCT with a delay to reinforcement to evaluate mand, or FCRs, variability. The results from Muething et al. were mixed. For one out of the two participants with an escape-maintained problem behavior, FCR variability was not observed.

Two additional studies assessed FCT on mand variability (e.g., Grow, et al., 2008; Falcomata et al., 2018). In addition to evaluating mand variability, Falcomata et al. (2018) assessed the effects of an increasing lag schedule of reinforcement on problem behavior. Mand variability remained high throughout the increasing lag schedules and problem behavior remained low. These preliminary results showed the potential utility of the use of lag schedules within FCT to thin the schedule of reinforcement and increase mand variability.

Mands or Functional Communication Responses. In addition to evaluating mand variability within FCT, four out of the 47 studies have looked at persistence, preference, and the use of existing versus novel FCR (e.g., mands).

Winborn et al. (2002) examined the effects of training novel and existing FCRs during FCT. Two distinct stimulus conditions (e.g., therapist and setting) were implemented to train the novel and existing FCRs. Response allocation and levels of problem behavior was measured across these two conditions. Thus, preference was then evaluated utilizing a concurrent schedule of reinforcement. Novel and existing FCR, both, effectively replaced problem behavior. FCT with the existing FCR was associated with lower percentage of manding and higher problem behavior than FCT with the novel FCR. When preference was assessed, the existing mand was chosen most often than the novel mand but an increase in problem behavior was observed for one out of the two participants. These results suggested that past relations with the existing FCRs should be evaluated carefully because problem behavior may occur at higher rates with existing FCRs. Two other studies evaluated proficiency and preference of mand topographies (e.g., FCRs) as well as the effects of problem behavior during FCT (e.g., Torelli et al., 2016; Kunnaratanna et al., 2018). Torelli et al. (2016) evaluated preference after independent manding was observed in the acquisition phase whereas Kunnaratanna et al. (2018) assessed preference during the response acquisition phase (e.g., prior to reaching mastery). The results from these studies, suggested that for some participants (n = 2), the preferred FCR corresponded with higher rates of independent manding (e.g., higher proficiency). For other participants (n = 1), their results showed that proficiency may not be indicative of preference. Lower rates of problem behavior were observed with the preferred FCRs across all participants.

Kunnaratanna et al. (2018) showed that preference may emerge at different times during the acquisition phase. For one of the participants, preference emerged as independent responding increased during the acquisition training phase. For the other participant preference emerged after the first training block. These training blocks consisted of three training sessions, one session per FCRs. These results suggested that there may be a minimum level of proficiency that had to be obtained before preference of FCRs could be evaluated. Thus, for some individuals, preference of the FCR was not correlated to their most proficient FCR in their repertoire.

EO Effects. The presence and absence of the EO was evaluated by Brown et al. (2000) using two different FCRs (e.g., mand) across two contexts: one in which the EO that was relevant to the function of the problem behavior was present; and one in which the EO that was relevant to the function of problem behavior was absent. For instance, for an individual whose problem behavior is escape maintained, the EO-present context will be one in which demands are presented and the EO-absent context will be one in which removal of tangibles (e.g., preferred items) or attention is implemented. It was hypothesized that the individuals' engagement in problem behavior would correspond to the EO that was relevant to the function of the problem behavior. Thus, Brown et al. used different mands or communication responses across these two contexts. The communication response that was used in the EO-present context was functionally equivalent to the function of problem behavior. When the functional EO was present, one out of the two participants, with an escape function, displayed the relevant mand more frequently than the irrelevant mand. The other participant emitted both FCRs, to escape or access to tangible items in the EO-present context and manded for tangible items in the EO-absent context. Overall, the results of Brown et al. suggested that, for one of the two participants with an escape function, both relevant mands and aberrant behavior varied as a function of the

EO. Irrelevant mands may have been displayed at lower rates because the relevant EO was absent and the irrelevant mands did not provide reinforcement that serve the same function as problem behavior. For the other participant, researchers hypothesized that lack of discrimination across the two contexts may have influenced his responses. The results from Brown et al. suggested that identifying the function of the problem behavior and selecting a FCR that provided access to the reinforcer maintaining the problem behavior was important for FCT to be effective at decreasing problem behavior and increasing FCRs.

In addition, De Rosa et al. (2015) and Fisher et al. (2018) tested whether limited exposure to the EO and extended exposure to the EO for problem behavior during FCT affected treatment efficacy and extinction bursts. De Rosa et al. compared two FCT conditions with two different FCRs. The two FCT conditions that were evaluated were (a) one which consisted of selecting a FCR (e.g., card touch/card exchange) that could be physically prompted to limit the exposure of the EO for problem behavior; and (b) the other one consisted of a FCR (e.g., vocal response) that could not be physically prompted to extend the exposure of the EO for problem behavior. Limited exposure to the EO was correlated to larger and rapid reductions of problem behavior, faster acquisition of the target FCR, and less extinction bursts for all participants in the study. A second experiment was conducted in which an NCR schedule was yoked to the obtained reinforcement schedule from the last two sessions of the FCT condition in study 1. The card touch, which was associated with limited exposure to the EO, was more effective at reducing problem behavior than the vocal response. The results of De Rosa et al. provided some evidence that the duration of exposure to the EO may affect the effectiveness of FCT. One limitation of De Rosa et al. was that the observed differences across contexts resulted from the FCR being different rather than the exposure to the EO. Fisher et al. addressed this limitation. They selected an equivalent card touch or card exchange in both contexts to evaluate the differential exposure to the EO across two FCT conditions. The results from Fisher et al. further supported the results from the De Rosa et al. study. More rapid reductions in problem behavior, acquisition of the target mand, and lower extinction bursts were observed in the limited EO exposure condition when compared to the extended EO exposure condition. Therefore, the level of EO exposure affected the efficacy of FCT and the occurrence of extinction bursts.

Some of the components of FCT have also been evaluated in isolation or modified. The purpose of evaluating these components in isolation has been to identify the essential components of FCT. Whereas the purpose of modifying these components has been to further examine how altering these components affect the effectiveness of FCT on decreasing problem behavior and increasing the FCR. The following section will provide a summary of these studies and components of FCT that have been evaluated.

FCT Effectiveness and Component Analysis. Nineteen out of the 47 included studies have either assessed the components of FCT (e.g., the use of extinction or punishment; Casey & Merical, 2006) or modified some of the components of FCT (e.g., schedule of reinforcement, FCR modality, reinforcement quality provided, difficulty of the tasks; Horner & Day, 1991) to evaluate the outcome of FCT on problem behavior and identify the active components of FCT.

Use of Extinction. The use of extinction in FCT was evaluated in four out of the 19 studies. For instance, Shirley et al. (1997) examined the effectiveness of FCT in reducing problem behavior (e.g., self-injurious behaviors) and shaping the FCR while problem behavior continued to be reinforced. Therefore, extinction was not in place for problem behavior. When the FCR was emitted at acceptable levels they evaluated the effects of procedural drift, or inadvertently reinforcing problem behavior in FCT. This evaluation consisted of providing reinforcement for both, problem behavior and the FCR. The results from Shirley et al. suggested that extinction was needed initially for problem behavior to decrease and the FCR to increase. When reinforcement was provided again for problem behavior, the FCR was maintained and did not lead to an increase in problem behavior. Another finding was that response chaining occurred when reinforcement was provided for either the problem behavior or the FCR. Additional procedures, such as using extinction before teaching the FCR, may be needed for problem behavior to decrease in some participants (Shirley et al., 1997). The overall results from these four studies suggested that the use of extinction may be a necessary component for (a) some participants; (b) the treatment of problem behavior; and (c) the acquisition of the FCR.

An alternative method that has been implemented to evaluate if extinction is an active component of FCT, has been through the use of concurrent schedules of reinforcement. Davis et al. (2012) and Davis et al. (2018) used concurrent schedules of reinforcement in FCT instead of extinction to reduce problem behavior and increase FCR. The results from these studies, as it was previously noted, suggest that the use of extinction may not be essential if higher quality of reinforcement is provided for the FCR and demand completion than the one provided for engaging in problem behavior. Therefore, different reinforcement magnitudes, in the form of providing a lengthier or shorter duration of a break, have been utilized to evaluate response rate, post-reinforcement pause, and maintenance of the FCR during extinction (Lerman et al., 2002).

Lerman et al. (2002) compared two magnitude of reinforcement parameters (e.g., providing a 20-s break or 60-s break). Reinforcement was provided in a variable interval for the FCR and problem behavior was placed on extinction. Problem behavior remained low when extinction was in place and across the different reinforcement magnitude parameters. Thus, the FCR continued to occur at moderate rates, throughout the different reinforcement magnitude parameters. Therefore, the relation between response maintenance and reinforcement magnitude was examined in Experiment 2 (Lerman et al., 2002). In Experiment 2, Lerman et al. included two participants who had an escape-maintained problem behavior. Different maintenance conditions which consisted of differing the magnitude of reinforcement were conducted. The three magnitude of reinforcement conditions that were evaluated were a (a) small reinforcement magnitude condition of 20 s; (b) medium reinforcement condition of 60 s; and (c) a large reinforcement magnitude condition of 300 s. The researchers then measured the response rate and the post-reinforcement pauses for each one of these three conditions and compared them.

The results for Experiment 2 were mixed. For one out of the two participants with an escape-maintained problem behavior, there was an increase in response rates from the 300 s to the 20 s condition. This participant requested for more breaks in the 20 s condition than during the 300 s condition. For the other participant his results were the opposite. The effects of magnitude on post-reinforcement pause were also mixed. For one of the participants, as the magnitude of reinforcement increased the post-reinforcement pause also increased. For the other participant, the opposite effect was observed. Some of the most relevant conclusion from these results was that regardless of the duration of the break (e.g., 20 s), problem behavior did not increase. These mixed results suggest that further research is still warranted to evaluate the effects of magnitude of reinforcement within FCT.

Another active component that has been evaluated in FCT is the use of punishment for problem behavior instead of extinction.

Use of Punishment. Wacker et al., (1990) evaluated separate treatment components of FCT. One of the components they examined was the importance of providing immediate reinforcement for the FCR during FCT. The second component they assessed was the use of punishment contingent upon inappropriate behavior (e.g., the use of time-out or graduated guidance). The implementation of FCT with punishment lead to a decrease of inappropriate behavior whereas FCT without punishment lead to an increase of inappropriate behavior. These results suggested that for some participants only reinforcing appropriate behaviors might not lead to effectively reducing problem behavior.

FCT Alone. Three out of the 19 studies evaluated the effectiveness of FCT without the use of punishment and extinction. Results across the studies provide mixed results. Fisher et al. (1993) and Hagopian et al. (1998) suggested that FCT alone did not produce a clinically acceptable reduction in problem behavior. However, FCT alone was found to be effective at maintaining low levels of problem behavior after punishment was implemented with FCT in Fisher et al. Another finding from these two studies was that for some participants FCT with extinction was still not sufficient to suppress problem behavior. For these unresponsive cases, punishment was implemented which lead to higher reductions of problem behavior. These results suggested that when extinction is not effective to reduce problem behavior punishment may also be needed. Once the levels of problem behavior have been reduced, FCT alone can be implemented as a method to fade the use of punishment and prevent clinical relapse (Hagopian et al., 1998).

Casey and Merical (2006) implemented FCT without extinction or punishment with their participant across different classrooms. They noticed that lower levels of problem behavior were observed in the classrooms where FCT was in place. The findings from this study suggested the opposite of Hagopian et al. (1998) and the Fisher et al. (1993). Therefore, one might conclude that for some participants FCT alone may suppress problem behavior even when the reinforcement schedule for problem behavior and the FCR is the same. However, there are some potential reasons for this outcome. A yellow card was used in the classrooms where FCT was being implemented (Casey & Merical, 2006). Therefore, the yellow card might have served as a discriminative stimulus for both the problem behavior and the FCR. Thus, response effort could have also influenced this study result. For instance, the participant could have chosen to emit the FCR at higher levels than engage in problem behavior because it was the response that was the most effortless and less painful. It is important to mention that a within session data revealed the occurrence of response chaining in this study. This finding suggested the possibility that without an extinction or punishment component, a response chaining consisting of engaging in problem behavior followed by the FCR can occur and be intermittently reinforced. Overall, the results from these three studies showed that the use of extinction and even punishment depends on the participants' characteristics.

Functionally Equivalent Communicative Response. 3 out of these 19 studies evaluated if the communication response, used in FCT, was functionally equivalent to the problem behavior and consequently reduced problem behavior (e.g., Radstaake et al., 2013; Day & Horner, 1994). In other words, for a problem behavior that has been empirically validated that is escape-maintained, teaching an individual to request for attention instead of requesting for "help with the task" or for a "break" may not suppress the EO to engage in the problem behavior. Horner and Day (1994) conducted a study in which the participant's problem behavior was multiply maintained either by escape and access to preferred items (e.g., tangible). They taught a communication response for each function and treated each function separately. The results from this study showed that once both communicative responses were taught problem behavior decreased. Therefore, problem behavior reduced when the responses that were taught were functionally equivalent to the problem behavior. Brown et al., (2000) in their evaluation of EOs being present or absent for problem behavior, also taught two communicative responses; one that was functionally equivalent (e.g., relevant; "break") and another one that was irrelevant (e.g., "toys") to the EO for problem behavior. The irrelevant communicative response was displayed at lower rates because the relevant EO to engage in problem behavior was absent. Thus, this communicative response did not produce reinforcement that was the same function as problem behavior. The overall results from these three studies, suggested that in order for the alternative communicative response to decrease problem behavior, the communicative response must produce the same reinforcement as the problem behavior. In other words, the alternative communicative response and problem behavior have to be functionally equivalent in order for FCT to decrease problem behavior.

However, when the quality of reinforcement is manipulated to favor working or requesting for a break, participants may shift their response allocation to these two options instead of engaging in problem behavior (e.g., Peterson et al., 2005). Therefore, problem behavior might decrease as a consequence of providing a higher quality of reinforcement for working or asking for a break. One way to provide a higher quality of reinforcement for escape-maintained problem behavior is to provide access to positive reinforcers during the breaks.

Positive Reinforcers. Three of the 19 studies evaluated the use of positive reinforcers in the form of access to preferred toys and/or attention to enrich the breaks that were provided to the participants (e.g., Harding et al., 2009; Peterson et al., 2005; Peterson et al., 2009). The presence of positive reinforcers and the length of the break influenced the participants' response allocation across three available responses. Peterson et al. (2005) and Peterson et al. (2009) used a concurrent schedule of reinforcement for all three responses and extinction was not in place for problem behavior.

This differed from Harding et al. (2009) in which problem behavior was placed on extinction. Harding et al. separated a room into two areas. The participants could choose between (a) being alone with no access to attention or preferred items in one side of the room or (b) completing the demand to have access to preferred toys and attention during their break on the other side of the room. The participants chose to complete the work rather than escape the demand even when avoidance was available. The results from Harding et al., Peterson et al. (2005), and Peterson et al. (2009) suggested that response allocation can be shifted from problem behavior to requesting for a break or completing work when the reinforcement quality is manipulated. These studies also showed that providing positive reinforcers, in the form of attention and/or preferred items, can help enrich breaks and treat escape-maintained problem behaviors.

Positive and Negative Reinforcement. Call et al. (2014) conducted a demand analysis that consisted of three conditions. One of these three conditions was the same as the demand condition in the FA. The second condition consisted of providing access to preferred items before the demand was presented and the third condition was similar to the second condition but access to preferred items were provided during the break. Problem behavior was observed throughout all three conditions. A within session analysis showed that problem behavior stopped when the break consisted of providing access to preferred items. Two vocal communicative responses were taught. One response was to request for a break and the other one to request for trains. They then evaluated FCT for negative reinforcement only and FCT for both negative reinforcement and positive reinforcement. During FCT for negative reinforcement, the participant could only request for a break whereas in the FCT for both the negative and positive reinforcement, the participant could request for a break and access to the preferred item. The results from this study, showed that the communicative response for the positive reinforcement was acquired faster than the communicative response for negative reinforcement. Also, problem behavior reduced when the participant could request for the positive reinforcement and not only for the negative reinforcement. There are some potential reasons for these results, the participant had a multiply maintained problem behavior. There is the possibility that his behavior was primarily maintained by positive rather than negatively reinforcement. Also, problem behavior that is maintained by positive reinforcement can occur during demands especially if these demands restrict access to preferred items, activities, or attention.

