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An Evaluation of Distributed and Accumulated Reinforcer Arrangements on Skill Acquisition and Preference

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by

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DEDICATION

I dedicate this dissertation to my late grandfather Jules Rose. Thank you for advocating for me and providing me the opportunity to succeed academically. Your unwavering support allowed me to reach this milestone.

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ABSTRACT

Discrete trial training (DTT), an evidence-based instructional procedure (Wong et al., 2015), is often used to teach skills to individuals with autism. Manipulations to the reinforcement component of DTT have increased its instructional efficiency, resulting in acquisition of skills in less time (e.g., Cividini-Motta & Ahearn, 2013). Results of previous studies (e.g., DeLeon et al., 2014) indicate that some individuals prefer to complete larger work requirements that result in a larger amount of a reinforcer (i.e., accumulated arrangement), rather than receiving access to small amounts of a reinforcer dispersed throughout the work requirement (i.e., distributed arrangement). In addition, accumulated reinforcer arrangements have been shown to be more efficient in increasing target responses (e.g., response rate; Robinson & St. Peter, 2019). However, few studies have evaluated the impact of these reinforcer arrangements on skill acquisition and the literature comparing the effects of these reinforcer arrangements on efficiency and/or participant preference primarily included adolescent participants and only activity-based reinforcers. Therefore, the purpose of this study was to determine the efficacy and efficiency of DTT programs that included accumulated and distributed reinforcer arrangements with both edible and activity-based reinforcers. Participants were two young children with autism. Overall, the distributed arrangements required fewer sessions and the distributed with edibles arrangement was associated with the shortest duration to mastery and least amount of disruptive behavior. Participants preferred the distributed with edible or activity arrangement. Finally, caregivers and clinical team members agreed both types of arrangements and reinforcers are acceptable.

CHAPTER ONE:

INTRODUCTION

Discrete Trial Training

Individuals diagnosed with an autism spectrum disorder (ASD) tend to acquire skills more slowly or in a different manner than their typically developing peers. For instance, Bredekamp and Copple (1997) suggested that typically developing children (TDC) may continually learn from their environment through observation and interactions with others. However, in comparison to TDC and children with Down Syndrome, children with autism (CWA) have fewer communication, daily living, and social skills (Rodrigue et al., 1991), indicating that many CWA may not readily acquire new skills. There are several plausible reasons why individuals with an ASD may learn skills more slowly than TDC. Reduced acquisition of skills may be due to fewer social initiations (Lerman et al., 2016; Sigafoos et al., 2019), reduced information seeking (Young et al., 2016), and possible comorbid intellectual disabilities (Matson & Shoemaker, 2009). Therefore, for CWA, direct teaching of a variety of skills using a structured instructional approach that allows for increased learning opportunities (Lerman et al., 2016; Sigafoos et al., 2019) may be imperative (Smith, 2001).

Discrete trial training (DTT) is a structured and systematic method for teaching skills that simplifies and individualizes instruction (Smith, 2001). It has been suggested that DTT is the most extensively researched (Smith, 2001) and commonly used teaching procedure for individuals with an ASD (Lerman et al., 2016). In a recent review of multiple comparative studies on the efficacy of DTT, Lerman et al. (2016) concluded that individuals assigned to a group receiving DTT had, in comparison to the control groups, more substantial gains in various skills and more notable symptom and problem behavior reduction. Furthermore, DTT is an evidence-based procedure for CWA (Odom et al., 2010; Wong et al., 2015).

According to Konrad et al. (2011), currently available evidence-based instructional methods may not be efficient or efficacious enough to allow individuals with disabilities to catch up academically with other TDC. Therefore, instructional time must be maximized by employing not only effective but also efficient procedures. Instructional efficiency refers to the number of skills a learner acquires in a specific time frame (Konrad et al., 2011; Skinner et al., 2002). Thus, indexes of instructional efficiency include time and number of trials or sessions to reach mastery criteria (Vladescu & Kodak, 2013). Given that DTT is a multi-component instructional procedure that includes the presentation of a discriminative stimulus or instruction, an optional prompt, the learner's response, and a consequence (i.e., reinforcer delivery; error correction) (Smith, 2001), it is likely that variations within each of these components may impact its efficacy and efficiency.

Antecedent Variations in Discrete Trial Training

Every discrete trial begins with an antecedent component that includes a discriminative stimulus and at least in some cases, prompts. A discriminative stimulus is a specific antecedent stimulus that is present when a certain response is reinforced (Miltenberger, 2016); this stimulus signals the availability of reinforcement for a specific response (Tarbox & Najdowki, 2008). The type of discriminative stimulus used in a discrete trial depends on the type of target response. For instance, in the case of a tact training trial, the discriminative stimulus may include a two or a three-dimensional depiction of the non-verbal stimulus associated with that tact (e.g., for the tact “ball” the antecedent stimulus could consist of a picture of or an actual ball). Results of previous studies suggest the type of discriminative stimuli used may differentially impact acquisition. For instance, in Salmon et al. (1986), three-dimensional objects led to faster acquisition and greater generalization of tacts than two-dimensional pictures. Similarly, the participants in a study by Partington et al. (1994) required less time to acquire tacts when taught with three-dimensional items in comparison to two-dimensional pictures.

In addition to the discriminative stimulus, response and stimulus prompts may also be included in the antecedent portion of DTT. A prompt is a supplementary stimulus that assists the learner in engaging in the correct response (Tarbox & Najdowki, 2008). Response prompts involve the behavior of another person (Miltenberger, 2016), and can include physical, model, verbal, and gestural prompts (Wolery & Gast, 1984). Examples of response prompt fading procedures, as reviewed by Collins et al. (2018), include graduated guidance (Wolery et al., 1992), most-to-least prompting (Demchak, 1989), least-to-most prompting (Doyle et al., 1988), simultaneous prompting (Morse & Schuster, 2004), and time delay (Walker, 2007). Stimulus prompts, on the other hand, involve temporary modifications to the discriminative stimulus (Cengher et al., 2017) and include extra-stimulus prompts and within-stimulus prompts. In the case of extra-stimulus prompts, one or more additional stimuli are presented in conjunction with the discriminative stimulus; once correct responding occurs, these prompts are systematically reduced (Schreibman, 1975). A within-stimulus prompt involves directly altering the discriminative stimulus (i.e., a dimension of the stimulus is changed); this alteration is faded once correct responding occurs (Green, 2001).

Various studies have evaluated acquisition of skills across different types of prompting procedures. For instance, Markham et al. (2018) showed physical prompts were more effective, in comparison to gestural and model prompts, for two out of three participants in fostering acquisition of receptive identification during DTT. Additionally, all participants preferred the physical prompt. Leaf et al. (2016) assessed acquisition of tacts across two prompting procedures, most-to-least and flexible prompt fading. Both procedures were efficacious for all four participants; however, for three participants the flexible prompt fading procedure was the more efficient in terms of the number of trials, sessions, and amount of time to mastery. Lastly, research has also assessed the use of supplemental prompts alongside a non-vocal discriminative stimulus (e.g., "what is it?" when teaching tacts). For instance, in a study by Marchese et al. (2012) two of the four participants acquired tacts more efficiently when the supplemental prompt was omitted. Results of previous research indicate that the type of discriminative stimuli (i.e., vocal or non-vocal), the inclusion of supplementary prompts (e.g., “what is it?”), as well as the type of prompt and prompt fading procedure can differentially affect acquisition of novel skills during DTT.