Fisher et al. (1998) evaluated the possibility that problem behavior that occurs after a demand is present could be maintained by positive reinforcement rather than negative reinforcement. The results from this study suggested that problem behavior occurred when parents' requests interrupted an on-going preferred activity and ceased when he was allowed to return to the interrupted activity. Overall, the results from Call et al. (2014), Fisher et al. (1998), and Fisher et al. (2005) showed that problem behavior that appears to be negatively maintained may be positively maintained, especially when the demand interrupts access to a preferred activity. This finding has important implications for clinicians. Clinicians must take into consideration the type of demand and when the demand is provided when generating hypothesis to identify the function of the problem behavior.

Another consideration that clinicians must have when implementing FCT and treating escape-maintained problem behavior is the efficacy of the FCR (e.g., response effort, schedule of reinforcement, delivery of reinforcement). Thus, the level of difficulty of a task and the support that is provided when a task or demand is presented should also be taken into consideration.

Response Efficacy and Task Difficulty. Three of the 19 studies evaluated response efficacy, level of task difficulty and support provided within FCT for the treatment of escape-maintained problem behavior (Horner & Day, 1991; Kahng et al.,1997; Umbreit, 1996). Horner and Day (1991) selected a response that was less efficient than problem behavior in three different ways: a) the selected response was more effortful to be emitted; b) it was reinforced on a leaner schedule of reinforcement, or; c) a longer delay between the selected response and the delivery of reinforcement was implemented.

Throughout the Horner and Day (1991) evaluation, problem behavior also produced reinforcement and each efficiency component (e.g., physical effort, schedule of reinforcement, and delay to reinforcement) was evaluated with a different participant. When a more effortful response, which consisted of signing an entire sentence to ask for a break, problem behavior remained at high levels and the FCR remained at low levels. The participant was then taught a less effortful response, which consisted of signing one word to request for a break instead of signing an entire sentence. Once the less effortful response was learned and reinforcement was provided, the participant's problem behavior decreased and the FCR increased. These results showed that the response effort for the FCR had to be lower than the effort required to engage in problem behavior for FCT to be effective at decreasing problem behavior and increasing the FCR. The results from this study, also revealed that when a fixed-ratio 3 (FR-3) schedule of reinforcement was in place for the FCR instead of a FR1 schedule of reinforcement, the FCR did not increase and problem behavior remained at high levels. This result suggested that for the FCR to be more efficient than problem behavior, the FCR must produce higher rates of reinforcement. Another interesting finding from this study was that the delay to reinforcement played a factor in the efficacy of the FCR replacing problem behavior. For problem behavior to decrease, reinforcement contingent upon the FCR should be delivered at a more immediate rate than for problem behavior.

Another important factor that might affect the effectiveness of FCT for the treatment of escape-maintained problem behavior, is the task or demand difficulty and the assistance level that is provided (Umbreit, 1997). Umbreit (1997) results showed that considering the pre-requisite skills needed to complete a specific task was important to identify if the task was an appropriate or difficult task. The results also demonstrated that providing difficult tasks lead to higher levels of problem behavior and lower levels of the FCR when compared to the levels observed with appropriate tasks. Thus, the presence and absence of assistance with difficult tasks influenced the levels of problem behavior and the FCR. Lower levels of problem behavior and higher levels of the FCR were observed when the researchers provided support with difficult tasks than when no support was provided. Therefore, the occurrence of escape-maintained problem behavior can be prevented, in some cases, when help, and adequate tasks or demands are provided to individuals with DD and ASD.

The effectiveness of FCT has also been evaluated in conjunction with other interventions (e.g., as a treatment package) or compared to other interventions. The studies that conducted these evaluations will be summarized in the following section.

FCT in conjunction with other treatments or versus other treatments. Four of the 19 studies evaluated FCT alone versus other treatments or in conjunction with other treatments (e.g., Mildon et al., 2004; Kahng et al., 1997). Mildon et al. (2004) and Hagopian et al. (2001) examined the use of NCR or NCE in combination with FCT to reduce escape-maintained problem behavior and reduce the probability of the occurrence of response chaining. NCE alone decreased problem behavior and increased compliance. However, NCE plus FCT not only maintained low levels of problem behavior but an increase in the alternative communication response was also observed. When a changing criterion component was added to the NCE plus FCT treatment, compliance and the alternative communication response increased, and problem behavior remained low. Overall, the NCE plus FCT lead to greater reductions in problem behavior and increases in the alternative communication response than NCE alone. The effects of two types of differential negative reinforcement (DNR), DNR-communication versus DNR compliance, were compared in Marcus and Vollmer (1995). DNR communication consisted of traditional FCT in which an alternative communicative response (e.g., requesting for a break), was reinforced and problem behavior was placed on extinction. DNR-compliance consisted of providing reinforcement contingent on compliance with the task and problem behavior being on extinction. Results from this study suggested that if contingencies for compliance are not stipulated, DNR-communication alone may still result in low levels of task completion or compliance.

Discussion

The results from the current synthesis reveal that many of the best FCT practices suggested in the Tiger et al. (2008) and Hagopian et al. (2011) literature reviews also applied to participants whose problem behavior was escape-maintained. For instance, clinicians must consider efficacy variables such as, the effort level and the functional equivalence of the FCR to ensure that the FCR competes with problem behavior (e.g., Day & Horner, 1991). Thus, when selecting the FCR, clinicians must also think about the likelihood of the FCR to generalize across people and contexts. For instance, using an assistive device instead of a sign to emit the FCR may lead to better generalization outcomes.

Another best practice or factor that was also identified in the current synthesis was that when punishment or extinction was not implemented with FCT, participants developed a response chain consisting of problem behavior followed by the FCR. When response chaining formed, problem behavior may be intermittently reinforced (e.g., Shirley et al., 1997; Wacker et al., 1990). Intermittently reinforcing problem behavior while trying to teach the FCR does not decrease problem behavior and prevents the participant from learning the FCR (Kelley et al., 2002). The use of extinction or punishment may be needed for some participants for FCT to be effective at reducing problem behavior.

An additional common finding from the current synthesis was the use of schedule thinning procedures within FCT. As Hagopian et al. (2011) reported in their literature review, chain schedules of reinforcement are more likely used when the problem behavior is escape maintained. The results from this literature review support this finding as 50% of the studies that evaluated schedule thinning procedures as part of their study purpose, examined the use of chain schedules of reinforcement. The use of schedule thinning procedures within FCT for the FCR to be emitted at acceptable rates and to increase compliance or task completion is an important factor to increase the generalizability, maintenance, and social validity of FCT (Davis et al., 2018; Hagopian et al., 2011; Lalli et al., 1995).

There were other additional factors in this synthesis that were not identified in prior FCT literature reviews. The current synthesis only included studies that had at least one participant with an escape-maintained problem behavior and data were extracted for only the participants with an escape function. Consequently, there is the possibility that these newly identified factors could be exclusively for participants whose problem behavior is escape-maintained. Some of these new identified factors could also be ones that extend the findings from past literature reviews on FCT or that could also affect participants with other functions of problem behavior. For instance, a new finding, regarding the FCR, was the use of lag schedules of reinforcement and delays to reinforcement lead to increases in mands variability (Adami et al., 2017; Falcomata et al., 2018; Muething et al., 2018).

The use of existing versus novel mands, mand proficiency, and mands preference within FCT have been furthered explored by Torelli et al. (2016) and Kunnaratanna et al. (2018). The results from these studies suggested that for some participants, preference may be correlated to higher levels of proficiency (i.e., independent manding). However, lower rates of problem behavior were observed with the preferred FCR. These findings have clinical implications that are worth mentioning. For example, preference should be taken into consideration, as much as possible, to select the FCR used in FCT. According to these findings, preference could be assessed throughout the acquisition phase or after all the selected FCR are proficiently acquired. However, preference may shift throughout the acquisition phase. So, it might be best practice to continue to assess preference on an on-going basis. Future research could identify if there is a certain mastery criterion that each mand or FCR, that is being taught through FCT, should reach to best assess preference. This could save time and consequently, increase the effectiveness of the identified FCRs to compete with problem behavior.

Another interesting finding that extends prior research on the effect of the EO within FCT is the amount of exposure to the EO for problem behavior can impact treatment efficacy and the occurrence of extinction bursts. The results of De Rosa et al. (2015) and Fisher et al. (2018) suggested that limited exposure to the EO led to faster reductions on problem behavior, faster acquisition of the FCR, and lower extinction bursts. This finding brings to light two FCT procedural modifications that could potentially limit the exposure to the EO for problem behavior. The therapist could either use a most to least prompting procedure to teach the FCR or select the most proficient FCRs. However, there are circumstances in which a client may only respond correctly when a specific prompt is presented. Therefore, there is the possibility that using a most-to-least prompting procedure may cause some clients to become prompt dependent (Clark & Green, 2004). The therapist should make this decision on a case-by-case basis.

Future studies could also implement a mand topography assessment (MTA; Ringdahl et al., 2009) to select three of the most proficient FCRs and measure the EO exposure across these FCRs. This evaluation could determine whether or not different levels of proficiency lead to more or less exposure to the EO. Researchers could also then evaluate the effect of these different EO exposures on problem behavior, the FCR rate of acquisition, presence of extinction bursts, and clinical relapse (i.e., resurgence). Further evaluating the exposure to the EO within FCT may also help identify other ways schedule thinning procedures could be implemented or modified to prevent resurgence and increase the generalizability and maintenance of FCT outcomes into the natural environment.

Factors that could affect or mitigate clinical relapse of problem behavior (i.e., resurgence) were also identified in this synthesis. During FCT, there are situations in which the parents, therapists, or teachers cannot reinforce the FCR and this may lead to problem behavior to re-occur. This behavioral phenomenon is called resurgence or clinical relapse. Studies that have used lag schedules of reinforcement to increase mands or FCRs variability have shown that when the alternative communicative response or the FCR is placed on extinction, persistence of the FCR is observed before problem behavior re-occurs (Peterson et al., 2017). Increasing the communicative responses, the individual with ASD or DD emits allows the individual to use other forms of communication before he or she engages in problem behavior (Berg et al., 2015; Hoffman & Falcomata, 2014; Lambert et al., 2015). Research in this area is still warranted.

Winborn et al. (2002) evaluated the use of novel versus existing mands within FCT. The results suggested that both mands replaced problem behavior. However, FCT with the existing mand lead to lower levels of manding and higher levels of problem behavior. Therefore, the history of reinforcement of the FCRs should be evaluated when selecting the FCR used in FCT. More recently, Fisher et al. (2019) compared the effects of a lean versus a dense schedule of reinforcement during baseline. The results from this study have some clinical implications because problem behavior that has been reinforced in a denser schedule of reinforcement may lead to higher levels of resurgence of problem behavior. Future research could extend Winborn et al. and Fisher et al. and examine if the use of novel versus existing mands within FCT can mitigate resurgence of problem behavior.

The results from this synthesis also helped identify factors that could potentially optimize the effects of FCT to treat escape-maintained problem behavior. For instance, considering the task difficulty, the level of assistance, and whether the demand is interrupting the current engagement with a preferred item or activity can help prevent or ameliorate the escape-maintained problem behavior (Call et al., 2014; Fisher et al., 1998; Horner & Day, 1991; Umbreit, 1996). Considering all these factors could also increase the likelihood for the individual to comply because the demand aversiveness might be reduced. Another way to increase the likelihood for the individual to comply with tasks is to provide a consequence for compliance. For instance, providing a higher quality of reinforcement contingent upon work completion and emitting the FCR, to request for a “break”, can influence the clients’ response allocation (Davis et al., 2018; Peterson et al., 2009; Peterson et al., 2017). Clinicians can use positive reinforcers (e.g., access to preferred items and attention) to enrich these breaks and influence the response allocation to shift from problem behavior to engaging in task completion while maintaining the FCR.

An interesting finding that was not reported under the results section but that is worth mentioning is that only 14 of the 47 included studies measured compliance for their participants with an escape function. For FCT to be a socially valid treatment for escape-maintained problem behavior, monitoring for compliance is vital. FCT may reduce the levels of escape-maintained problem behavior but task completion or compliance may still remain low (Umbreit, 1996; Hagopian et al., 2011). For this reason, schedule thinning procedures (e.g., chain schedules of reinforcement) have been implemented within FCT. Future research continues to be warranted to develop new technologies to improve schedule thinning procedures and the FCT effectiveness to increase compliance while maintaining low levels of problem behavior and sustaining the FCR within FCT (Hagopian et al., 2011).

Limitations

The new factors that were identified to affect FCT effectiveness were extracted from the results from the participants with an escape-maintained problem behavior. Therefore, there is the possibility that these factors may also apply to participants with other behavior functions (e.g., tangible, attention, or automatic). Also, the results from the current synthesis is limited in the sense that the purpose of the study was used to identify the investigated factors of the study. For instance, there were some studies that used schedule thinning as part of their procedures, but these studies were not included under the schedule thinning procedure section because their study's purpose was not to evaluate schedule thinning.

Future reviews of the literature may want to examine the procedures used throughout the study and categorize studies according to these procedures. Thus, the results from this synthesis did not describe the procedures that were used to implement the independent variable(s) and measure the dependent variable(s). For instance, it would be interesting to analyze (a) the most common procedures used to teach the FCR; (b) the most common measurement procedures for compliance; and (c) the most common way to implement chain schedule thinning procedures to thin the schedule of reinforcement. This will provide clinicians and teachers with additional guidelines for implementing FCT successfully in the natural environment.

Conclusion

In summary, the current synthesis sought to identify factors that affect the effectiveness of FCT to treat escape-maintained problem behaviors and that should be considered to increase the social validity and the generalizability of FCT in the natural environment. The overall results from this synthesis not only validated the results mentioned on prior literature reviews of FCT but also extended these results. Additional set of factors that impact the effectiveness of FCT to treat escape-maintained problem behavior were identified. Some of these factors were higher quality of reinforcement, mand variability, clinical relapse, and exposure to the EO for problem behavior. Due to the importance of treating escape-maintained problem behavior in individuals with developmental disabilities, procedures that seek not only to reduce the problem behavior but also increase compliance while sustaining the occurrence of the FCR within FCT are extremely important.

CHAPTER 3: Method

Participants

Four children with ASD diagnoses participated in the study. Three completed the entirety of the study while one dropped out prior to completion of aspects of the study. Participants were recruited from schools and applied behavior analysis (ABA) clinics in the Central Texas area. Four children met the inclusion criteria but only three participated in this study. After giving consent and having administered three indirect assessments (e.g., interviews and preference assessment), one participant's family declined services due to lack of availability.

The inclusion criteria included (a) the presence of problem behavior maintained by escape from demands or escape from transitions from high preferred activities to low preferred activities (e.g., academic work), (b) a diagnosis of ASD according to medical or school records (e.g., Individualized Education Plan), (c) moderate to limited verbal communication skills status and (d) demonstrated match-to-sample skills.

Table 2 displays each participant's characteristics including, pseudonym, age at time of study, gender, ethnicity, race, diagnosis, their 2nd Edition of the Childhood Autism Rating Scale (CARS-2; Schopler et al., 2010) assessment score, communication skills, and services being received at time of study. The demographic information for our fourth participant, Asher, is also summarized in Table 2. Asher only participated for the intake interview and preference assessment. For this reason, his CARS-2 assessment scores are not reported.