Consequence Variations in Discrete Trial Training

Two common consequences delivered during a DTT program include the implementation of an error correction procedure and the delivery of a reinforcer. Specifically, reinforcers are usually delivered for correct responses emitted following the antecedent discriminative stimulus (Smith, 2001) whereas appetitive consequences (e.g., preferred items, reinforcers) are withheld following an incorrect response. Furthermore, an error correction procedure, which may or may not include a prompt to emit the target response (Smith, 2001), is often implemented contingent on errors. However, during certain error correction procedures, an appetitive consequence is delivered contingent on prompted correct response (e.g., Carroll et al., 2015). Additionally, it has been recommended that DTT programs include differential reinforcement to help promote correct responding (e.g., Grow & LeBlanc, 2013). Differential reinforcement within a skill acquisition program entails manipulating reinforcement to favor independent correct responding (Johnson et al., 2017). Variations to the types of consequences (i.e., type of error correction; type of differential reinforcement) within a DTT program may affect learning outcomes.

Error Correction

There are many types of error correction procedures and these procedures usually differ in regard to the delivery of reinforcers for correct responses emitted during the error correction procedure, the number of additional opportunities to respond, and the representation of the original discriminative stimulus (e.g., Carroll et al., 2015). For instance, Carroll et al. (2015) assessed the effects of four commonly used error correction procedures on acquisition of expressive responses by learners with an ASD or attention deficit hyperactivity disorder (ADHD). A specific error correction procedure (i.e., re-present until independent) led to faster acquisition for three of five participants. Similarly, Kodak et al. (2016) assessed the effects of five error correction procedures on acquisition of an expressive task by CWA. The error correction procedure termed demonstration (i.e., experimenter demonstration of the correct response following an incorrect response) was the most efficient for three participants and was one of the two most efficient interventions for a fourth participant in terms of number of sessions and exposures, and/or minutes to mastery criteria. Additionally, four out of the five participants demonstrated a preference for one of the error correction procedures, but only one participant's preference aligned with the most efficient procedure. The results of these studies suggest that specific error correction procedures may lead to more efficient acquisition of skills and that learners may prefer different types of error correction procedures.

Iterations of Differential Reinforcement in Discrete Trial Training

The delivery, and in some cases withholding, of a reinforcer is another component of a DTT program. Differential reinforcement within skill acquisition may involve reinforcement for any correct responses and extinction (i.e., no consequences) for errors (Cividini-Motta & Ahearn, 2013). For the purposes of this paper, this procedure will be termed differential reinforcement of correct responses (DR/CR). However, differential reinforcement can also be in effect for correct independent and correct prompted responses (e.g., Cividini-Motta & Ahearn, 2013; Karsten & Carr, 2009). That is, a more potent reinforcer is delivered for correct independent responses whereas correct prompted responses result in a less potent reinforcer or no consequences. In fact, a common recommendation for skill acquisition programs is to provide high-quality reinforcers for correct independent responses rather than prompted correct responses (Anderson et al., 1996; Lerman et al., 2016; Sundberg & Partington, 1998). Within this paper, this procedure will be termed differential reinforcement of independent correct responses (DR/ICR). Furthermore, previous studies have also assessed, in the content of differential reinforcement procedures, the effects of different types of reinforcers (i.e., types of praise, types of tangibles) and various reinforcer parameters (i.e., quality, immediacy, magnitude) on acquisition of skills.

Types of Reinforcers. Results of a survey of clinicians (Graff & Karsten, 2012) indicated that clinical programming often includes a variety of reinforcers such as social attention, tokens, breaks, edibles, toys, physical activity, sensory items, and community-based activities. A few studies have compared the effects of different types of reinforcers on acquisition of skills during DTT. For instance, Leaf et al. (2014) examined the effects of four types of consequences within an DR/CR procedure on acquisition of tacts by three CWA. Correct responding resulted in edibles, social reinforcers (i.e., high-fives, dance, etc.), tangibles, or feedback (i.e., saying "yes" for a correct response). Incorrect responses in all conditions resulted in the experimenter saying “no” and stating the correct response. All conditions were efficacious; however, all participants acquired tacts in fewer teaching sessions when edibles were delivered as the consequence for correct responding.

One procedural variation related to the type of reinforcer included in a DTT program is the type of praise statement delivered following a correct response (Lerman et al., 2016). A common recommendation is to use behavior-specific praise which involves the inclusion of the targeted behavior within the praise statement (e.g., "Nice job tying your shoes") (e.g., Maurice et al., 1996). In comparison, general praise entails a broader praise statement that does not specify the target behavior (e.g., “good job “) (Polick et al., 2012). Previous research has compared the impact of different types of praise statements, in combination with prompting and/or error correction (Polick et al., 2012; Senn et al., 2019; Stevens et al., 2011) and without prompting and error correction (Mandel et al., 2020) on acquisition. Results indicated that when the effects of the two types of praise statements combined with prompting and/or error correction were compared, differences on rate of acquisition of intraverbals (Polick et al., 2012) or tacts (Senn et al., 2019; Stevens et al., 2011) were marginal. However, Mandel et al. (2020) found when these types of praise statements were compared within a DR/CR procedure, but without the use of prompting or error correction, behavior-specific praise was more efficient in acquisition of receptive identification for two of three participants. The results of Leaf et al. (2014) and Mandel et al. (2020) suggest the use a specific reinforcer may differentially affect the efficiency of a DTT program.

Reinforcer Quality. A few studies have evaluated the impact of differing qualities of reinforcers on acquisition (e.g., Cividini-Motta & Ahearn, 2013; Karsten & Carr, 2009). Both of these studies assessed acquisition of target skills across a differential reinforcement procedure favoring independent correct responses (i.e., DR/ICR; high-quality reinforcer for correct independent responses; low-quality reinforcer for prompted correct responses) in comparison to a condition in which all correct responses resulted in a high-quality reinforcer (i.e., DR/CR; same high-quality reinforcer for prompted and independent correct responses). However, Cividini-Motta and Ahearn (2013) also included a second DR/ICR procedure in which prompted correct responses did not result in any reinforcement. Karsten and Carr (2009) showed, both conditions were efficacious, but overall, participants mastered more targets in the DR/ICR condition. In Cividini-Motta and Ahearn, three of the four participants acquired the skills faster in the DR/ICR condition in which correct prompted responding was reinforced with low quality reinforcer; whereas, for the fourth participant the DR/ICR procedure in which correct prompted responding was not reinforced was most efficacious. Results of these studies indicate that the manipulations of reinforcer quality can increase efficiency of DTT programs; specifically, the exclusive delivery of high-quality reinforcers for independent correct responses can lead to faster skill acquisition.

Reinforcer Immediacy. One reinforcer parameter that may affect the efficiency of instructional procedures is the delay to reinforcer delivery. The immediate delivery of a reinforcer is recommended (e.g., Lovaas, 2003) and supported (e.g., Carroll et al., 2016). For instance, Carroll et al. (2016) evaluated acquisition of tacts by two CWA across three reinforcement conditions: immediate reinforcement, delayed (i.e., 10 s) reinforcement with immediate praise, and delayed (i.e., 10 s) reinforcement with delayed praise. The reinforcers used in all conditions were edibles or toys combined with praise. This study also included a DR/ICR procedure; however, that procedure was implemented only after each participant engaged in independent correct responding on at least 50% of the trials across two consecutive sessions. That is, prior to reaching this criterion, both correct prompted and independent responses resulted in the same reinforcer (i.e., DR/CR). Both participants met mastery criterion in fewer sessions in the immediate reinforcement condition and although one participant acquired tacts across all conditions, the other only acquired the tacts when reinforcement was delivered immediately. In a similar study, Majdalany et al. (2016) examined the acquisition of tacts by three CWA within a DR/ICR procedure with a 0 s, 6 s, and 12 s delay to reinforcer delivery. Independent responses resulted in either immediate or delayed access to an edible and praise, whereas, prompted responses resulted in immediate or delayed praise. In this study, two out of three participants acquired tacts in fewer sessions when the reinforcer was delivered immediately after each correct response suggesting that even short delays (i.e., 6 s) to reinforcer delivery may affect learning outcomes. Results of these studies indicate that the immediacy of reinforcer delivery can impact the efficacy and efficiency of instructional procedures.