Table 2

Participants' Characteristics

	Participant 1	Participant 2	Participant 3	Participant 4
Pseudonym	Leo	Noah	Daniel	Asher
Age	7	5	6	6
Gender	Male	Male	Male	Male

Ethnicity Race	Hispanic White	Caucasian White	Caucasian White	Caucasian White
Diagnosis (DSM-V)	Autism Spectrum Disorder (F84.0)	Autism Spectrum Disorder (F84.0)	Autism Spectrum Disorder (F84.0)	Autism Spectrum Disorder (F84.0)
CARS-2				
Raw Score	33.5	32.5	36.5	Not obtained due to attrition
Severity Group	Mild to Moderate (30-36.5)	Mild to Moderate (30-36.5)	Mild to Moderate (30-36.5)	Not obtained due to attrition
CARS-2 Communication Ratings (1-5 scale)				
Listening Response	Mildly abnormal (2.0)	Mildly abnormal (2.0)	Mildly abnormal (2.0)	Not obtained due to attrition
Verbal Communication	Moderately abnormal (3.0)	Almost Normal Verbal Communication (1.5)	Moderately abnormal (3.0)	Not obtained due to attrition
Nonverbal communication	Mildly abnormal (2.0)	Normal (1.0)	Mildly abnormal (2.0)	Not obtained due to attrition
Communication mode and skills	Limited Expressive Communication Skills (e.g., three to four-word utterances)	Moderate Expressive Communication Skills (e.g., spoke in full simple sentences with some grammatical or articulation errors).	Limited Expressive Communication Skills (e.g., three to four-word utterances)	Limited Expressive Communication Skills (e.g., used Proloquo 2 go- "I want _")
Services	20-25 hours of ABA therapy in clinic; speech therapy in school	Speech and occupational therapy in school	20-25 hours of ABA therapy in clinic	20 hours of ABA therapy in school, speech therapy in school

Note. This table demonstrates the participants' characteristics, assessment scores, and services being provided at the time of the study. CARS-2= 2nd Edition of the Childhood Autism Rating Scale.

Pseudonym, Age, and Ethnicity

Leo, Noah, and Daniel participated in all phases of the study. They were 7, 5, and 6-year-old males diagnosed with ASD, respectively. Leo was Hispanic, and his family spoke both Spanish and English at home. Noah and Daniel were Caucasian, and their families spoke English at home.

Communication Skills, CARS-2 scores, and Services

Leo's and Daniel's overall communication skills were limited, and they had difficulty communicating their needs. Leo's and Daniel's verbal communication consisted of a mixture of some meaningful speech (e.g., three to four-word utterances; "I want ___") and some echolalia, scripts, or jargons. Noah used full sentences with some grammar (e.g., pronoun reversals) and articulation errors. Caregivers reported that Noah, at times, still had difficulty communicating his needs effectively. According to their 2.0 ratings on the CARS-2, Leo and Daniel displayed mildly abnormal use of non-verbal communication (e.g., they vaguely pointed or reached toward wanted items). According to his 1.0 rating on the CARS-2, Noah engaged in normal use of nonverbal communication.

Leo's, Noah's, and Daniel's raw scores of 33.5, 32.5, and 36.5, respectively, on the CARS-2 assessment placed them in the mild-to-moderate range of autism symptoms. Leo and Daniel received 20-25 hours of ABA therapy in a private clinic. Leo and Noah qualified for special education services and received speech therapy in school. Noah also received occupational therapy in school. Both Leo and Noah received inclusion and pull out support in school. Daniel was not attending school at the time of the study.

Research Team

The research team consisted of four graduate students from the University of Texas at Austin. Three of the four graduate students were certified as Board Certified Behavior Analysts (BCBA). All members of the research team were trained in providing behavioral interventions to children with ASD and their families. The first author, a doctoral student who was bilingual in English and Spanish, was the main researcher for this study. The first author (a) recruited participants, (b) conducted indirect interviews with caregivers, (c) identified and organized work materials for each participant, (d) collected data via session videos, (e) conducted all study sessions including the functional analysis (FA) and experimental conditions, and (f) collected social validity and fidelity data.

The three other graduate students assisted the main researcher throughout the study. The graduate students (a) collected secondary data for interobserver agreement calculation purposes, (b) scored the experimenter's treatment fidelity, and (c) assisted with the implementation of sessions (e.g., in-vivo data collection, video recording the session, monitoring timers etc.).

Indirect Assessments

The caregivers or therapists filled out the CARS-2 (Schopler et al., 2010) to evaluate the severity of autism and the participants' communication ability. Table 2 displays the scores for the CARS-2 for each participant. Caregivers or therapists filled out the *Negative Reinforcement Rating Scale* (NRRS; Zarcone et al., 1999) to identify the task (i.e., demand) for the functional analysis (FA; Iwata et al., 1982/1994) and the evaluation. The task that was selected for the FA and evaluation must have been scored as "often bothers the child" or "always bothers the child" in the NRRS (i.e., 3 or a 4; NRRS). The caregivers or therapists had to also report that the task was mastered but problem behavior still co-occurred. The task was also selected if it was reported to be a meaningful skill for the participant to perform without engaging in problem behavior. Leisure items were also identified via caregivers' or therapists' reports.

Setting and Materials

Sessions were conducted in a quiet room in the participant's home or clinic. Sessions for Leo and Daniel were conducted in the clinic. Sessions for Noah were conducted in the home. Sessions were 5 min in length. Materials included academic tasks that were reported in the NRRS to be mastered but evoked problem behavior for each participant. This academic task was included under the escape condition of the FA and the experimental conditions for each participant. For Leo and Daniel, the tasks consisted of a variety of matching to sample activities (e.g., identity matching). These matching activities consisted of matching an identical picture of a familiar item (e.g., animal, school supply, and house item) to the same picture presented in a field of one to three pictures. Noah's task consisted of using crayons or markers to color different coloring pages.

Other materials included leisure items identified via preference assessments. A multiple stimulus without replacement preference assessment (MSWO; DeLeon & Iwata, 1996) was conducted for Leo and Noah. A free operant preference assessment was conducted for Daniel (Roane et al., 1998) due to high levels of problem behavior during the first five trials of the MSWO assessment. Leo preferred items consisted of an iPad, a foam block, and plastic dinosaurs. His least preferred items consisted of Play-Doh or sand. Noah's preferred items consisted of iPad and Play-Doh and his least preferred item was a kitchen playset. Daniel's preference shifted from day to day. For this reason, a free operant was conducted each day or every fourth session. Daniel's preferred items mostly consisted of trains (e.g., Thomas and Percy) and tracks, and sand. His least preferred items mostly consisted of Play-Doh, coloring items, and iPad. Depending on Daniel's motivation that day, the sand and iPad could shift from preferred to least preferred. It appeared that the motivating properties of the item(s) depended on whether he had access to them prior to sessions.

Three different microswitches with discriminative stimuli (i.e., colors) that corresponded to different schedules of delays to reinforcement were implemented for Leo and Daniel. Noah showed an extreme interest in the microswitches and wanted to play with them. This made it difficult to remove the microswitches without evoking problem behavior. This also inhibited the microswitches from serving as a FCR, to make a choice, rather than as a preferred item. For this reason, three different-colored cards were used with Noah. The colors were the same as the microswitches (e.g., green, purple, and black).

All sessions were video recorded using a digital video camera. Data collection software and computers were used to score the session videos. Digital timers were used to measure the delays, session length, and reinforcement time. Data sheets were also used to collect in-vivo data during each session.

Dependent Variables

Preference/Choices

The primary dependent variable for this study allocation of choice responding between a 0-s delay arrangement, a fixed delay arrangement (e.g., 15-s delay), and a mixed delay arrangement (e.g., 0-s or 30-s delay). For Leo and Daniel, a choice was defined as compressing one out of the three microswitches with the palm of his hands or fingers to select a delay to reinforcement. For Noah, a choice was defined as either touching or verbally saying, the color of the card (e.g., "green") to select a delay to reinforcement, whichever happened first.

Problem Behavior

Another primary dependent variable for this evaluation was problem behavior. Problem behavior included disruptive behaviors, self-injurious (i.e., SIB), and aggression. Disruptive behaviors included verbal protesting for all three participants. Verbal protesting, for Leo and Noah, was defined as using loud vocalizations above conversational level that lasted more than a count of two to say "No" or the name of the researcher. For Daniel, verbal protesting consisted of whining in the form of high-pitched vocalizations above conversational level that lasted more than a count of two and consisted of non-meaningful speech. For Noah and Daniel, disruptive behaviors also included property destruction. Their property destruction behavior consisted of grabbing an object such as a task material (e.g., crayons or matching card) with one or two hands and throwing the object at least one foot away from the participant's body.

All three participants engaged in some form of SIB. Leo's SIB consisted of using his wrist, knee, or a hard surface (e.g., table) to make a forceful physical contact with his forehead or chin. Noah's and Daniel's SIB was defined as using the palm of his hands to hit (make forceful physical contact) his legs, face, or a hard surface. Noah's SIB also included using the back of his head to hit a hard surface with force (e.g., hit the back of the chair). Due to the participants engaging in SIB, a termination criterion was set for all three participants. The session was terminated if any visible mark was seen at any time and sessions were resumed until the next day. If the researcher could not block for three consecutive times within a session, the session was terminated by providing access to a break. During the break, access to low preferred items was provided until problem behavior was not observed for 5 min. Sessions resumed after 5 min elapsed with no problem behavior. However, if the researcher was unable to block the SIB, sessions were terminated for the day. Across all phases of the evaluation, the termination criterion was never reached. Lower intense behaviors such as vocal protesting and disruptive behaviors were mainly observed during the evaluation. In the case of Leo, the researcher was able to block SIB instances effectively and the intensity of the SIB also decreased as the sessions progressed.

Noah's and Daniel's aggressive behaviors consisted of pushing or kicking another person. Pushing was defined as using one or two open hands to push against another person's body (arm, torso, or legs) for a count of five. Kicking was defined as the participant using one or two legs or feet to make a forceful physical contact with another person's body for a count of five. For all three participants, the offset for all problem behavior was a count of five without the participant engaging in any of their target behaviors (e.g., aggressive, property destruction, SIB, and disruptive behaviors).

Task Engagement/Compliance

A secondary dependent variable for the current study was task engagement (i.e., compliance). Similar to Call and Lomas Mevers (2014), task engagement was defined as completing a task (i.e., demand) within 10 s of the presentation of the task and without physical assistance (e.g., independently or with a model/gesture prompt). For Leo and Daniel, task engagement was defined as grabbing the matching sample card with one hand within the 10 s of the presentation of the demand (e.g., "match") and matching the sample card without physical assistance. For Noah, task engagement was defined as grabbing the marker or crayon with one hand to make visible traces on the coloring page without physical assistance and within 10 s of the presentation of the demand (e.g., "color").

Data Collection and Interobserver Agreement

Data Collection

Sessions throughout the evaluation (i.e., FA, preference assessment, and the experimental conditions) were video recorded for subsequent data collection. A computer-based data collection system, Data Analyzer, was used to code data on all of the dependent variables. Paper and pencil data collection was used within sessions on problem behavior and choices. For choices/preference, the number of times each delay choice was selected (i.e., each microswitch or colored card was selected) within each session of the concurrent choice-delay condition was summed. This number was then divided by the number of choices made during the five-minute session to obtain a percentage of times each response was selected. Choices were also displayed using a cumulative graph to evaluate preference across the three schedules of delays to reinforcement. For problem behavior, frequency data were collected within sessions and subsequently converted to responses per minute (RPM), for analysis. Computer-based data were used to collect data on the duration of task engagement. For each session, the percent of time engaged in the task was calculated by dividing the total duration of task engagement by the total duration in which the task was presented (i.e., establishing operation) during the session.

Interobserver Agreement

The main researcher and trained observers independently scored, 50%, 42%, and 41% of sessions across both FA conditions for Leo, Noah, and Daniel, respectively. Interobserver agreement (IOA) was also calculated for 36.7%, 35.8%, and 38.9% of sessions across both choice delay conditions for Leo, Noah, and Daniel, respectively. The choice delay conditions included the free choice sessions and the forced choice sessions. To calculate agreement data, each session was divided into 10-s intervals and agreement were calculated on an interval-by-interval basis. For each interval, the smaller frequency of responses (e.g., problem behavior or choice) or duration (e.g., task engagement) recorded was divided by the largest number recorded for each target behavior for each participant. If both observers did not record problem behavior or a specific delay to reinforcement choice being selected within that interval, agreement was 100% for that interval. The overall percentage agreement was calculated for each session by averaging the resulting agreement data across all intervals with the resulting number multiplied by 100.

For the FA conditions, IOA for problem behavior averaged 98% (range = 91.9-100), 99% (range = 98.4-100), and 99% (range = 95.2-100) for Leo, Noah, and Daniel, respectively. IOA for task engagement across the FA conditions was 92%, 95% (range = 92.13-98.12), and 96% (range = 95.5-95.7) for Leo, Noah, and Daniel, respectively. For the choice delay conditions (i.e., treatment conditions), Leo's, Noah's, and Daniel's IOA for problem behavior averaged 100%, 99% (range = 96.7-100), 99% (range = 97.06-100), respectively. For task engagement, IOA averaged 94% (range = 88.9-100), 94% (range = 91.3-98.3), 97% (range = 91-100), for Leo, Noah, and Daniel. For Leo and Daniel, IOA for choice or preference averaged 100% for each delay to reinforcement choice (i.e., mixed, fixed, and 0-s delay). For Noah, IOA for the mixed delay to reinforcement choice averaged 99.4% (range = 93.6-100), 100% for the fixed delay, and 99.6% (range = 96.3-100) for the 0-s delay.

Procedures

Direct Assessments

Preference Assessment. A list of preferred items was identified by interviewing caregivers or therapists. Like DeLeon & Iwata (1996), a MSWO assessment was conducted for Leo and Noah. For Daniel, a free operant preference assessment like Roane et al. (1998) was conducted prior to the FA and every new day or every fourth session due to his motivation changing among preferred items. The two or three highest preferred items for each participant were selected for the tangible and the free-play condition of the FA. The highest preferred items were also selected as “high quality” reinforcers. These “high quality” reinforcers were delivered contingent upon the mixed and the fixed delay to reinforcement microswitch or colored card being selected. The least preferred items for each participant were also selected for the escape and attention condition of the FA and were delivered as the “low quality” reinforcers for the 0-s delay to reinforcement.

Analogue Functional Analysis (FA). FAs were conducted to confirm that the problem behavior was maintained by an escape function or escape to tangible function (Iwata et al., 1982/1994). All FAs were conducted based on procedures described by Iwata et al., (1982/1994). All FAs were conducted using a multielement design and included a free-play, escape, tangible, and attention condition. The FA sessions were five minutes in duration. During the escape conditions, the participants were asked to complete their corresponding task (i.e., demand) identified via the NRRS. A 3-step progressive prompting procedure (i.e., verbal, model, and full physical prompt) was used. Contingent upon problem behavior, the task materials were removed, and the therapist or main researcher turned away and provided access to low-preferred items and no demands for 30 s. Problem behavior that occurred during the break did not postpone the presentation of the next demand. Contingent on task engagement with verbal or model prompt, verbal praise and the next matching card or coloring page was immediately delivered. Task engagement with full physical did not produce praise and the next matching card or coloring page was immediately delivered. Following the 30-s break, the next task was presented.

During the tangible condition, the participants were pre-exposed to 1 min of free access to the most highly preferred items before the session began. After the one minute of pre-exposure, the preferred items were removed only returned for 30 s contingent on the occurrence of problem behavior. Prior to the attention condition, low preferred items and attention were freely available for one minute. At the onset of the attention condition, attention was withdrawn, and the participant was told that he could play with the low preferred items but that the therapist was going to be busy. Contingent on each occurrence of problem behavior, attention in the form of disapproval statements (e.g., don't do that, that hurts, etc.) was delivered. During the free play condition, the participants had non-contingent access to high, low, and moderate preferred items, no demands were in place, and attention was provided approximately every 15 s. Problem behavior was ignored and/or blocked with minimal attention.

Experimental Design and Conditions

A combination of a concurrent schedule design (Harding et al., 1999) and an ABAB reversal design was used to evaluate the effects of presenting three concurrent choices, each correlated to a different delay to reinforcement (i.e., 0-s delay, fixed 15-s delay, and mixed 0-s or 30-s delay), within FCT, on problem behavior, preference, and task engagement.

FA/Baseline. The first FA condition served as a baseline for the purpose of comparing the dependent variables (i.e., task engagement and problem behavior). For task engagement, baseline was only obtained from the escape conditions of the FA. For problem behavior, baseline was attained from the escape and tangible conditions of the FA. The second FA condition or baseline consisted of a pairwise FA of the tangible and escape conditions. A total of three to four series was conducted for each participant. A multielement design was used within each series. The tangible and escape conditions were five minutes in length. The order of the conditions was randomized and counterbalanced for each series. The procedures for these conditions were the same as the ones used during the first FA tangible and escape conditions.

Forced Choice Trials. At the start of a new day or every fourth session, each microswitch or colored card corresponding to each possible delay duration (i.e., 0-s delay, mixed, and fixed) was presented in isolation followed by the statement "It's time to wait while we work" or "It's time to do some work while we wait, press the button." To ensure the participants were exposed to each possible delay duration, one trial of each delay value was presented consecutively but in a randomized order. This procedure was repeated once to allow the participants to experience both values under the mixed delay. With the mixed delay, a counterbalance procedure was used to determine the order of the short (0 s) or long (30 s) delay to reinforcer. Counterbalancing for the fixed (15-s) or 0-s delay was not required because these delays were constant. If Leo and Daniel did not push the microswitch or Noah did not touch or verbally label the colored card (e.g., "green") within 10 s of the microswitch or colored card being presented, a 3-step progressive prompting procedure (e.g., verbal, model, and physical guidance) was implemented.

Once the microswitch was compressed or the colored card was labeled or touched, regardless of prompting level, a countdown timer for the corresponding delay was started followed by the presentation of the corresponding task (e.g., matching identical pictures or coloring pages) for each participant. During the 15-s or 30-s delays, a 3-step progressive prompting procedure was implemented, and praise was provided for task engagement occurring with a verbal or model/gesture prompt followed by the presentation of the next demand. If full physical guidance was required, praise was not delivered and the next demand (e.g., matching card or coloring page) was presented. A 5-s delay was implemented within prompt level. The delay was not restarted or paused contingent on problem behavior or the absence of task engagement.

For the fixed 15-s delay, the participants had to wait for 15 s to earn 30 s of access with high preferred items. For the mixed delay, the participants had to wait for 30 s or not wait (0 s) to earn 30 s of access to high preferred items. For the 0-s delay, the participants did not have to wait and had access to a 30-s break with access to low preferred items. For Noah, the mixed delay and fixed delay also produced high quality attention in the form of socially interacting with Noah. The 0-s delay produced neutral attention in the form of redirection to low preferred items. For Leo and Daniel, attention was only provided during the mixed or fixed delay if they needed help with a high preferred item, which rarely occurred. Following the 30-s break, preferred or low preferred items were removed, and the next forced choice trial was presented. Problem behavior was ignored or blocked.

Concurrent Choice Delay Condition. This condition was similar to the forced choice trials with the exception that the session started with first programming the establishing operation (EO) for escape or escape to tangible (i.e., presentation of the choices). The five-minute session began with the verbal statement "It's time to do wait while we work," followed by the presentation of the choices and the verbal prompt "pick one." The choices consisted of the three microswitches for Leo and Daniel, whereas for Noah they were three colored cards. Upon the participant making a choice, the microswitches or colored cards were removed, and the corresponding task (i.e., demand) was presented for each participant. The position of the microswitches or colored cards were randomly alternated after each presentation to prevent side bias. If no choice was made within 10 s, the microswitches or colored cards were removed and represented with the verbal statement, "It's time to do some work while we wait, pick one." This phase was repeated every 10-15 s until the session ended or the participant made a choice. If the participant did not make a choice for the entire session, a forced choice session was then conducted. Because all three participants made choices during the free choice sessions, a forced choice session was not required. If the participant was to choose two options, the microswitches or colored cards were removed and represented with the verbal statement, “choose only one.”

When a choice was made, the timer for the corresponding delay was initiated. The timer was not paused even if the participant did not complete the task independently or with prompts. The timer was also not paused contingent upon problem behavior. Problem behavior was ignored or blocked with minimal attention. Upon the delay elapsing, the timer signaled that the delay was over, and the participant was provided with verbal praise and access to the corresponding preferred items for 30 s. Following the 30-s break, access to the preferred items were removed and the process was repeated until the five-minute session was over.

Treatment Integrity

Treatment integrity was assessed for 40%, 34%, and 33.3% of the video recordings across all phases of the study (i.e., FA and the choice delay condition), for Leo, Noah, and Daniel, respectively. Similar to Falcomata et al. (2018), the delivery of reinforcement was scored as correct if it was provided within 5 s of the participant engaging in problem behavior during the FA and within 5 s of the corresponding delay to reinforcement elapsing. The withholding of reinforcement was scored as correct contingent upon problem behavior and a choice (i.e., microswitch or colored card) not being selected. The delivery of reinforcement was also scored as correct if it was removed within 5 s of the reinforcement interval elapsing (i.e., 30 s). Reinforcement was scored as incorrect if reinforcement was not provided within 5 s of the delay to reinforcement elapsing and if it was not provided for 30 s and removed within 5 s of the reinforcement interval elapsing.

The establishing operations (EO) was scored as correctly or incorrectly programmed following reinforcement intervals, which consisted of presenting the three delays to reinforcement choices (e.g., microswitches or colored cards). The delay to reinforcement for the fixed 15-s delay and the mixed 30-s interval was scored as correct if the delay started within 5s of the participants selecting these delays and the task was presented during the delay. The delay to reinforcement was also scored correct if the task was removed within 5 s of the fixed or the mixed 30-s delay elapsing to provide access to the corresponding preferred items (e.g., high preferred items). For the 0 s delay and the 0 s interval of the mixed delay, the delay to reinforcement was scored correct if a task was not presented and access to the corresponding reinforcement (e.g., access to low preferred items) was delivered within 5 s of the participants making a choice. Treatment integrity was calculated by dividing the number of correct responses by the total number of opportunities and multiplying the resulting number by 100.

Social Validity

The main researcher created a 12-question social validity survey that was based on the Treatment Acceptability Form-Revised (TARF-R; Reimers et al., 1992) scale. The main researcher selected nine questions from the TARF-R that were more relevant to this evaluation and added three additional questions to evaluate the extent to which this treatment could be used with other behavior interventions or to treat other behaviors. The social validity survey that was used to evaluate the acceptability and effectiveness of the treatment can be seen in Appendix A and consisted of a seven-point Likert scale. Higher scores indicate greater levels of treatment acceptability.

When the evaluation was completed, the main researcher randomly selected two videos from the first and second FA condition (i.e., pre-intervention) and two videos from the choice delay conditions (i.e., free choice sessions) for each participant. The main researcher met, in person, with each one of Leo's and Daniel's therapists [i.e., registered behavior technicians (RBTs)] or with Noah's caregivers. During the meeting with each therapist or caregiver, the main researcher provided a hard copy of the modified TARF-R social validity survey and briefly explained the intervention. Then the main researcher showed the four videos (e.g., two pre-intervention and two intervention videos) that corresponded to each participant. For example, Leo's therapist watched the four videos that were selected from his evaluation and then rated the acceptability and effectiveness of the treatment. The same process was conducted with Daniel's therapist and Noah's caregivers.

CHAPTER 4: Results

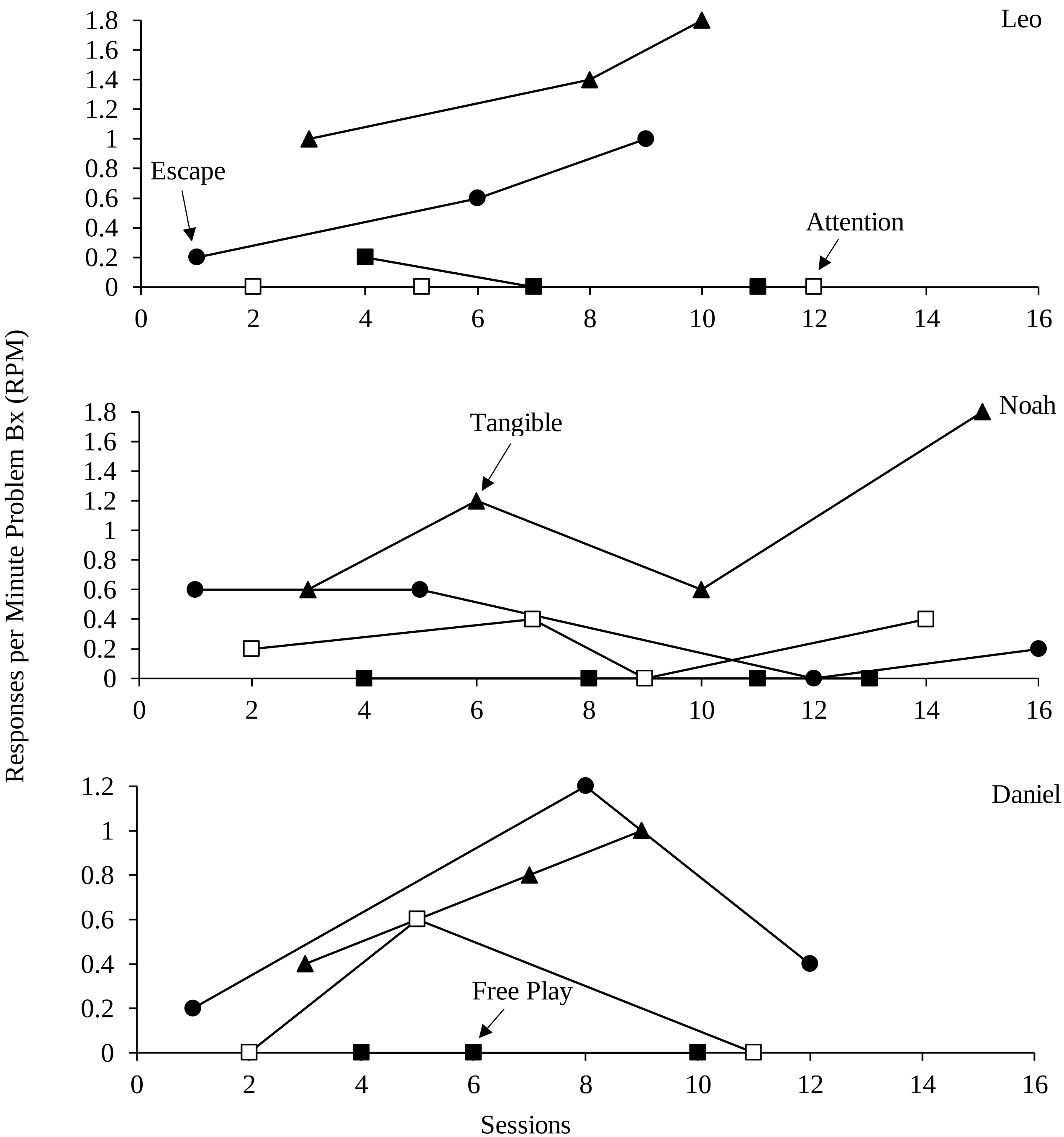
Functional Analysis

Figure 1 displays the FA results for all three participants. Leo (see top panel of Figure 1), engaged in low levels of problem behavior during the control condition (i.e., free play; *M* = 0.06 RPM) and attention condition (*M* = 0 RPM). He engaged in higher levels of problem behavior during the escape (*M* = 0.6 RPM) and tangible (*M* = 1.1 RPM) conditions when compared to free play and attention conditions. During the escape condition, Leo engaged in high levels of task engagement (*M* = 86%). Noah's FA results are displayed in the middle panel of Figure 1. Noah engaged in low levels of problem behavior during the free play condition (*M* = 0 RPM). He engaged in higher levels of problem behavior relative to the free play condition during the tangible (*M* = 1.1 RPM) and escape conditions (*M* = 0.4 RPM). During the attention condition, problem behavior occurred at levels (*M* = 0.3 RPM) slightly above those observed during the free play condition. Low levels of task engagement were observed during the escape condition for Noah (*M* = 56.86%). Daniel (see bottom panel of Figure 1) engaged in zero levels of problem behavior during the free play condition. Daniel engaged in elevated levels of problem behavior during the escape (*M* = 0.6 RPM) and tangible (*M* = 0.7 RPM) conditions. Daniel's overall levels of task engagement were lower than Leo's (*M* = 9%) but higher than Noah's (*M* = 56.9%) with an average of 66.6% of time engaged on the task.

The results from the FAs suggested that for Daniel and Leo, escape and tangible functions were maintaining problem behavior. There was one session in which Daniel engaged in problem behavior (e.g., 0.1 RPM) during the attention condition. However, problem behavior was not observed in any of the other attention sessions. Therefore, an attention function was less evident given that problem behavior was only observed for one out of the three attention sessions conducted during the FA. For this reason, attention was not provided during the high quality or low-quality breaks unless Daniel needed redirection or help with toys. For Noah, the levels of problem behavior were elevated in the escape and tangible condition. Although levels of problem behavior were not considerably elevated in the attention condition, they occurred at levels above free play. Problem behavior was also observed in three out of four attention sessions. These results suggested that Noah's problem behavior was multiply maintained. Noah was still included in the study because he engaged in higher levels of problem behavior during the tangible and escape conditions relative to the other two conditions (i.e., attention and free play).

Figure 1

Functional Analysis Results



Note. This figure demonstrates the functional analysis results for each participant. Bx= behavior, the closed triangles = tangible condition, the closed circles = escape condition, the closed squares = free play condition, and opened squares = attention condition.

Concurrent Choice Delay Condition

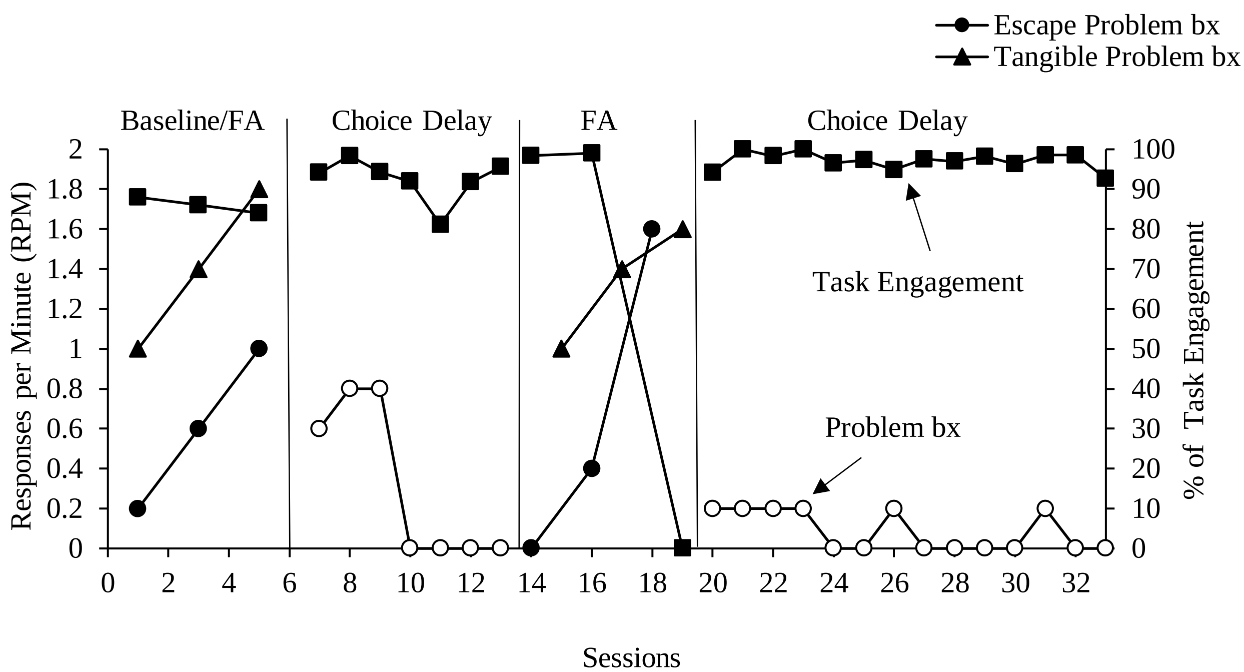
Figures 2, 5, and 8 show the results of the concurrent choice delay evaluation (i.e., treatment) for each participant. The primary y-axis displays the rate of problem behavior and the secondary y-axis the percentage of task engagement across sessions and conditions. The closed circles and closed triangles represent problem behavior during the escape condition and tangible condition, respectively. The closed squares represent task engagement across the FA conditions and the concurrent choice delay conditions. Problem behavior during the concurrent choice delay conditions (i.e., treatment) are represented with open circles. Figures 3, 6, and 9 display the cumulative number of choices each participant made for each delay alternative during each concurrent choice delay session (i.e., free choices). The closed circles represent the cumulative number of times the participant chose the mixed delay to reinforcement. The closed triangles and the closed squares represent the cumulative number of times the fixed delay and the 0-s delay to reinforcement were selected throughout each concurrent choice delay session.