Magnitude. Similarly, magnitude (i.e., intensity of the reinforcer) (Paden & Kodak; 2015) is a reinforcer parameter that can affect efficiency of and preference for different instructional procedures. For example, Paden and Kodak (2015) evaluated the effects of reinforcer magnitude on participant preference and on acquisition of auditory-visual discriminations or tacts by four CWA. The experimental conditions in this study included large edibles (with praise), small edibles (with praise), and praise only. A modified DR/ICR procedure was implemented during both of the edible conditions; the specified sized edible and praise were delivered for independent and prompted correct responding (DR/CR) until independent responding was above 50% for two consecutive sessions; during subsequent sessions, praise alone was delivered for prompted correct responses. In the praise only condition, brief praise was provided contingent on independent and prompted correct responses. Additionally, participant preference was measured through a concurrent operant arrangement. All participants preferred the larger magnitude reinforcer. However, in terms of efficiency, the larger magnitude reinforcer condition resulted in the longest or second longest duration of training time to meet mastery criteria for all participants; nevertheless, one participant met mastery criteria in this condition in the least number of sessions. Results of this study indicate that the magnitude of a reinforcer may impact the efficiency of instructional procedures and participant preference.

Iterations of Reinforcer Arrangements (Distributed/Accumulated). The arrangement of reinforcer delivery employed can impact efficacy, efficiency, and participant preference (e.g., DeLeon et al., 2014). Many teaching programs for individuals with an ASD involve brief access to reinforcers after a small number of responses but, with some stimuli (e.g., activity-based reinforcers), the reinforcing value may depend on the continuity of access to that stimulus (DeLeon et al., 2014). In a distributed arrangement, a reinforcer is delivered immediately after a specific response requirement is met; both the duration or amount of the reinforcer and the response requirement are usually small (DeLeon et al., 2014). For example, a learner may receive access to a video for 30 s immediately after emitting one instance of a correct response. An accumulated arrangement involves banking a specified parameter of reinforcement (i.e., time, quantity) through an instructional period or larger work requirement; the entire quantity of the reinforcer is delivered at the end of the period or larger work requirement (DeLeon et al., 2014). For example, a learner may earn 30 s of a video contingent on every target response; after 10 trials, the learner receives access to the video for the total duration of time accrued during the session (e.g., 300 s).

I identified 13 peer-reviewed published studies that compared distributed and accumulated reinforcer arrangements with human participants; however, only three of these studies compared these arrangements in the context of skill acquisition within DTT (Frank-Crawford et al., 2019; Joachim & Carroll, 2018; Kocher et al., 2015). All studies within this literature review evaluated participant preference for the two arrangements. In seven studies the majority (Falligant et al., 2020; Frank-Crawford et al., 2019) or all (Bukala et al., 2015; DeLeon et al., 2014; Falligant & Kornman, 2019; Fienup et al., 2011; Ward-Horner et al., 2014) of the participants preferred the accumulated arrangement. In three other studies, preference for these arrangements was idiosyncratic (Fulton et al., 2020; Joachim & Carroll, 2018; Kocher et al., 2015) and in one study no preference hierarchy was identified (Weston et al., 2020). Furthermore, in only two studies the majority or all of the participants preferred the distributed arrangement; however, the participants in these studies were all young children (Ward-Horner et al., 2017) or children diagnosed with ADHD (Robinson & St. Peter, 2019). Overall, these results indicate that the accumulated arrangement is often preferred.

Across these articles, the effects of these two reinforcer arrangements were evaluated across a variety of dependent measures including response rate (DeLeon et al., 2014; Robinson & St. Peter, 2019; Weston et al., 2020), session duration (Bukala et al., 2015), transition duration (i.e., time within a session not engaged in work or reinforcer consumption) (Bukala et al., 2015), reinforcer engagement (Kocher et al., 2015), response accuracy (Robinson & St. Peter, 2019), compliance to complete a task (Fulton et al., 2020), and reduction of problem behavior (Fulton et al., 2020; Robinson & St. Peter, 2019). The results of the majority of these studies indicate that the accumulated arrangement may be the most effective and efficient in terms of response rate (DeLeon et al., 2014; Robinson & St. Peter., 2019; Weston, 2020), session duration (Bukala et al., 2015; Kocher et al., 2015), transition duration (Bukala et al., 2015), response accuracy (Robinson & St. Peter; 2015), and reduction of problem behavior (Fulton et al., 2020; Robinson & St. Peter, 2019). However, only three of these studies (Frank-Crawford et al., 2019; Joachim & Carroll, 2018; Kocher et al., 2015) assessed the effects of accumulated and distributed reinforcer arrangements on acquisition of skills in the context of a DTT program.

For instance, Kocher et al. (2015) evaluated the effects of the different reinforcer arrangements on the speed of skill acquisition, generalization, and preference. During the distributed arrangement (termed: discontinuous), correct responding resulted in checkmarks and were exchanged (FR5 or FR10) for 1 min with a preferred activity. In the accumulated arrangement (termed: continuous), correct responding also resulted in checkmarks but higher amounts (FR25 or FR50) were required to access 5 min with a preferred activity. Across both conditions, DR/ICR was implemented in which a prompted correct response resulted in one checkmark and an independent correct response resulted in two checkmarks. Error correction was implemented for errors. In terms of efficiency, across all participants the cumulative duration of sessions was shorter during the accumulated arrangement condition and for three of the five comparisons, mastery criterion was met in fewer sessions in the accumulated arrangement. Regarding efficacy, two participants acquired the target skills with both arrangements, but the third participant only acquired the skill in the accumulated condition. Furthermore, the distributed arrangement was associated with more correct responding during the generalization probes for three out of five comparisons. Finally, one participant preferred the accumulated arrangement, another preferred the distributed arrangement, and one participant did not demonstrate a consistent preference. Overall, the results of this study suggest that an accumulated arrangement could be the more efficient regarding skill acquisition, but participant preference may be idiosyncratic.

Joachim and Carroll (2018) assessed the effects of four different consequences for correct responding on acquisition of expressive tasks (i.e., reading sight words, tacting, intraverbals). Four treatment conditions were evaluated: prompt, praise (i.e., behavior-specific), distributed (termed: tangible), and accumulated (termed: tokens). Across all treatment conditions, prompts and error correction were implemented. Additionally, a modified DR/ICR procedure was implemented in which DR/CR was used until independent correct responding for 50% of trials across two sessions; after that criterion was met, prompted responses resulted in general praise only (e.g., “good”). During the prompt condition, no programmed consequences occurred for correct responding. The praise condition differed in that a correct response resulted in immediate behavior-specific praise. During the distributed and accumulated arrangement conditions, either an activity or an activity or edible (for only two participants) was delivered alongside praise for correct responding. During the distributed condition 25 s with the activity or a small edible was delivered immediately contingent on a correct response; during the accumulated condition a token signifying 25 s or a small edible was delivered immediately contingent on a correct response and the total duration or amount of the reinforcer earned was delivered at the end of the session. After the acquisition evaluation, preference was assessed. During the acquisition portion, one participant did not acquire any target skills. For the other three participants, in terms of total sessions to mastery, the accumulated condition was the most efficient for two participants and the distributed condition was the most efficient for one participant. One participant equally preferred the accumulated and distributed condition, another equally preferred the praise and accumulated condition, another preferred the accumulated condition, and the last participant preferred the praise condition. Overall, these results suggest that, in comparison to a distributed arrangement, the accumulated arrangement may result in faster acquisition, but participant preference may be idiosyncratic.