Results for Leo

At baseline, which consisted of the escape and tangible conditions of the FA, Leo engaged in high levels of problem behavior (e.g., M = 0.6 RPM; M = 1.1 RPM) and task engagement (M = 86%). During the initial concurrent choice delay condition (i.e., free choice sessions), Leo's problem behavior decreased to near-zero levels across four consecutive sessions (M = 0.3 RPM). From baseline levels, Leo's task engagement increased slightly by 6.5% (M = 92.5%). Upon the return to baseline (i.e., the second FA condition), problem behavior returned to levels similar to the initial escape condition (M = 0.6 RPM). For the tangible condition, problem behavior was slightly higher (M = 1.3 RPM) during the second FA condition when compared to the initial FA tangible condition (M = 1.1 RPM). Persistence of task engagement was observed during the first two escape sessions (range = 98.4%- 99.0%) of the second FA condition. However, task engagement decreased to near-zero levels on the third escape session. A 27% decrease in task engagement (*M* = 66%) was observed during the second FA implementation when compared to the initial concurrent choice delay condition (*M* = 92.5%). When the second concurrent choice delay condition was implemented, problem behavior returned to near zero levels (*M* = 0.1 RPM) and were lower than during the initial concurrent choice delay condition. Task engagement increased to an average of 97.1% (range = 91.8%-98.4%). The levels of task engagement were higher than during baseline (*M* = 86%) and the initial concurrent choice delay condition (*M* = 92.5%). The results for Leo suggest that presenting three concurrent choices each correlated to a different delay to reinforcement was effective at decreasing problem behavior. Even though task engagement occurred prior to the concurrent choice delay condition, the levels of task engagement increased throughout the evaluation. These results show that while problem behavior decreased, task engagement remained and slightly increased.

Figure 2

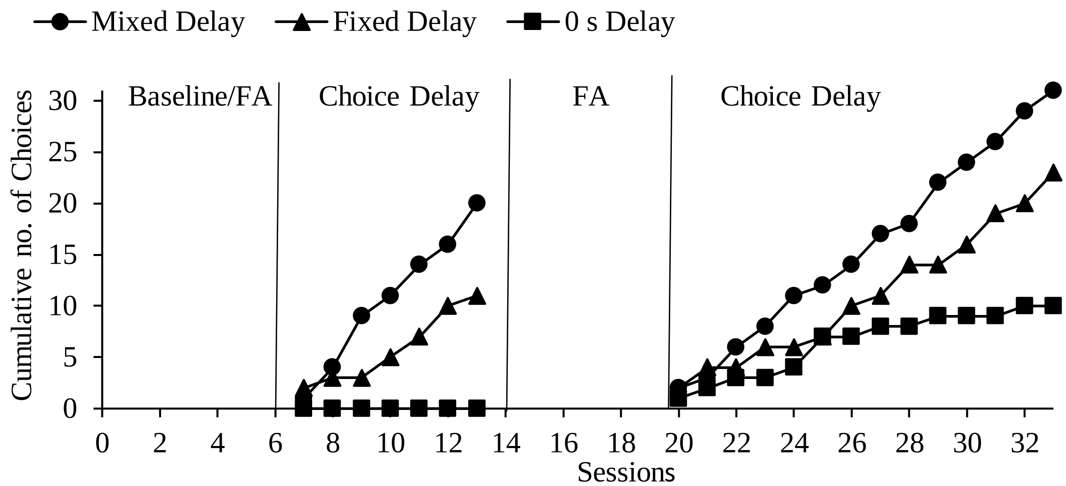
Leo's Concurrent Choice Evaluation Results



Note. This figure demonstrates Leo's concurrent choice evaluation results. Choice Delay = Concurrent Choice Delay Condition (i.e., free choice sessions), bx= behavior.

Figure 3

Leo's Cumulative Number of Choices for Each Delay Alternative



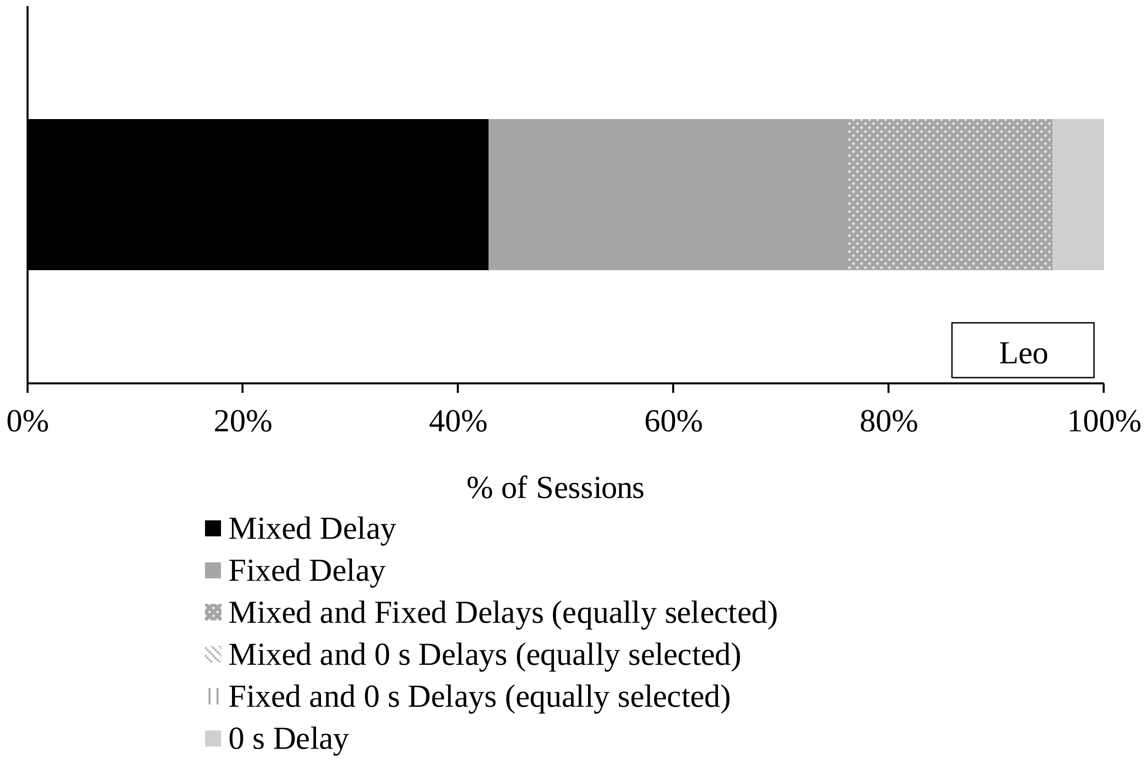
Note. This figure represents the cumulative number of choices for each delay alternative across each concurrent choice delay session. no. = number.

During the initial concurrent choice delay condition (i.e., sessions 7-13), Leo allocated 20 choice responses towards the mixed delay microswitch. Leo allocated 11 choice responses toward the fixed delay and 0 choice responses toward the 0 s delay microswitch. The cumulative number of choices for each delay to reinforcement suggested a preference for the mixed delay to reinforcement (i.e., 0-s or 30-s delay) followed by the fixed 15-s delay. When the second concurrent choice delay condition was implemented, Leo allocated 31 responses to the mixed delay microswitch, 23 responses to the fixed delay microswitch and 10 responses to the 0-s delay microswitch. Leo's results showed a preference for the mixed delay across both concurrent choice delay conditions followed by the fixed and the 0-s delay. Leo's data also suggest that at times within a session he would select the fixed delay.

Across both concurrent choice delay conditions, there were a total of 21 sessions (i.e., free choice sessions). For most of the trials within a session, Leo chose the mixed delay microswitch in 42.8% of the concurrent choice delay sessions (i.e., 9 sessions). Leo chose the fixed delay more often than any of the other delay alternatives in 33.3% (i.e., 7 sessions) of concurrent choice delay sessions. The 0-s delay was chosen in 4.7% of concurrent choice delay sessions (i.e., one session). Both the mixed and fixed delay microswitch were equally selected in 19% (i.e., four sessions) of the concurrent choice delay sessions. The percentage of sessions a delay to reinforcement alternative was more frequently selected across both concurrent choice delay conditions are displayed in Figure 4.

Figure 4

Leo's Percentage of Sessions Each Delay Was Chosen Most Frequently



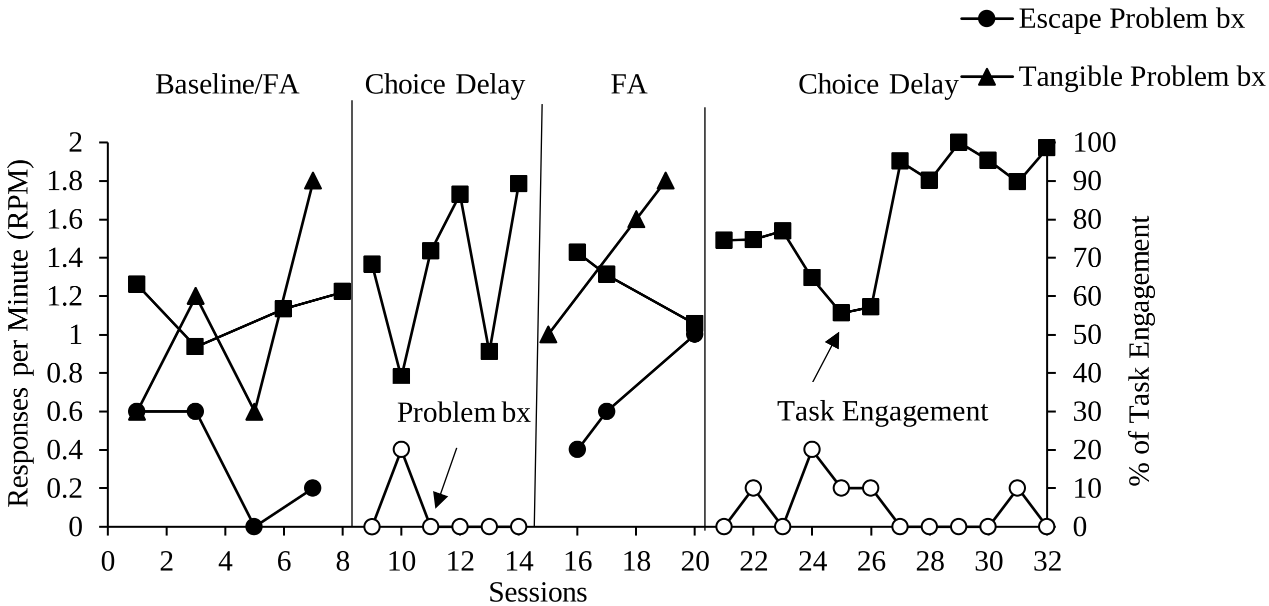
Results for Noah

Noah engaged in high levels of problem behavior during the escape (*M* = 0.4) and tangible (*M* = 1.1 RPM) conditions prior to the concurrent choice delay condition (i.e., treatment). During the escape condition, task engagement occurred 56.8% of the time the task was presented. During the initial concurrent choice delay condition, problem behavior decreased to near-zero levels (*M* = 0.1 RPM). A 9.85% increase in task engagement was also observed (*M* = 66.7%). However, Noah's task engagement levels were variable, ranging from 68.3% to 89.23%. Upon the return to baseline (i.e., the second FA condition), problem behavior increased during the escape (*M* = 0.6 RPM) and tangible (*M* = 1.5 RPM) conditions. The levels of problem behavior increased and were higher than those observed during the escape (*M* = 0.4) and tangible

(*M* = 1.1 RPM) conditions of the first FA. Even though a slight decrease was observed in the levels of task engagement, the overall levels of task engagement (*M* = 63.3%) remained similar to the levels observed during the initial concurrent choice delay condition (*M* = 66.7%). When the second concurrent delay condition was implemented, problem behavior returned to near-zero levels despite some variability (*M* = 0.1 RPM; range = 0.0 - 0.4 RPM). The levels of problem behavior were lower than during the escape and tangible conditions for both FA conditions. Task engagement levels increased during the second concurrent delay condition (*M* = 81.01%). Task engagement levels were higher than during baseline (*M* = 56.9%) and the initial concurrent delay condition (*M* = 66.7%). The results for Noah suggest that presenting three concurrent choices, each correlated to a different delay to reinforcement, was effective at decreasing problem behavior. The results showed that task engagement increased. These results should be taken with caution as a reversal was not obtained with task engagement. These results still show the positive effect of task engagement occurring while problem behavior decreased.

Figure 5

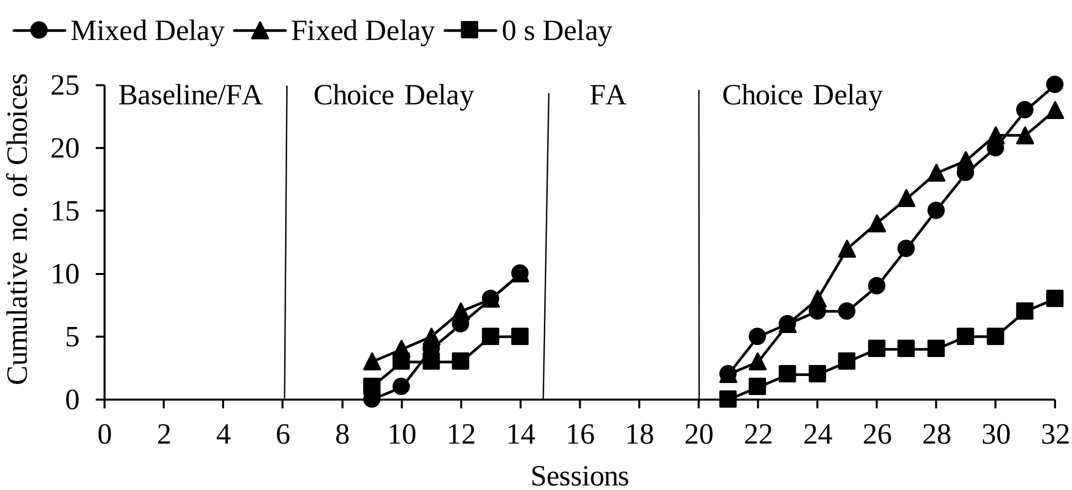
Noah's Concurrent Choice Evaluation Results



Note. This figure demonstrates Noah's concurrent choice evaluation results. Choice Delay = Concurrent Choice Delay Condition (i.e., free choice sessions), bx= behavior.

Figure 6

Noah's Cumulative Number of Choices for Each Delay Alternative



Note. This figure represents the cumulative number of choices for each delay alternative across each concurrent choice delay session. no. = number.

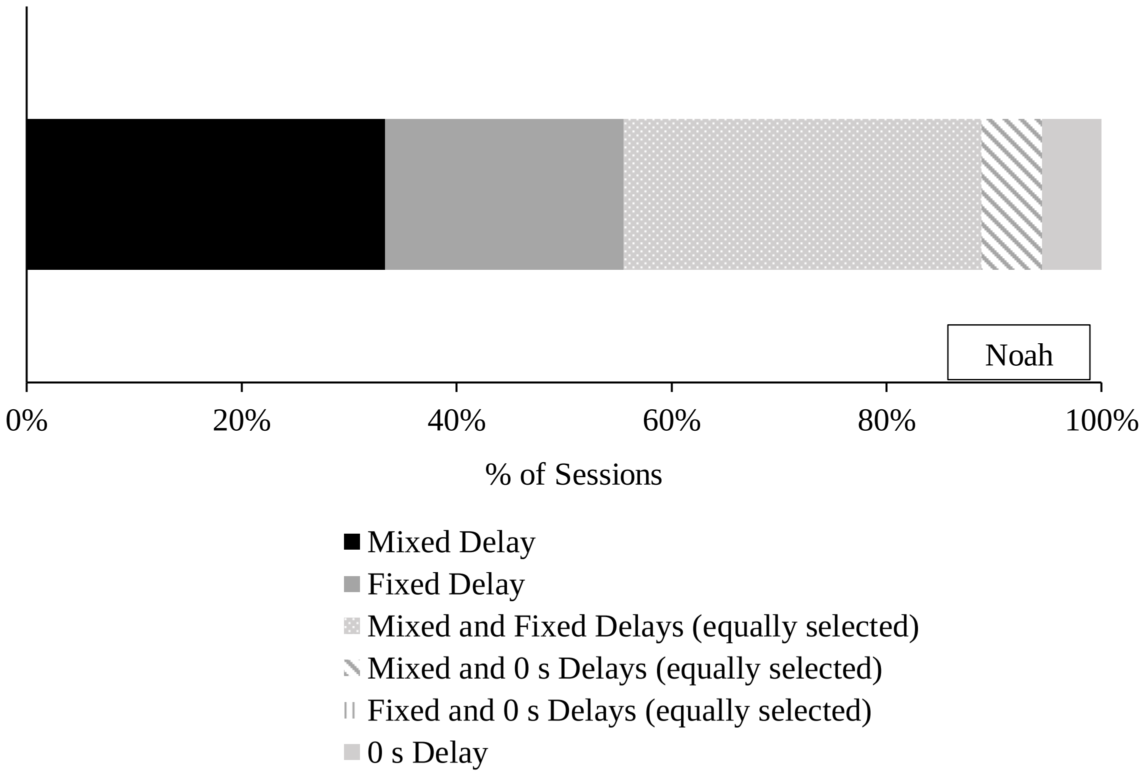
During the initial concurrent choice delay condition (i.e., sessions 9-14), Noah allocated 10 choice responses towards each the mixed delay and the fixed delay colored card. The cumulative number of choices for the mixed and the fixed delay showed that Noah had no preference for the mixed over the fixed delay to reinforcement, or vice versa. He also allocated five choice responses toward the 0-s delay condition. Noah showed a preference for the mixed and the fixed delay over the 0-s delay to reinforcement.

When the second concurrent choice delay condition was implemented, Noah allocated 25 responses to the mixed delay colored card, 23 responses to the fixed delay colored card, and eight responses to the 0-s delay colored card. Noah's results show a pattern of indifference toward the mixed and the fixed delays to reinforcement. Noah's data suggest that within sessions and across sessions, his preference shifted between the mixed and the fixed delay to reinforcement.

There was a total of 18 sessions (i.e., free choice sessions) across both concurrent choice delay conditions. For most of the trials within a session, Noah chose the mixed delay colored card in 33.3% of the concurrent choice delay sessions (six sessions). Noah chose the fixed delay in 22.2% (four sessions) of concurrent choice delay sessions. The 0-s delay was chosen in 5.6% of concurrent choice delay sessions (one session). Both the mixed and fixed delay colored cards were equally selected in 33.3% (six sessions) of the concurrent choice delay sessions. Both the mixed delay and the 0-s delay were equally selected in 5.6% of concurrent choice delay sessions (one session). These data suggest that Noah had no clear preference for the mixed versus the fixed delay. However, his data suggest that he did not prefer the 0-s delay to reinforcement over the mixed and the fixed delays alternatives. The percentage of sessions a delay to reinforcement alternative was more frequently selected across both concurrent choice delay conditions are displayed in Figure 7.

Figure 7

Noah's Percentage of Sessions Each Delay Was Chosen Most Frequently

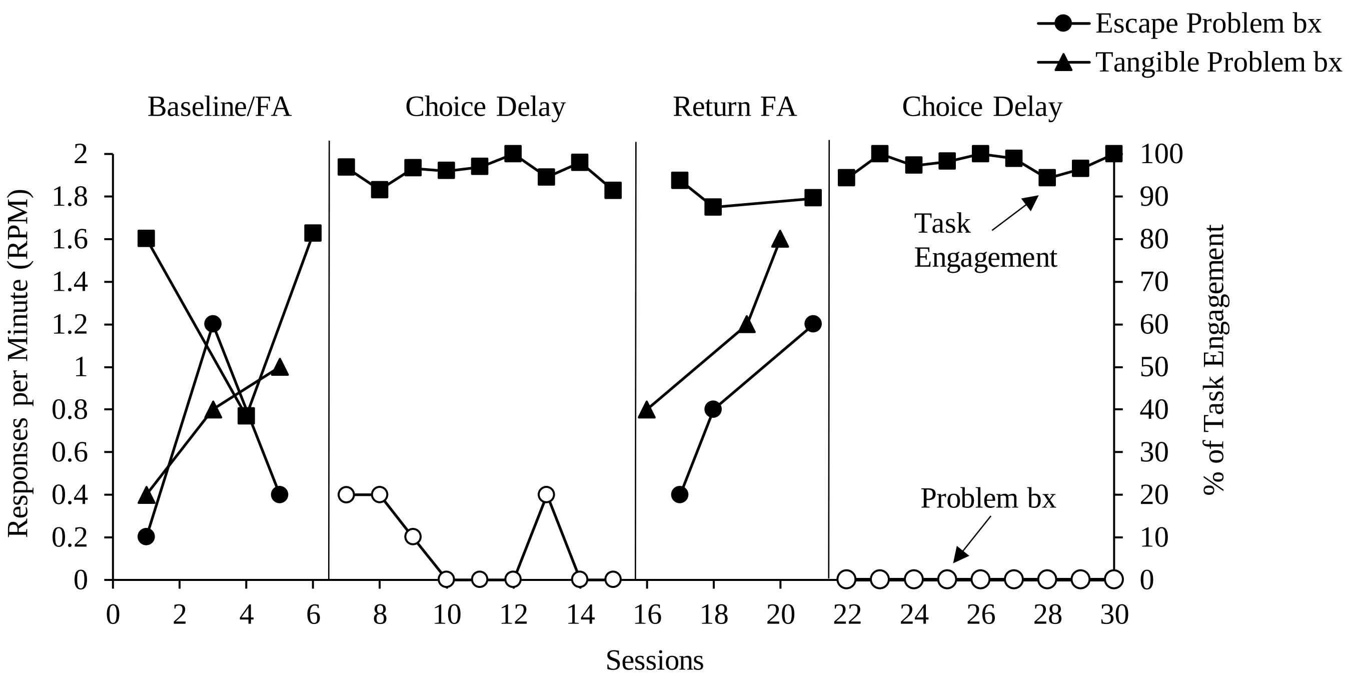


Results for Daniel

During baseline or the first FA condition, Daniel engaged in high levels of problem behavior during the escape (*M* = 0.6 RPM) and tangible (*M* = 0.7 RPM) conditions. During the escape condition, task engagement occurred an average of 66.6% of the time the task was presented. During the initial concurrent choice delay condition, problem behavior decreased to near-zero levels (*M* = 0.2 RPM). A 29.15% increase was observed in task engagement (*M* = 95.8%). Upon the return to baseline (i.e., the second FA condition), problem behavior increased during the escape (*M* = 0.8 RPM) and tangible (*M* = 1.2 RPM) conditions. The levels of problem behavior increased and were higher than those observed during the escape (*M* = 0.6) and tangible (*M* = 0.7 RPM) conditions of the first FA condition. Task engagement levels slightly decreased (*M* = 90.3%) when compared to the initial concurrent choice delay condition. The overall levels of task engagement remained to similar levels that those observed during the initial concurrent choice delay condition. When the second concurrent delay condition was implemented, problem behavior returned to near-zero levels and remained stable throughout the condition (*M* = 0.0 RPM). The levels of problem behavior were significantly lower than during the escape and tangible conditions for both FA conditions. Task engagement levels increased during the second concurrent delay condition (*M* = 97.7%) to levels similar to the ones observed during the initial concurrent delay condition (*M* =95.8%). For task engagement, there was an increase above baseline levels (*M* = 66.6%) that was replicated in both treatment conditions. The results for Daniel also suggest that presenting three concurrent choices each correlated to a different delay to reinforcement was effective at decreasing problem behavior. The results show that task engagement increased during the concurrent choice conditions when compared to baseline levels. However, these results should be taken with caution, as a reversal was not obtained with task engagement. These results still show the positive effect of task engagement occurring while problem behavior decreased.

Figure 8

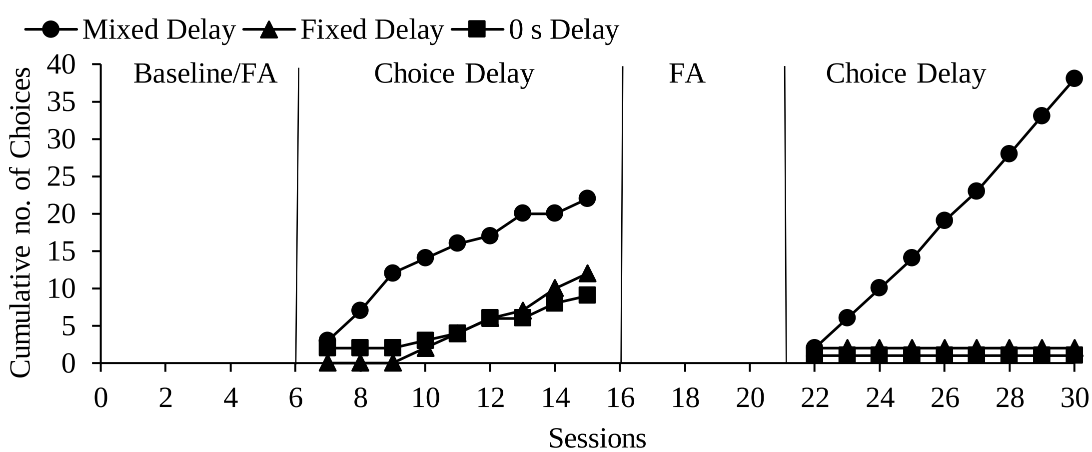
Daniel's Concurrent Choice Evaluation Results



Note. This figure demonstrates Daniel's concurrent choice evaluation results. Choice Delay = Concurrent Choice Delay Condition (i.e., free choice sessions), bx= behavior.

Figure 9

Daniel's Cumulative Number of Choices for Each Delay Alternative



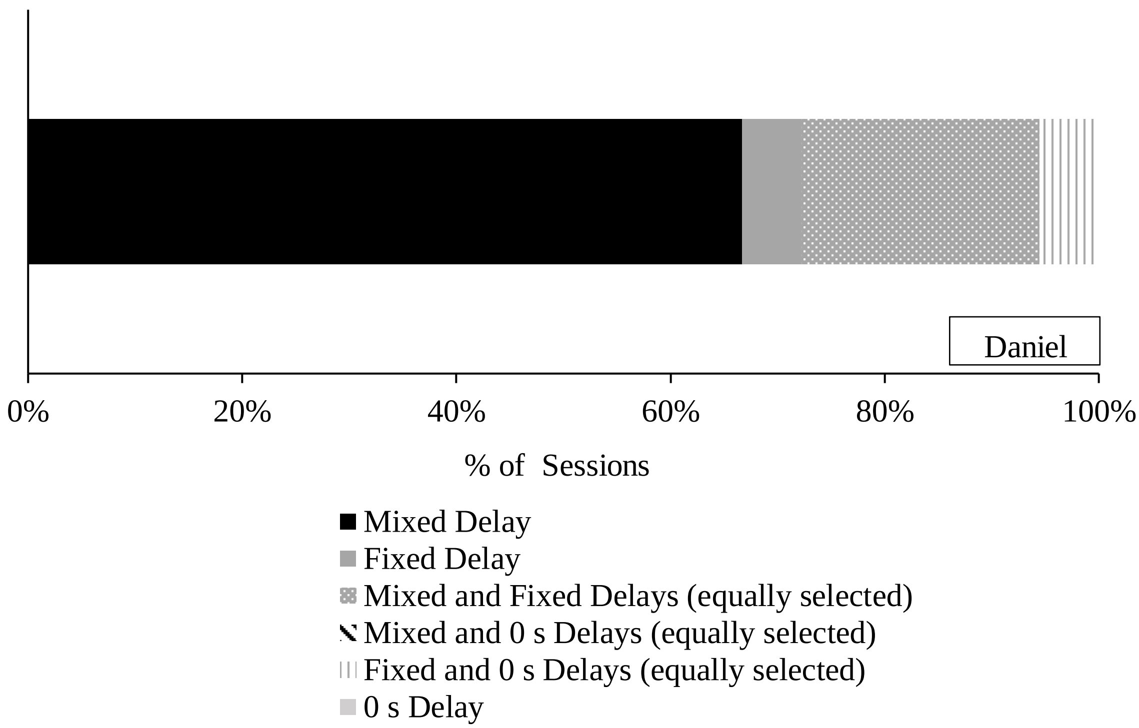
Note. This figure represents the cumulative number of choices for each delay alternative across each concurrent choice delay session. no. = number.

During the initial concurrent choice delay condition (i.e., sessions 7-15), Daniel allocated 22, 12, and nine choice responses toward the mixed, the fixed, and the 0-s delay microswitch, respectively. The cumulative number of choices for the mixed delay alternative (i.e., microswitch) suggested a clear preference for this delay to reinforcement. Upon the second concurrent choice delay implementation, Daniel allocated 38 choice responses toward the mixed delay microswitch. In session 22, Daniel chose the fixed delay twice and the 0-s delay microswitch once. Daniel did not choose the fixed nor the 0-s delay microswitch in any other session. Daniel's data showed a clear preference for the mixed delay to reinforcement over the fixed and the 0-s delay to reinforcement alternatives.

There was a total of 18 sessions (i.e., free choice sessions), across both concurrent choice delay conditions. For most of the trials within a session, Daniel chose the mixed delay microswitch in 66.7% of the concurrent choice delay sessions (12 sessions). The fixed delay microswitch and the 0-s delay microswitches were equally selected in 5.6% of the concurrent choice delay sessions (one session). The fixed delay microswitch was chosen, for most trials within a session, in 5.6% of the concurrent choice delay sessions. Both the mixed delay and the fixed delay microswitches were equally selected in 22.2% of concurrent choice delay sessions (four sessions). This data suggest that Daniel had a clear preference for the mixed delay to reinforcement alternative. Figure 10 displays the percentage of sessions a delay to reinforcement alternative was more frequently selected across both concurrent choice delay conditions.

Figure 10

Percentage of Sessions Each Delay Was Chosen Most Frequently



Treatment Integrity Results

Across both FA conditions, treatment integrity for reinforcement delivery averaged 100% for Leo and 97% (range = 80%-100%) for Noah and Daniel. The average treatment integrity for programming the establishing operation (i.e., EO), was 100% across both FA conditions for all three participants.