Lastly, Frank-Crawford et al. (2019) examined the preference, efficiency, and efficacy of accumulated and distributed reinforcer arrangements on acquisition of academic skills. The first experiment examined preference for a distributed arrangement, accumulated arrangement, and accumulated arrangement with tokens for both mastered and unmastered tasks. In this study, a DR/ICR procedure was implemented across all conditions and experiments. Correct independent responding in the distributed condition resulted in immediate praise and 30 s with the preferred activity. In the accumulated condition 30 s was banked for each correct independent response and the total time earned was delivered at the end of 10 trials; the accumulated with tokens condition differed in that a token was delivered immediately after a correct response signifying 30 s earned. For both mastered and unmastered tasks, four participants preferred one of the accumulated arrangements and the fifth participant preferred the distributed arrangement. The second experiment sought to determine the efficacy and efficiency of these reinforcer arrangements on skill acquisition. During baseline and training, prompting, praise, and error correction were used. Additionally, during the training phase correct responding was reinforced according to the same reinforcer arrangements in experiment 1. Overall, across three participants, fewer sessions to mastery were required in the accumulated with tokens condition in four evaluations, in the accumulated condition in two, and in the distributed in one. Additionally, in six out of seven evaluations, mean task duration and total duration to mastery were shorter during one of the accumulated conditions. Regarding efficacy, mastery criteria were not met in the distributed condition for two analyses while mastery criteria for accumulated conditions were met in all but one analysis. Therefore, the results of this study indicate that an accumulated reinforcer arrangement may be more efficient and preferred.

In summary, the findings of these three studies indicate that an accumulated arrangement may more efficient than a distributed arrangement (Frank-Crawford et al., 2019; Joachim & Carroll, 2018; Kocher et al., 2015). Additionally, in two of these studies, preference for the reinforcer arrangements was idiosyncratic (Joachim & Carroll, 2018; Kocher et al., 2015). However, there are several limitations within these studies. Across all three studies, replication within participants was attempted for six of the 10 participants (Frank-Crawford et al., 2019; Joachim & Carroll, 2018; Kocher et al., 2015) and was only observed for three participants (Frank-Crawford et al., 2019; Joachim & Carroll, 2018). Additionally, once responding in a condition met mastery criterion, data collection either stopped across all conditions (Kocher et al., 2015) or the mastered condition was discontinued (Frank-Crawford et al., 2019; Joachim & Carroll, 2018). Thus, in cases where data collection for the mastered condition ceased, it is plausible that more rapid acquisition occurred for the remaining conditions due to an increase in frequency of exposure to the remaining condition(s). Another limitation in all three studies is that the teaching procedures included several components (i.e., error correction and prompting); as a result, it is unclear if acquisition is due to the additional teaching variables or the reinforcer arrangements. For example, in Frank-Crawford et al. (2019) prompting, praise, and error correction were used in baseline and baseline data were on an increasing trend in several analyses; therefore, it remains unclear which variables resulted in acquisition.

Gaps in Current Literature. Results of previous studies indicate that accumulated reinforcement is often preferred (e.g., Bukala et al., 2015) and more efficient (e.g., DeLeon et al., 2014). However, as Frank-Crawford et al. (2019) and Ward-Horner et al. (2017a) concluded, few studies included young participants (i.e., 6 years or younger; Frank-Crawford et al., 2019; Joachim & Carroll, 2018; Ward-Horner et al., 2017; Weston et al., 2020). Of these studies, Weston et al. (2020) attempted to identify participant preference; however, results did not indicate a preference hierarchy. For the six participants across the other studies, two preferred the accumulated arrangement, two preferred the distributed arrangement, one equally preferred both arrangements, and the last preferred a different arrangement (praise only). These results differ from the results of the majority of related studies with older participants indicating the accumulated arrangement is most preferred (Bukala et al., 2015; DeLeon et al., 2014; Falligant et al., 2020; Falligant & Kornman, 2019; Fienup et al., 2011; Frank-Crawford et al., 2019; Ward-Horner et al., 2014). Given that only a few studies included young participants and preference differed across participants, the generality of these findings to other young children remains unclear. Furthermore, only four studies included a reinforcer other than an activity-based reinforcer. However, three of these studies allowed the participants to select either an edible or activity reinforcer, separate data comparing the effects of these reinforcers were not collected, and the authors reported the participants selected the activity reinforcer on most occasions (Falligant et al., 2020; Falligant & Kornman., 2019; Joachim & Carroll., 2019). In the fourth study, DeLeon et al. (2014) assessed preference for distributed and accumulated arrangements with edibles as compared to activity-based reinforcers; all participants preferred the accumulated arrangement regardless of the type of reinforcer. As this is the only study to compare the effects of these arrangements with edible reinforcers, the generality of these findings remains unclear. Additional research on the impact of these reinforcer arrangements when edibles are the programmed reinforcer is warranted as clinicians often use edibles as reinforcers (Graff & Karsten, 2012) and edible reinforcement may lead to faster acquisition (Leaf et al., 2014); to our knowledge, there is no research comparing distributed and accumulated arrangements with activity and edible reinforcers on the efficiency and efficacy of skill acquisition.

Therefore, the purpose of the current study was to examine the effects of accumulated and distributed arrangements on preference, disruptive behavior, as well as efficiency and efficacy of skill acquisition for learners of preschool age (i.e., 2-5 years old) diagnosed with an ASD. Previous research was extended by examining the effect of the arrangements on skill acquisition, using both edible and activity-based reinforcers, and using a preschool-age population.

CHAPTER TWO:

METHOD

Participants, Settings, and Materials

There were two participants in this study, Liam and Asher. Liam was a 4.25 year-old male and Asher was a 3.67 year-old male. Per caregiver report (Appendix A) both participants had autism, were receiving ABA, speech therapy, and occupational therapy services at the time of the study, had the ability to sit at a table for at least 2 min, feed orally, and had normal hearing. Additional information about each participant was obtained via an interview completed with each participant's Board Certified Behavior Analyst® (BCBA®) (Appendix B). At the time of the study, Liam had been receiving ABA services for around a year, participated in ABA therapy for 30 hrs a week, had experience with DTT for a year, had 6 months of experience with tokens that were systematically trained, did not receive edibles as a reinforcer, and was receiving activity-based reinforcers on a FR-15 schedule. Asher was also receiving ABA services for around a year, participated in ABA therapy for 30 hrs a week, had approximately one year of experience with DTT, had experience with tokens for an unspecified amount of time, had a history with receiving edible reinforcers, and was receiving activity-based reinforcers on an unspecified schedule.

Sessions were completed in a room within the clinic from which the participants received ABA services. The room used for research sessions was the same room used for ABA therapy. Research sessions were completed three to five times per week and each research session lasted between 30-60 min. Materials for this study included a table, chairs, stimuli used for teaching (e.g., 7.62 x 7.62 cm tact picture cards), 7.62 x 7.62 cm colored cards, edibles, activities, datasheets, timers, the Countee© application, pens, and a video camera. The experimenter recorded sessions to calculate duration of sessions, time engaged in disruptive behavior, interobserver agreement (IOA), and assess procedural integrity (PI).

Response Definitions and Measurement

The primary dependent measures for this study were *stimulus selection*, *free-operant response*, *independent correct responses,* and *disruptive behavior*. During the preference assessments, *stimulus selection* was measured and consisted of the participant making physical contact, pointing, or vocally requesting for one of the available stimuli within 5 s of the onset of the trial. *Stimulus selection* was measured as a count and reported as percentage of opportunities; this calculation was done by dividing the number of times the participant selected a specific stimulus by the number of times it was available and multiplying by 100. For the activity, edible, and color preference assessments, data are depicted as the percentage of trials selected, and for the concurrent-chain preference assessment, data are reported as the cumulative number of selections. During the reinforcer assessment, the occurrence of a *free-operant response* (i.e., putting a ball in a cup) was measured and summarized as rate (responses per minute) by dividing the frequency of the free-operant response by the total duration of the session, in minutes.

Each participant's tact, intraverbal, and listener responding skills were assessed using the corresponding sections of the VB-MAPP Milestones Assessment. During this assessment, data were recorded on *independent correct responding* during each trial/opportunity defined within each milestone (i.e., criteria including a specific response). These data were used to determine each participant's developmental level regarding a specific skill, level 1 (i.e., 0-18 months), level

2 (i.e., 18-30 months), or level 3 (i.e., 30-48 months). The number of milestones met and developmental level for each of these sections are reported.

During the acquisition portion of this study, responding on each trial was categorized as *independent correct responding, prompted correct responding, or errors. Independent correct responding* was defined as the emission of a response, in the absence of prompts, and within 5 s of receiving the discriminative stimulus, specific to the discriminative stimulus provided by the experimenter. *Prompted correct responses* were responses emitted that correspond to the specified discriminative stimulus, but that required a prompt from the experimenter. *Errors* consisted of the participant not responding within 5 s of the presentation of the discriminative stimulus (i.e., omission errors) and responding incorrectly with or without the presentation of a prompt (i.e., commission errors). The percentage of independent correct responding per session was calculated by dividing the number of trials with independent correct responses by the total trials in the session and multiplying by 100.

As an additional measure of efficiency, the continuous *duration* of each DTT session was measured using a timer. Each DTT session began when the experimenter presented the discriminative stimuli for the first trial and ended after consumption of the reinforcer provided after the last trial of the session. Duration of session, including (i.e., *duration with reinforcer consumption*) and excluding (i.e., *duration without reinforcer consumption*) the amount of time spent in reinforcer consumption, is reported as the mean duration per condition.

Additionally, the duration of disruptive behavior which occurred during the training sessions of the skill acquisition evaluation phase (i.e., teaching sessions until mastery criteria was met) was measured using an immediate onset and 2-sec offset criterion. *Disruptive behavior* consisted of any instance of non-contextually appropriate vocalizations (e.g., vocal noncompliance such as stating “I won’t do that”; vocalizations louder than conversation volume), property destruction (e.g., ripping/damaging stimuli), actual or attempted aggression (e.g., hitting of others with open or closed hand; biting others), any self-injury (e.g., hitting self with open or closed hand), and actual or attempts to grab stimuli without permission. Data on disruptive behavior are reported as the mean percentage of training time with disruptive behavior across comparisons and includes only the training sessions completed until mastery criterion was met. For each comparison, these data were calculated by dividing the total duration of disruptive behavior in a condition by the total duration of session time to mastery criterion for that condition including and excluding reinforcer consumption, multiplied by 100; then the average of all three comparisons was calculated. In the case that mastery criterion was not met in a condition, only the sessions completed until the reinforcer arrangement in effect was changed were included in these calculations.

Interobserver Agreement (IOA) and Procedural Integrity (PI)

The experimenter trained a research assistant (RA) using behavior skills training (BST; Miltenberger, 2016). The experimenter provided instructions, model, role-play, and feedback to the RA on data collection and correct steps within each condition (Appendices C-E). Training continued until the RA independently recorded data that produced IOA and PI data with at least 90% accuracy across one session for each condition. For IOA, the RA independently collected data on the dependent measures for 100% of preassessments and concurrent-chains assessments and for a mean of 46.6% (range, 41.4%-51.7%) for the acquisition evaluation across participants. Mean-count-per-interval IOA was calculated for the *free-operant response*. This calculation involved dividing the session into 10 s intervals, then dividing the smallest frequency by the largest frequency during each interval, adding the proportions, dividing by the number of intervals, then multiplying by 100. For *stimulus selection, independent correct responding, correct prompted responding,* and *errors* IOA scores were calculated using the trial-by-trial method. That is, the number of trials with agreement were divided by the total number of trials in a session and then multiplied by 100. Lastly, for *duration* of sessions and disruptive behavior, IOA scores were calculated using a total duration method. The shorter duration recorded was divided by the larger duration and multiplied by 100. The mean IOA score for Liam was 96.9% (range, 80%-100%) and for Asher was 99.7% (range, 90%-100%).

To assess procedural integrity, a RA used a checklist to record data on whether the experimenter implemented the procedures as described (see Appendices C-E). A RA collected PI for 100% of preassessments and concurrent-chains assessments and for a mean of 46.6% (range, 41.4%-51.7%) for the acquisition evaluation across participants. To calculate PI, the number of steps the experimenter completed correctly was divided by total steps and multiplied by 100. The mean PI score for Liam was 99.5% (range, 96%-100%) and for Asher was 97.6% (range, 96%-100%).

CHAPTER THREE:

INITIAL ASSESSMENTS

Prior to the skill acquisition portion of this study, the experimenter completed a series of preference and reinforcer assessments with each participant to identify appropriate consequences used in subsequent phases. Additionally, the experimenter assessed the participant's repertoire of certain skills using sections of the VB-MAPP; for each participant a target verbal operant was selected for the skill acquisition evaluation based on results of this skills assessment.

Preference Assessments

Before conducting the preference assessments, the experimenter interviewed the participant's caregiver to identify a list of potentially preferred edibles and activity items to be evaluated in the preference assessments (Appendix A). Preference assessments were conducted for all participants to identify highly preferred edibles and activities (e.g., iPad, books), and neutral colors. Highly preferred items were consequences in the subsequent reinforcer assessment. Colored cards were associated with conditions evaluated in the skill acquisition phase and included in the concurrent-chain preference assessment. The two stimuli selected most often (i.e., top two from the preference hierarchy) were deemed as the most preferred and were used in the following reinforcer assessment. The four colors selected during the same number of trials or in the middle of the preference hierarchy were used in subsequent analyses to signify contingencies. Furthermore, the experimenter repeated the edible and activity preference assessments for all participants prior to each skill acquisition comparison; however, for each participant the most preferred items remained consistent across all assessments and as a result, the same items were used as a consequence throughout the three skill acquisition comparisons.

Each preference assessment was completed in a paired-stimulus format (PS; Fisher et al., 1992). During the PS preference assessment two stimuli (i.e., edibles, items, or colors) were presented on the table approximately 5.08 cm apart. The experimenter instructed the participant to select a stimulus. Once a stimulus was selected, the experimenter removed the remaining stimulus from the array and gave the participant 30 s to consume (i.e., eat, play with) the item chosen. If no selection was made, the trial was presented an additional time; if the participant did not make a selection during the second presentation, the experimenter removed the materials, scored the trial as a non-selection (NS), and began the next trial. Trials continued in the same format until each stimulus had been paired with every other stimulus of the same category (i.e., edibles, activities, or colors) at least twice. Additionally, placement of the items was balanced across trials.