For the choice delay conditions (i.e., forced choice sessions and concurrent choice delay sessions), Leo's, Noah's, and Daniel's treatment integrity for delivery and withholding of reinforcement averaged 97% (range = 88.9-100), 94% (range = 80-100), 97% (range = 83.3-100), respectively. For programming the EO, treatment integrity averaged 100% for all three participants. Treatment integrity for the delay to reinforcement across all three delays to reinforcement alternatives averaged 94% (range = 75-100), 98% (range = 83.3-100), 98% (range 80-100) for Leo, Noah, and Daniel.

Social Validity Results

Table 3 shows the mean and the range of responses made by each therapist or caregiver for each question in the modified TARF-R. Each question was rated on a seven-point Likert scale. For most of the questions, a score of 1 meant that the treatment was not effective, not acceptable, or not all suitable. A score of 7 meant that the treatment was very effective, very acceptable, and very suitable. For most questions, the higher the score, the more acceptable and effective the treatment was considered. However, for questions 4, 8, and 9, a score of 1 meant the treatment was not costly at all, no side effects were likely, or the participant did not experience discomfort at all. A score of 7 meant that the treatment was very costly or that the participant experienced a lot of discomfort or side effects. For these questions, a score of a 1 meant the treatment was more acceptable than a score of 7.

In response to questions 1 and 3, Daniel's and Leo's therapists and both Noah's caregivers (100%) reported finding the treatment acceptable and reasonable with a mean rating score of 7.0. In response to question 5, Daniel's therapist and one of Noah's caregivers rated the treatment as effective (i.e., rating of 6). Leo's therapist and Noah's other caregivers rated the treatment as very effective (i.e., rating of 7). The overall rating score for question 5 was a mean of 6.5. In response to questions 2 and 6, both therapists and one of Noah's caregivers rated that they liked the procedures very much and would be willing to carry out the treatment with training (rating of 7). One of Noah's caregivers rated that he or she liked the procedures and was willing to carry out the treatment (rating of 6). The mean rating for both questions was 6.75. Both of Noah's caregivers and Daniel's therapist rated that the treatment was not very costly (rating of 2). Leo's therapist rated the cost of the treatment as "neutral" (rating of 4). The treatment was not costly across all raters (*M* = 2.5, range = 2 to 4). Across all raters, minimal side effects were likely to result from this treatment (*M* = 2.0). In response to question 9, Daniel's therapist reported that Daniel experienced no discomfort during this treatment (rating of 1). Leo's therapist and both of Noah's caregivers, reported that Leo or their child experienced very little discomfort because of the treatment (rating of 2.0). The average rating for the participant experiencing discomfort due to this treatment was 1.75 (range = 1 to 2). For question 10, Leo's therapist considered the procedures very suitable to be incorporated with other behavior interventions and treatments with a rating of 7. Daniel's therapist considered the procedures suitable with a score of 6.0. Overall, across raters the procedures were suitable to be incorporated with other interventions. Regarding question 11, raters considered that other behaviors related to problem behavior would improve or improve a lot with these procedures (*M* = 6.8, range = 6 to 7). Questions 7 and 12 were only answered by Leo's and Daniel's therapists due to them having a better understanding of behavior interventions. For these two questions, both therapists rated that other behaviors related to problem behavior could very likely improve with this treatment and that these procedures could be used within functional communication training and have a positive effect for both Leo and Daniel (*M* = 7). Overall, the treatment received an acceptability score of 67.55 out of 84 possible points (80%).

Table 3

Social Validity Results

Item	Question	*M*	Range
1	How acceptable do you find the treatment regarding problem behavior this individual present(ed)?	7.00	7
2	How willing are you to carry out this treatment with training?	6.75	6 to 7
3	Given this individual's behavioral problems, how reasonable do you find the treatment?	7.00	7
4	How costly will it be to carry out this treatment?	2.5	2 to 4
5	How effective was this treatment for this individual?	6.50	6 to 7
6	How much do you like the procedures used in the treatment?	6.75	6 to 7
*7	Given your observations from the effects of preliminary evaluation on problem behavior and task engagement, how likely do you find these procedures can be used with functional communication training and have a positive impact for this individual?	7.00	7
8	To what extent are undesirable side effects likely to result from this treatment?	2.00	2
9	How much discomfort was this individual likely to experience during this treatment?	1.75	1 to 2
*10	Given this individual's behavioral problems, how suitable would you find these procedures to be incorporated with other behavior interventions and treatments?	6.50	6 to 7
11	To what extent you think that other behaviors related to the problem behavior could also likely improve by using these procedures?	6.75	6 to 7
*12	To what extent you think that other behaviors related to problem behavior could also likely improve by incorporating these procedures within other behavior interventions (e.g., functional communication training)	7.00	7

Note. All items scored in a 1 to 7 Likert point-scale. For most items, higher scores were correlated to better acceptability (e.g., 1 = not all acceptable, 4 = neutral, 7 = very acceptable). However, for items 4, 8, and 9, lower scores meant more acceptability (e.g., 1 = not at all costly, 4 = neutral, 7 = very costly). * = questions that Noah's caregivers were not required to respond

CHAPTER 5: Discussion

The purpose of the current study was to evaluate the effects of presenting three concurrent delays to reinforcement alternatives (i.e., choices; 0-s delay, fixed 15-s delay, and a mixed [0,30-s] delay) within FCT on problem behavior, preference, and task engagement exhibited by individuals with ASD. The current study also aimed to extend and replicate findings from previous basic and applied studies on delays to reinforcement by examining preference between these three delays to reinforcement alternatives when (a) the arithmetic average of the two mixed delays (0, 30-s) equaled the fixed delay (15-s), (b) both the mixed and fixed delay alternatives resulted in high quality reinforcement (i.e., access to high preferred items) for 30 s, and (c) the 0-s delay alternative resulted in low quality reinforcement (i.e., access to low preferred items) for 30 s. A combination of a concurrent and an ABAB reversal single case designs were implemented in the current study to evaluate the effects of a concurrent choice delay condition (i.e., treatment) on problem behavior, preference, and task engagement.

The current study also sought to extend the literature on the implementation of potential procedure variations (i.e., specific delay arrangements) within FCT that could help clinicians address some of the limitations of FCT. For instance, traditional FCT for escape-maintained problem behavior begins with reinforcing a FCR to request for a break using a continuous schedule of reinforcement. FCT often results in increases in FCR rates which, in turn decreases problem behavior. However, task engagement is commonly reported to remain at low levels (Hagopian et al., 2011). This effect brings to question the social validity of FCT for the treatment of escape-maintained problem behavior. Schedule thinning procedures have been beneficial to address this limitation (Hagopian et al., 2011). However, schedule thinning procedures are usually implemented toward the end of the treatment to increase task engagement. During the current study, all three delays to reinforcement alternatives were presented from the beginning of the treatment rather than at the end of treatment. This procedural variation, if observed to be effective, could provide insight on how to increase and maintain task engagement levels while the FCR is emitted at steady levels and problem behavior decreases to near-zero levels. This procedural variation could also increase the social validity of FCT by potentially addressing one of its limitations.

The current chapter will first address the main findings from the current study and how these findings are either supported by or extend the current literature. The current chapter will then address the potential behavioral mechanisms, within the treatment, that could be responsible for the observed effects on the dependent variables (i.e., problem behavior, preference, and task engagement). Last, the current chapter will address the study limitations followed by future research avenues and concluding statements.

Overall Findings

Based on the response allocation to each delay alternative, two out of three participants (Leo and Daniel) demonstrated a preference for the mixed delay (0-s, 30-s) to reinforcement to a fixed 15-s delay and a 0-s delay alternative. One of the two participants (Daniel) demonstrated a clear and reliable preference for the mixed delay over the fixed delay and 0-s delay to reinforcement alternatives. He selected the mixed delay to reinforcement alternative, for most of the trials, in 66.7% of the concurrent choice delay sessions. Both the mixed and fixed delays were equally selected in 22.2% of concurrent choice delay sessions. Even though Leo selected the mixed delay alternative, for most trials within a session, across 9 out of 12 concurrent choice delay sessions, Leo at times would select the fixed 15-s delay within the same session. Therefore, there were sessions in which Leo alternated between the fixed and the mixed delay to reinforcement alternatives. Leo's response allocation across each delay to reinforcement alternative showed a preference for the mixed delay followed by the fixed delay and the 0-s delay. For one of our participants (Noah), even though he selected the mixed delay to reinforcement in 33.3% of concurrent choice delay sessions over the fixed delay (22%) and the 0-s delay (5.6%), a preference between the mixed over the fixed delay could not be identified. Both the mixed and the fixed delay to reinforcement alternatives were equally selected in 33.33% of concurrent choice delay sessions. Drawing conclusions about a preference is not possible for Noah, because his data shows no consistent differentiation between the mixed and the fixed delay to reinforcement alternatives. Noah would alternate between the mixed and the fixed delay alternatives. However, Noah's data suggested that the 0-s delay to reinforcement was least preferred (5.6% of the concurrent sessions) over the two other delay alternatives (fixed and mixed). The response allocations across all three participants suggested that they preferred either the mixed delay or the mixed and fixed delay to reinforcement alternatives to access 30 s of high preferred items to an alternative of a 0-s delay to access 30 s of low preferred items.

These results add to the emerging evidence supporting that applied populations prefer the mixed delay over a fixed delay arrangement and extends this finding to some individuals with autism (Mullane et al., 2017; Mullane et al., 2020). The current study also provides evidence that when the quality and the magnitude of the reinforcement are the same for the mixed and the fixed delay alternatives, some individuals with autism prefer the mixed delays over the fixed delays to reinforcement. The results also provide preliminary evidence that individuals with autism may prefer the mixed and the fixed delay over the 0-s delay when the quality of the reinforcement is manipulated. These results extend the literature on concurrent schedules of reinforcement and the manipulation of reinforcement parameters (e.g., quality of reinforcement) to influence response allocation and preference among delays to reinforcement (e.g., Cicerone, 1976; Davis et al., 2012; Mullane et al., 2020; Peterson et al., 2005; Peterson et al., 2009; Peterson et al., 2017).

Across all three participants, problem behavior decreased to near zero levels across both concurrent delay conditions. When the intervention was withdrawn, levels of problem behavior increased to similar levels to the ones observed during the first FA condition, demonstrating experimental control over problem behavior across participants. Problem behavior was also placed on extinction throughout both concurrent choice delay conditions in the current study. This procedural variation extends Mullane et al.'s (2020) study, in which problem behavior was not initially placed on extinction. Mullane et al. asserted that an element of extinction was needed to reduce problem behavior to near zero levels. The results from our study also demonstrated that after exposing the participants to each delay alternative and its corresponding reinforcement contingencies, the three delays to reinforcement alternatives could be presented concurrently and lead to low levels of problem behavior when problem behavior was placed on extinction.

Regarding task engagement, all three participants engaged in some level of task engagement prior to treatment (i.e., first FA condition). As previously mentioned, one of the limitations of traditional FCT for the treatment of escape-maintained problem behavior is that individuals learn to request a break at high rates, which in turn leads to low levels of task engagement (Hagopian et al., 2011). The results from this study, suggested that task engagement did not decrease during the concurrent choice delay condition. Even though experimental control was not obtained on task engagement for any of our participants, the levels of task engagement remained or were slightly higher than the levels observed during the first and the second FA condition. Across all participants, the results on task engagement showed that contingent upon selecting the fixed 15-s delay or the mixed delay, all participants decided to wait and engage in the non-preferred task (i.e., matching or coloring activity) during the 15-s or the 30-s delay. This was demonstrated by the levels of task engagement observed across both concurrent choice delay conditions. The results from this study provide preliminary evidence that presenting the three delays to reinforcement alternatives concurrently at the onset of the treatment can have positive effects on a) decreasing problem behavior among individuals with autism and b) can prevent task engagement from decreasing. However, there is the possibility that task engagement levels could have also been influenced by the quality of the reinforcement (i.e., high quality) that was delivered upon both the mixed and the fixed delay alternatives.

Behavioral Mechanisms

In this study, the quality of the reinforcement was manipulated to favor the mixed and the fixed delay to reinforcement over the 0-s delay to reinforcement. Manipulating different parameters of reinforcement (e.g., quality, rate, magnitude, and immediacy of reinforcement) using concurrent reinforcement contingencies (i.e., schedules) have demonstrated effects on shifting response allocation from aberrant behaviors to appropriate behaviors (Horner & Day, 1991; Peck et al., 1996; Peck Peterson et al., 2005; Peterson et al., 2009; Peterson et al., 2017). Concurrent schedules are often arranged in which emitting the FCR and engaging in the task produces a more favorable schedule of reinforcement relative to problem behavior or emitting the FCR without engaging in the task (Peck Peterson et al., 2005; Peterson et al., 2009). These applications of manipulating the different parameters of reinforcement within FCT have shown a procedural alternative that increases the possibility of task engagement occurring without the use of traditional schedule thinning procedures. This procedural modification also provides an effective alternative to decrease problem behavior without having to use extinction (Davis et al., 2012; Hock et al., 2002). This alternative can be useful when extinction is not possible to be implemented due to the severity of the problem behavior the individuals display (e.g., elopement). This is especially true when experiencing an extinction burst could place the individual's and others well-being at risk. During an extinction burst, problem behavior increases (i.e., frequency, magnitude, or duration) before it reduces. Implementing extinction may not always be plausible nor safe and alternatives should be considered. However, most researchers have found that extinction may be needed to achieve positive behavior reductions for at least some participants (Fisher et al., 1993; Hagopian et al., 1998; Kelley et al., 2002; Piazza et al., 1997).

This finding also applies to delays to reinforcement. As the schedule of reinforcement is thinned, re-emergence of problem behavior may occur (Hanley et al., 2001; Volkert et al., 2009; Hagopian et al., 2011). Therefore, extinction may have to be implemented to maintain problem behavior to near zero levels as the delay to reinforcement increases (Fisher et al., 1993; Hagopian et al., 1998; Kelley et al., 2002; Piazza et al., 1997). Mullane et al. (2020) implemented in one phase, of his study, equivalent fixed delays for the FCRs and problem behavior and in another phase a mixed delay for FCRs and a fixed delay for problem behavior. Mullane et al. started with a pretraining condition in which they reinforced the FCR in a continuous schedule, then implemented the delays to reinforcement phases previously described. Their results showed that when the FCR was reinforced in a mixed delay and problem behavior in a fixed delay, the FCR decreased and problem behavior increased. When the extinction component was added, the FCR increased and problem behavior decreased. Delay fading was then implemented, and problem behavior remained at zero levels. Mullane et al. suggests that problem behavior may have to be placed on extinction when using mixed and fixed delays to reinforcement and during delay fading. Our study extended Mullane et al. in several ways. First, extinction was used throughout the evaluation. Secondly, the delays to reinforcement (mixed delay, fixed delay, and 0-s delay) were presented since the beginning of the intervention without any pretraining phase that produced immediate reinforcement. Finally, low levels of problem behavior were observed across our three participants. Our participants also continued to make choices (i.e., select a microswitch or colored card; FCR) throughout the evaluation. These findings suggested that mixed and fixed delays to reinforcement may be able to be implemented at the beginning of the treatment when an extinction component for problem behavior is in place and the quality of the reinforcement is manipulated.

Questions regarding how delays to reinforcement could be arranged within concurrent schedules of reinforcement to maintain steady levels of responding toward the appropriate behaviors relative to problem behavior with or without extinction still remain unanswered. One alternative to the delays to reinforcement arrangement that was explored during the current study was the use of variable delays (mixed delays) over constant delays (fixed 15-s delay or 0-s delay). The use of variable (i.e., intermittent) delays appears to increase resistance to extinction whereas the constant delays appear to weaken resistance (Crum et al., 1951). Within the context of FCT, reinforcing the FCR contingent upon a mixed delay to reinforcement of 0 s or 30 s elapsing may maintain the FCR at steady rates. For instance, the mixed delay interval in the current study offered an equal probability of contacting immediate reinforcement during the 0 s (i.e., short interval) than having to wait 30 s (i.e., long interval). There is the possibility that the presence of the short delay being 0 s could have influenced the response allocation in favor of the mixed delay for two of the participants (Mullane et al., 2017; Rider, 1983), thus, maintaining low levels of problem behavior during the long delay. However, we did not do a comparison of different mixed interval values on preference, problem behavior, and task engagement. So, drawing conclusions about the effects of the 0-s value within the mixed delay should be taken with caution. Studies still need to be conducted on how the mixed interval values and the specific delay arrangement can influence resurgence of problem behavior (e.g., prevent the recovery of problem behavior) and whether this helps maintain low levels of problem behavior during the long delay interval of the mixed delay arrangement.