Reinforcer Assessments

A single operant reinforcer assessment (Roscoe et al., 1999) was conducted with the top two items from both edible and activity preference assessments to assess if these items had reinforcing properties. For the edible reinforcer assessment, each emission of the target response resulted in access to a small amount of the edible (e.g., half of a gummy, an eighth of a cookie). For the activity reinforcer assessment, each emission of the target response resulted in 30 s of access to that activity.

Prior to the reinforcer assessment, the experimenter conducted two forced exposure trials. During these trials, the experimenter vocally stated the target response and the programmed consequence (e.g., "if you put the ball in the cup, you will get a gummy"), physically prompted the participant to emit the target response, and then delivered the consequence. The experimenter conducted at least two forced exposure trials for each contingency before every reinforcer assessment session. During each session, a single consequence (preferred item or no consequences) was available for each emission of the target response, which for both participants was putting a ball in a cup. Therefore, one set of materials required to emit the target response was available. These sessions were a total of 5 min, excluding reinforcer consumption time.

VB-MAPP

The experimenter assessed each participants' current skill repertoires using specific sections of the VB-MAPP Milestones Assessment (Sundberg, 2008). The VB-MAPP Milestones Assessment is divided into 16 domains (i.e., skill areas); each domain contains several learning and language milestones across three levels. The specific levels correspond to skills observed in typically developing individuals of each age range (i.e., level 1 (0-18 months), level 2 (18-30 months), and level 3 (30-48 months)). The levels within each domain contain five separate learning and language milestones; milestones specify an amount of a specific target response. As developmental levels increase, the milestones within them increase in difficulty. For instance, an example of a level 1 milestone within the tact domain includes tacting six non-reinforcing items; whereas, an example of a level 3 milestone is tacts four different prepositions and four pronouns (Sundberg, 2008). The experimenter assessed each participants' repertoires for the tact, listener responding, and intraverbal sections.

To assess each participant's tact repertoire, the experimenter conducted a series of trials testing the responses specified within the tact milestones. The experimenter began the assessment with implementing trials for the five milestones within level 1. Contingent on the participant emitting the specified amount of the target response in at least three of the five milestones in level 1, the experimenter implemented trials for the milestones in the next level (i.e., level 2). This process continued until all levels for the tact section were completed or the participant did not meet at least three of the five milestones within a level. Next, the experimenter assessed the participant's listener responding repertoire in the same format. Lastly, the experimenter assessed the participant's intraverbal responses; however, the assessment of this domain began with the milestones in level 2 (there are no level 1 milestones for this domain). Upon completion of the assessment, the domain in which each participant met the least number of milestones was the assigned targeted operant in the subsequent evaluation.

CHAPTER FOUR:

REINFORCER ARRANGEMENT EVALUATION

The purpose of this evaluation was to determine the most efficient (i.e., number of sessions and time to reach mastery) and preferred reinforcer arrangement. Prior to the skill acquisition evaluation, appropriate targets were identified for each participant and were equated for difficulty. To determine the efficiency of these reinforcer arrangements, we evaluated acquisition of target responses across four different reinforcer arrangements (i.e., distributed with edibles, distributed with activities, accumulated with edibles, accumulated with activities) and three comparisons were completed per participant. Lastly, a preference assessment was used to assess the participant's most preferred arrangement.

Experimental Design

The skill acquisition evaluation utilized a combination of a nonconcurrent multiple baseline across behaviors design (three comparisons per participant) and an adapted alternating treatment design (Sindelar et al., 1985). Additionally, the participant's preference for reinforcer arrangement was examined through a concurrent-chain preference assessment (Hanley et al., 1997).

Verbal Operant and Target Identification

The target operant for each participant was determined based on results of the VB-MAPP. More specifically, the operant with the fewest mastered milestones was selected. The experimenter reviewed the milestones that were not met within the selected domain (e.g., tacts six non-reinforcing items) to create a list of appropriate potential targets. Then, the experimenter conducted three probe trials (Appendix C) for the potential targets to directly assess whether the participants had any of these targets in their repertoire. During these trials, the experimenter oriented towards the participant and waited for the participant to demonstrate attending (e.g., make eye contact). Next, the experimenter delivered the vocal discriminative stimuli (e.g., "what is this?") along with a non-verbal stimulus (i.e., picture), if applicable, for the specific target. The participant had up to 5 s to respond; no programmed consequences were delivered for correct or incorrect responses. The experimenter recorded if the participant emitted a correct response, an approximation of a correct response, or responded incorrectly. There was a 3 s inter-trial-interval (ITI). After every two to three trials, the experimenter delivered behavior-specific praise for appropriate session behavior (e.g., "nice job sitting"). If the participant did not emit the target response correctly in any of the probe trials, that response was considered as a potential target for the skill acquisition evaluation. For both participants, the target responses required vocal responses (i.e., tacts, intraverbal); as a result, the experimenter conducted an additional echoic evaluation.

The format of the echoic evaluation (Appendix C) was similar to the probe trials described above. However, during each trial, the experimenter emitted the target vocal response (e.g., "dog") and wait up to 5 s for the participant to emit a response. If the participant emitted a vocal response within 5 s, the experimenter recorded the participant's response verbatim. The response was scored as correct if the participant's vocalization had point-to-point correspondence and formal similarity to the experimenter's response. If the participant's vocalization resembled the experimenter's response (e.g., similar beginning or ending sounds; final consonant deletion) the response was scored as an approximation. If the participant did not emit a response or the response emitted did not resemble the experimenter's, it was scored as an error. If the participant emitted a correct response or the same approximation on all three probe trials, that target response remained a possible target for the skill acquisition evaluation.

The experimenter then reviewed the remaining target responses to create three set of four target responses that are similar in difficulty level. One target within each set was assigned to one of the four conditions in the skill acquisition evaluation. Specifically, a set of stimuli for one comparison included four responses (one for each reinforcer arrangement condition) that had the same number of syllables, did not begin with the same first letter, and either all end with the same sound or different sounds (Cariveau et al., 2020). Given that the included targets were equated in terms of correct responding and ability to emit the target vocalizations, targets were randomly assigned to one of the reinforcer arrangements.

Skill Acquisition Evaluation

During the skill acquisition evaluation (Appendix D), the experimenter sat next to or across from the participant. Sessions for each condition consisted of ten trials of the same target response assigned to that specific condition. Consecutive trials were presented immediately after the participant consumed the reinforcer or after a 3 s inter-trial-interval if no reinforcer was delivered. During these trials the experimenter oriented towards the participant and waited for the participant to demonstrate attending (e.g., make eye contact). If the participant did not independently make eye contact within 5 s of the experimenter orienting towards the participant, the experimenter used a least-to-most prompting procedure to establish eye contact. The prompting procedure consisted of the experimenter saying the participant's name, moving their finger or a reinforcer from the participant's eyes to their eyes, and using their hand to create a visual screen on the side of their face. Once attending was established, the experimenter delivered the vocal instruction specific to the trial. Additionally, during the preassessments, Liam did not attend to stimuli (e.g., after the experimenter delivered the verbal stimulus, Liam looked around the room rather than orienting towards the nonverbal stimulus); thus, an observing response that consisted of touching the nonverbal stimulus (i.e., picture) was physically prompted during all trials. The participants had an opportunity to take a break at the end of each session. During the break, participants had access to items located within the environment but not items used as reinforcers.