Past studies have shown that response allocation may shift from the FCR to problem behavior during schedule thinning (i.e., delays to reinforcement; Hagopian et al., 2004; Mullane et al., 2017). However, this was not observed during the current study, possibly owing to two reasons. First, problem behavior was placed on extinction. Second, as previously mentioned, the presence of the short delay of 0 s in the mixed delay alternative could have influenced response allocation (Mullane et al., 2017; Rider, 1983). The participant had a 50% chance to obtain immediate reinforcement, which may have influenced and maintained response allocation toward the mixed delay to reinforcement alternative rather than to problem behavior or the other alternatives. Mullane et al. (2017) compared three different mixed-ratio schedules to a fixed-ratio of 5 (i.e., FR-5) schedule with fourth-grade students. Mullane et al.'s findings supported that all of their participants preferred the mixed ratio schedule of 1, 9 over the fixed-ratio 5 schedule (i.e., FR-5). All of their participants preferred to complete 1 or 9 math problems over having to complete 5 math problems. For one of their participants, when the small ratio of the mixed ratio schedule was removed, preference shifted to the fixed-ratio 5 schedule of reinforcement. For example, when the mixed ratio (5,7) was implemented instead of the (1,9) mixed ratio schedule or the (1,11) mixed ratio, the participant selected the fixed ratio 5 schedule. For example, the participant preferred to complete 5 math problems over having to complete 5 or 7 math problems. This finding brings to question the possibility that the ratio or the interval of the mixed delay can influence preference and response allocation.

Another delay arrangement that could have influenced the effects of the concurrent choice delay condition (i.e., treatment) on problem behavior, preference, and task engagement could be the use of discriminative stimuli. During the current study, the use of discriminative stimuli for each delay to reinforcement alternative (i.e., three microswitches and three colored cards) was implemented. There is the possibility that the presentation of the choices functioned as signals of the contingencies. For example, these stimuli could have signaled that: (a) problem behavior was on extinction, (b) availability of low or high preferred items was contingent upon making a choice, and (c) the delivery of the reinforcers and removal of tasks occurred when the corresponding delay interval elapsed. The discriminative stimuli that functioned as the FCRs to make choices could have influence the likelihood of the participant to make a choice (i.e., selecting a microswitch or colored card) for a delay to reinforcement rather than to engage in problem behavior.

This phenomenon has been observed across species, including rats and pigeons (Williams & Lattal, 1999). For example, A.M. Williams and Lattal (1999) arranged a concurrent schedule in which pigeons' pecks on one key did not produce reinforcement and pecks on the other key were reinforced in a tandem schedule consisting of a variable interval of 15 s. The results suggested that pigeons allocated more responses to the key that produced reinforcement than to the key that did not produce reinforcement. This finding provides additional evidence that the reinforcer relation could also be responsible for the response allocation that occurred for each delay to reinforcement alternative in the current study (Stromer et al., 2000).

Previous literature has suggested that discrimination is acquired more rapidly when the stimuli that is presented during the delay-to-reinforcement interval and the consequences that are delivered remain the same across opportunities (Williams, 1999; Stromer et al., 2000). This arrangement makes it more likely for the delay to reinforcement option to be chosen because the stimuli that is presented during the delay predicts reinforcement. This arrangement also creates a response chain. In the current study, there is the possibility that each delay to reinforcement alternative became associated with a different response chain. For instance, each session started with the presentation of the three delay alternatives followed with the verbal statement of "It's time to wait while we work, pick one." Selecting the mixed delay resulted in a 50% likelihood of an intervening stimuli (i.e., task) being presented during the 30-s delay interval. Selecting the fixed delay always resulted in the intervening stimuli being presented during the 15-s delay interval. The colors and the reinforcement contingencies for each delay to reinforcement and the task that was presented (i.e., intervening stimuli) for the mixed and fixed delay remained consistent across the evaluation. These procedures could have influenced the participants being able to discriminate the contingencies for each delay to reinforcement alternative (i.e., response chain) that was available. These procedures could also have become signals that predicted delivery of reinforcement.

Also, there were no consequences contingent upon the participants not working during the interval other than the 3-step prompting procedure and praise. There is the possibility that the presentation of the choices and task signaled availability of high-quality reinforcement for the mixed and fixed delay alternatives, which could have increased the likelihood of the participants in the current study choosing the mixed and the fixed delay. The presentation of the choices and the task could have also become part of a response chain, which could have increased the likelihood of the participants in the current study engaging in the task during the mixed delay (i.e., 30-s) and the fixed 15-s delay. In addition, there were times in the study that the delay would elapse at the same time the participants were engaging in the task. This resulted in access to high quality reinforcement, which could have also increased the likelihood of the participants in the current study choosing the mixed or the fixed delay and engaging on the task over the 0-s delay alternative.

Limitations and Future Research

The purpose of the current study was not to compare whether providing a choice between the three different delays to reinforcement and not providing choices influenced problem behavior and task engagement. Post hoc analyses could be conducted with the current data from the forced choice sessions and the free choice sessions. This is because during the forced choice sessions, each delay to reinforcement alternative was presented in isolation. These sessions were conducted to expose the participants to the different contingencies. However, a choice was not presented. These sessions could be analyzed as probes within the concurrent choice delay condition. This would allow for the comparison between the levels of task engagement and problem behavior across the forced and free trial sessions. However, this post hoc analysis would still not allow a clear comparison. Future studies could explore within a single subject reversal design if providing a choice between these delays to reinforcement versus a forced choice condition influences problem behavior, task engagement, and even preference.

The interval value of the delays did not change throughout the evaluation. The mixed delay was always 0 s or 30 s; the fixed, 15 s; and the 0-s delay, 0 s. Also, the fixed delay interval of 15 s was equivalent to the average of the mixed delay values (0-s, 30-s). Future studies could continue to explore different values of the mixed delay relative to the fixed delay to reinforcement interval and evaluate how these values can affect preference, problem behavior, and task engagement among individuals with autism. For instance, the shortest value of the mixed delay interval could be the same value as the fixed delay used in the current study and the longest interval could be 18 seconds rather than 30 seconds. This will allow for a comparison of an equal lean mixed interval (e.g., 15-s, 18s) to the fixed interval of 15 s. This could also be explored with the mixed schedule increasing by 20% for the longer interval (e.g., 0-s, 36s) and the fixed interval remaining 15 s. There are some studies that have evaluated preference among different values of the mixed delay (e.g., intervals and ratios) relative to different fixed delay values (e.g., intervals and ratios) across species (Cicerone, 1976; Hagopian, et al., 2001; Rider, 1983; Mullane et al., 2017). None of these studies have evaluated different mixed delay values and their effects on problem behavior among individuals with ASD.

Until the present study, no applied study had manipulated the quality of reinforcement for a mixed delay, a fixed delay, and a 0-s delay with individuals with ASD. There are other applied studies that have investigated quality of reinforcement and response allocation within problem behavior, the FCR, and task engagement using concurrent schedules of reinforcement (e.g., Peck Peterson et al., 2005; Peterson et al., 2017). However, the quality and the magnitude of the reinforcement could be further investigated in the context of mixed delays to reinforcement. To this date, no applied study has manipulated the quality and the magnitude of the reinforcement for different mixed delays to reinforcement intervals and evaluated the effects on preference, problem behavior, and task engagement within individuals with ASD.

As previously mentioned, one common concern with the use of delays to reinforcement is that increasing the delay can lead to resurgence of problem behavior (Hanley et al., 2001; Volkert et al., 2009; Hagopian et al., 2011). The current study's findings provide some additional evidence that implementing the delay to reinforcement at the beginning of treatment may still lead to socially valid problem behavior reductions and task engagement levels. Future studies could explore within a single case design, if providing the mixed delay to reinforcement at the beginning of FCT mitigates resurgence of problem behavior. This could also be extended to evaluate whether the shortest value of the mixed delay must produce immediate reinforcement (0-s or 1s) in order for problem behavior to remain at near-zero levels during the longer intervals. This could also be done as an operant study or using an analogue to problem behavior.

During our study, all three participants engaged in some level of task engagement prior to treatment and experimental control on task engagement was not obtained. Future research should replicate the current study with other participants who do not engage in task engagement prior to treatment. Future studies could also conduct a demand latency assessment (Call et al., 2016) to identify the task and see if this could influence task engagement. During our study we used an indirect assessment (i.e., NRRS; Zarcone et al., 1999) rather than a direct assessment. There is the possibility that the task that was chosen for each participant was not as aversive to the participants as the therapists and caregivers reported. Also, exploring different academic tasks of varying difficulty would be interesting to evaluate how response effort could influence preference for mixed delays over fixed delays and a 0-s delay to reinforcement alternatives. Future studies could also implement mixed delays to reinforcement within mand training (i.e., beginning of FCT) to evaluate its effects on the acquisition of the FCR, problem behavior, and task engagement among individuals with ASD. Future studies could also compare the levels of problem behavior and task engagement when implementing mixed delays to reinforcement at the beginning of FCT versus at the end of FCT.

Concluding Statement

From the current study we can conclude that presenting three delays to reinforcement alternatives (i.e., mixed delay (0, 30-s), fixed delay (15-s), and 0-s delay) concurrently and manipulating the quality of the reinforcement for each delay to reinforcement arrangement, was successful at decreasing problem behavior for three individuals with ASD. Task engagement remained at socially valid levels throughout the concurrent choice delay conditions. From the current study, we have some preliminary evidence that implementing these three delays to reinforcement alternatives, which included a mixed, fixed, and 0-s delay to reinforcement at the beginning of treatment could have positive effects at decreasing problem behavior and maintaining high levels of task engagement. Practitioners should be aware that, in this evaluation, the arithmetic average of the two mixed delays (0-s, 30-s) equaled the fixed delay of 15 s. As practitioners, we are responsible to continue offering the most effective and socially valid treatments to individuals with ASD. Finding specific delay arrangements and procedural modifications that can influence the effectiveness and the social validity of behavioral interventions (e.g., FCT) is warranted.

Providing choices and considering the individuals' preferences are other ways to increase the social validity of a behavioral intervention. The results from the current study added to the literature on preference among variable (i.e., mixed delays) and constant delays (fixed 15-s, 0-s). The results of the current study also extended the literature regarding quality of reinforcement manipulation and concurrent schedules of reinforcement. The results from this study showed the preference for three delays to reinforcement alternatives when the quality of the reinforcement was the same for the mixed and fixed delay to reinforcement (e.g., high quality) and differed from the 0-s delay to reinforcement (e.g., low quality). Preference was observed for the mixed delay to reinforcement alternative for two participants. The third participant equally preferred the mixed and the fixed delay to reinforcement alternatives. The participants allocated more responses to the alternatives that produced high-quality reinforcement over the delay to reinforcement alternative that produced a low-quality reinforcement. Considering individuals with ASD's preferences and the factors that can influence preference is important to develop effective and feasible interventions within applied behavior analysis.

The results of the current study, in addition to previous studies, provides a framework for future researchers to explore how specific delay arrangements (e.g., mixed delays) may decrease problem behavior and maintain appropriate behaviors in the natural environment. Additional research is still warranted on delays to reinforcement but especially on the application of mixed delays to reinforcement in behavioral interventions. This research would increase the social validity and generalizability of behavioral interventions.

Appendices

Appendix A

Social Validity Questionnaire (Modified TARF-R)

SOCIAL VALIDITY RATING SCALE
(Based on the Treatment Acceptability Form-Revised (TARF-R)
(Reimers, T., Wacker D., Cooper, L., & DeRaad, A., 1992)

Please complete the items listed below by placing a checkmark on the line under the question that best indicates how you feel about the treatment

1. How acceptable do you find the treatment to be regarding the problem behavior this individual presents(ed)?

________	_______	________	________	_______	_________	________
Not at all acceptable			Neutral			Very acceptable

2. How willing are you to carry out this treatment with training?

________	_______	________	________	_______	_________	________
Not at all willing			Neutral			Very willing

3. Given this individual's behavioral problems, how reasonable do you find the treatment?

________	_______	________	________	_______	_________	________
Not all reasonable			Neutral			Very reasonable

4. How costly will it be to carry out this treatment?

________	_______	________	________	_______	_________	________
Not all costly			Neutral			Very costly

5. How effective was this treatment for this individual?

________	_______	________	________	_______	_________	________
Not at all effective			Neutral			Very effective

6. How much do you like the procedures used in the treatment?

________	_______	________	________	_______	_________	________
Do not like them at all			Neutral			Like them very much

7. Given your observations from the effects of preliminary evaluation on problem behavior and task engagement, how likely do you find these procedures can be used with functional communication training and have a positive impact for this individual?

________	_______	________	________	_______	_________	________
Not at all likely	Somewhat not likely	Slightly not likely	Neutral	Slightly likely	Somewhat likely	Very Likely

8. To what extent are undesirable side effects likely to result from this treatment?

________	_______	________	________	_______	_________	________
No side effects are likely			Neutral			Many side effects are likely

9. How much discomfort was this individual likely to experience during the course of this treatment?

________	_______	________	________	_______	_________	________
No discomfort at all			Neutral			Very much discomfort

10.- Given this individual's behavioral problems, how suitable would you find these procedures to be incorporated with other behavior interventions and treatments?

________	_______	________	________	_______	_________	________
Not all suitable			Neutral			Very suitable

11.- To what extent you think that other behaviors related to the problem behavior could also likely improve by using these procedures?

________	_______	________	________	_______	_________	________
Not improve at all			Neutral			Improve a lot

12. To what extent you think that other behaviors related to problem behavior could also likely improve by incorporating these procedures within other behavior interventions (e.g., functional communication training)?

________	________	________	________	________	________	________
Not all likely			Neutral			Very likely

Appendix B

Forced Choice Session Data Sheets

Forced Choice Data Sheet (New Day or Every 4th session)

Forced Choice session # ____________ Date: _____________ Participant: ___________

Forced Choices	Problem Bx	Notes

Forced Choice session # ____________ Date: _____________ Participant: __________

Forced Choices	Problem Bx	Notes

Notes:

Appendix C

Free Choice Session Data Sheets

Choice Delay Session Data Sheet

Session # ____________ Date: _____________ Participant: ___________

Opp. To make choice	Choice Made & Position (L, M, R) Black/Blue—0-s. Purple—Fixed 15-s – Green—Mixed (0-s-30-s)						Problem Bx Frequency	Task Engagement Duration
1	B	P	G	*L*	*M*	*R*		
2	B	P	G	*L*	*M*	*R*		
3	B	P	G	*L*	*M*	*R*		
4	B	P	G	*L*	*M*	*R*		
5	B	P	G	*L*	*M*	*R*		
6	B	P	G	*L*	*M*	*R*		
7	B	P	G	*L*	*M*	*R*		
% or totals				*N/A*	*N/A*	*N/A*		

Session # ____________ Date: _____________ Participant: ___________

Opp. To make choice	Choice Made & Position (L, M, R) Black/Blue—0-s. Purple—Fixed 15-s – Green—Mixed (0-s-30-s)						Problem Bx Frequency	Task Engagement Duration
1	B	P	G	*L*	*M*	*R*		
2	B	P	G	*L*	*M*	*R*		
3	B	P	G	*L*	*M*	*R*		
4	B	P	G	*L*	*M*	*R*		
5	B	P	G	*L*	*M*	*R*		
6	B	P	G	*L*	*M*	*R*		
7	B	P	G	*L*	*M*	*R*		
% or totals				*N/A*	*N/A*	*N/A*		

Notes:

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