Baseline Sessions

During baseline, there were no programmed consequences for correct or incorrect responses. However, behavior-specific praise was delivered for appropriate session behavior every two to three trials.

Teaching Sessions

Procedures employed during the teaching sessions were similar to baseline except for the modifications described here. First, a 7.62 x 7.62 cm colored card, assigned to the specific condition, was shown to the participant and remained within the participant's view (e.g., on a wall, on a table) for the remainder of the session. Second, before each session, a single trial preference assessment specific to the condition (edible or activity), including the items previously identified as reinforcers, was conducted. The item chosen was used as the consequence for correct responding during that session unless the participant requested the alternative item. Third, the experimenter stated to the participant the contingency in effect during that session (e.g., "If you are correct, you get a gummy right away," "If you are correct, I will put the gummy on this plate, and you can have all of them at the end").

Additionally, prompting was used. During the initial prompt step, a full prompt (e.g., "dog") was delivered immediately (i.e., 0 s) after the experimenter presented the vocal instruction. During the following prompt step, the experimenter delivered a full prompt (e.g., "dog") 2 s after the vocal instruction. Next, the experimenter delivered a partial prompt (e.g., "d") 2 s after the vocal instruction. During the last step, the participants had a chance to respond in the absence of a prompt. The criterion to increase prompt steps was at least 80% prompted or independent correct responding across one session; the criteria to return to a previous, more intrusive, step was three consecutive errors or four total errors within one session. A DR/ICR procedure was also implemented. A correct prompted response resulted in behavior-specific praise, whereas an independent correct response resulted in behavior-specific praise and access to a reinforcer specified by the reinforcer arrangement in effect. If the participant emitted an error, an error correction procedure was conducted. During the error correction procedure, the experimenter represented the vocal instruction and immediately modeled the correct response (e.g., "where is the toothbrush"; " bathroom"). Then the experimenter waited up to 5 s for the participant to imitate the experimenter's model. If the participant modeled the experimenter's response, a monotone vocal statement of approval (e.g., "that's better") was delivered and the next trial began. If the participant did not respond or did not respond correctly after the experimenter's model, the experimenter presented the vocal instruction again and modeled the correct response. This process was repeated until the participant responded correctly or the error correction procedure was implemented three times.

Teaching sessions continued until the participant reached the mastery criterion of 100% independent correct responding across three consecutive sessions and at least two days. The experimenter continued to implement sessions of all four conditions even after mastery criterion was met for a condition to ensure that the speed of acquisition in the other conditions did not increase due to mass implementation of sessions of the remaining conditions. Sessions continued until mastery criterion was met in the other conditions or double the number of sessions needed to reach mastery in the first condition were completed without an increase in independent correct responses. If after this time, mastery criterion was still not met for any of the remaining conditions, and independent correct responding was not increasing for a condition, the reinforcer arrangement in effect for these conditions was changed to the one in effect for the condition that was mastered first in that comparison. This was the case for the first comparison for Liam and the first and second comparisons for Asher.

Distributed with Edibles. During this condition, an independent correct response resulted in immediate behavior-specific praise and the preferred edible selected before the session.

Distributed with Activities. During this condition, an independent correct response resulted in immediate behavior-specific praise and 30 s with the preferred activity selected before the session.

Accumulated with Edibles. During this condition, an independent correct response was followed immediately with a behavior-specific praise statement, and a preferred edible was put on a plate where the participant could see it. After the last trial of the session, the experimenter gave the participant the plate containing all edibles earned during that session.

Accumulated with Activities. During this condition, an independent correct response was followed immediately with a behavior-specific praise statement and a small picture that signifies 30 s of the preferred activity was put on a plate where the participant could see it. At the end of the session the plate containing the pictures was given to the participant concurrently with access to the accumulated duration of the preferred activity. A timer was set to signal to the participant the duration of time available to interact with the activity.

CHAPTER FIVE:

SOCIAL VALIDITY

Concurrent-Chains Preference Assessment

A concurrent-chains preference assessment (Appendix E) was completed to determine each participant's preference for the reinforcement arrangements that were in effect during the skill acquisition evaluation. This assessment included four stimuli (7.62 x 7.62 cm colored squares), each associated with the different reinforcer arrangements evaluated. At the beginning of the assessment, the experimenter vocally stated the contingency associated with each card. Next, the experimenter implemented two forced exposure trials per condition by physically guiding the participant to select a specific card and then delivering the corresponding consequence (i.e., a session of distributed reinforcement with edibles). During choice trials, the experimenter presented the four cards in an array and then delivered the vocal instruction "pick the one you want to do." The participant was given up to 5 s to respond. After the participant made a selection, the experimenter removed the other colored cards from the array and implemented the teaching session in the same format as during the skill acquisition evaluation of the chosen reinforcer arrangement using the targets from third comparison of the skill acquisition evaluation. Then, the next choice trial was presented with the placement of the four contingency cards rotated across trials. This preference assessment continued until the participant chose the same reinforcer arrangement across five consecutive trials or a maximum of 15 trials were completed.

Caregiver and Professional

To assess the acceptability of the procedures employed in this study, the participant's caregivers and clinical team members (totaling two BCBAs® and one BCaBA®) completed a questionnaire developed by the experimenter (Appendix F). The questionnaire included eight statements and questions about the type of reinforcers used, reinforcer delivery methods, acceptability of the teaching procedures, and importance of efficient and preferred teaching methods. Caregivers and clinical team members responded to the questionnaire using a Likert scale ranging from 5 (s*trongly agree)* to 1 (*strongly disagree*) or selecting the response they most agreed with. To ensure that the responses were anonymous, the individuals received the questionnaire in an envelope and were instructed to complete the survey and return it in the closed envelope. The envelopes for the caregivers and clinical team members differed in size to distinguish between types of respondents. The experimenter opened the sealed envelopes after receiving all the questionnaires.

CHAPTER SIX:

RESULTS

Results of the preassessments and skill acquisition evaluation are presented in Tables 1-5 and Figures 1-4. The results of the VB-MAPP Milestone Assessment are depicted in Table 1. Both the tact and listener responding domains within the VB-MAPP contain 15 milestones across levels 1-3 (i.e., five per level) and the intraverbal domain contains 10 milestones across levels 2-3. Liam met the criteria for four milestones within the tact domain, five milestones within the listener responding domain, and one milestone within the intraverbal domain. Asher met the criteria for nine milestones within the tact domain, 12 milestones within the listener responding domain, and two milestones within the intraverbal domain. These data indicate that Liam had the most skill deficits in the tacting domain whereas Asher had more deficits in intraverbals. As a result, for Liam, the target responses in the skill acquisition phase included a variety of tacts and for Asher, the target responses were a variety of intraverbals (see Table 2).

Table 1

Number of Milestones Met in Each Domain of VB-MAPP

Participant	Tact	Listener Responding	Intraverbal
Liam	4/15 (Level 1)	5/15 (Level 1)	1/10 (Level 2)
Asher	9/15 (Level 2)	12/15 (Level 3)	2/10 (Level 2)

Note. Level 1 (0-18 months), Level 2 (18-30 months), Level 3 (30-48 months)

Table 2

Target Stimuli Taught During the Skill Acquisition Evaluation

Participant	Operant	Distributed (Edibles)	Distributed (Activity)	Accumulated (Edibles)	Accumulated (Activity)
Liam	Tact	R Nail Ant	G Chip Tape	H Tie Fork	T Fox Key
Asher	Intraverbal	"What do you do with nose?" (smell)	"What do you do with your teeth?" (chew)	"What do you do with your legs?" (walk)	"What do you do with your ears?" (hear)
		"Where do ants live?" (dirt)	"Where do snakes live?" (woods)	"Where do bats live?" (cave)	"Where do frogs live?" (pond)
		"What do you use to slice?" (knife)	"What do you use to wash?" (soap)	"What do you use to eat?" (fork)	"What do you use to brush?" (comb)

Figures 1-2 show the results of the paired stimulus color (top panel), edible (middle panel), and activity (bottom panel) preference assessments for Liam and Asher. Liam (see Figure 1) selected the colors purple, red, green, and yellow on 57% of opportunities. As these colors were selected on the same number of opportunities, these colors were randomly assigned to one of the conditions of the skill acquisition evaluation. During the first edible and activity preference assessments, Liam selected candy bar on 87.5%, M&M on 75%, iPad on 75%, and playdough on 75% of opportunities indicating that these activities were the highest preferred within the stimuli available. Asher (see Figure 2) selected yellow on 50% of opportunities, green and pink on 43% of opportunities, and orange on 36% of opportunities. These colors were in the middle of the hierarchy and were selected at least once; therefore, these colors were randomly assigned to one of the conditions of the skill acquisition evaluation. During the first edible and activity preference assessments, Asher selected gummies on 100%, Sixlets on 75%, iPad on 100%, and books on 62.5% of opportunities indicating that these activities were the highest preferred within the stimuli available. These same items were ranked as most preferred during the subsequent edible and activity preference assessments completed with Liam and Asher.

Results for the single operant reinforcer assessments are shown in Figures 3-4. During the edible and activity reinforcer assessments, Liam (see Figure 3) emitted the target response (i.e., putting a ball in a cup) more often when it resulted in access to a preferred edible or activity than when responding had no programmed consequences (i.e., extinction). Specifically, during the reinforcer assessment completed with edibles, Liam emitted the target response when responding resulted in access to the candy bar at a mean responses per minute (RPM) of 8.0 (range, 3-13), M&M 5.7 (range, 4.5-8), and extinction 0.7 (range, 0-1). During the activity reinforcer assessment, the mean RPM during the iPad condition was 12.8 (range, 12-13.5), playdoh was 11 (range, 9-12), and extinction was 2.5 (range, 1-4.5). These results indicate that the preferred stimuli assessed all functioned as reinforcers for Liam.

Asher (see Figure 4) also emitted the target response more often during the condition in which it resulted in access to a preferred edible or activity for 30 s than during extinction. During the edible reinforcer assessment, the mean RPM during the Sixlet condition was 6.5 (range, 4.5-9.5), gummy condition was 8 (range, 7-9), and extinction was 2.3 (range, 0.5-3.5). For the activity reinforcer assessment, mean RPM during the iPad condition was 12.5 (range, 12-13), book condition was 6.2 (range, 5.5-7), and extinction was 0.8 (range, 0-2). These results indicate that the preferred stimuli assessed all functioned as reinforcers for Asher.

Results for the skill acquisition evaluation for Liam are shown in Figure 5 and Table 3. During the first evaluation, shown on the top panel, mastery criterion was met for the distributed with edibles arrangement at session 35 (i.e., six training sessions), distributed with activity at session 42 (i.e., eight training sessions), and accumulated with edibles at session 49 (i.e., 10 training sessions). For the accumulated with activity arrangement, a decreasing trend was observed on session 60 (i.e., 12 training sessions) which was double the number of sessions needed to acquire the target in the most efficient condition (i.e., distributed with edibles); therefore, the reinforcer arrangement in effect was changed from the accumulated with activity arrangement to distributed with edibles. Mastery criterion for that target stimulus was met at session 84 (i.e., 18 total training sessions; six training sessions after the distributed with edible arrangement was introduced). During the second evaluation, shown on the middle panel, Liam met mastery criterion in the distributed with activity arrangement at session 40 (i.e., five training sessions), distributed with edibles at session 41 (i.e., six training sessions), accumulated with edibles at session 43 (i.e., six training sessions), and the accumulated with activity arrangement at session 50 (i.e., eight training sessions). Lastly in the third comparison, shown on the bottom panel, mastery criterion was met for the distributed with edibles arrangement at session 48 (i.e., five training sessions), distributed with activity at session 49 (i.e., six training sessions), accumulated with edibles at session 54 (i.e., seven training sessions), and with the accumulated with activity arrangement at session 63 (i.e., nine training sessions). Across the three comparisons completed with Liam, he met mastery criterion in the least number of sessions in one of the distributed arrangements; the distributed with edibles and distributed with activity arrangements required a similar number of sessions to mastery (i.e., one or two additional sessions). For Liam, mean sessions to mastery (see Table 3) for distributed with edibles arrangement was 5.7 (range, 5-6), distributed with activity was 6.3 (range, 5-8), accumulated with edibles was 7.6 (range, 6-10), and accumulated with activity including sessions in which the reinforcer arrangement changed in panel 1 was 11.7 (range, 8-18). These results suggest that, in terms of sessions to mastery criterion the distributed arrangements were the most efficient for Liam.

Results of the skill acquisition evaluation for Asher are shown in Figure 6 and Table 3. During the first evaluation, shown on the top panel, Asher met mastery criterion in the distributed with activity arrangement at session 32 (i.e., five training sessions), accumulated with edibles at session 35 (i.e., 6 training sessions), and distributed with edibles at session 41 (i.e., eight training sessions). For the accumulated with activity arrangement, a decreasing trend was observed on session 50 (i.e., 10 training sessions) which was double the number of sessions needed to acquire the target stimulus in the most efficient condition for this evaluation (i.e., distributed with activity); therefore, the reinforcer arrangement in place was modified from accumulated with activity to distributed with activity. Mastery criterion for that target stimulus was met at session 82 (i.e., 18 total training sessions; eight training sessions with the new reinforcer arrangement). During the second evaluation (middle panel), Asher met mastery criterion in the distributed with edibles arrangement at session 37 (i.e., five training sessions) and in the distributed with activity arrangement at session 48 (i.e., seven training sessions). After completing twice the number of sessions required to acquire the target stimulus in the most efficient condition for evaluation (i.e., distributed with edibles), a decreased trend was observed in the accumulated edible and activity arrangements, at session 59 and 70, respectively; therefore, the arrangement in place for the targets in the accumulated arrangements changed to distributed with edibles for the remaining sessions. Mastery criterion was met for the target stimuli originally assigned to the accumulated with edibles and activity arrangements at session 83 and 82 respectively (i.e., 16 total training sessions; six sessions for the accumulated with edible and three sessions for the accumulated with activity arrangement after the change in reinforcer arrangements). In the third comparison, shown on the bottom panel, mastery criterion was met for the distributed with edibles arrangement at session 49 (i.e., six training sessions), distributed with activity at session 52 (i.e., six training sessions), accumulated with activity at session 62 (i.e., nine training sessions), and accumulated with edibles at session 67 (i.e., ten training sessions). Across the three comparisons, the arrangement that required the least number of sessions to mastery was one of the distributed arrangements. Additionally, Asher met mastery criterion for all the target stimuli assigned to the distributed conditions (edible and activity) but acquisition was not consistent for the accumulated arrangement conditions. Overall, mean sessions to mastery criterion (see Table 3) for the distributed with activity arrangement was 6 (range, 5-7), distributed with edibles arrangement was 6.3 (range, 5-8), and for the accumulated with edible and activity arrangements including sessions in which the reinforcer arrangement changed was 10.7 (range, 6-16) and 14.3 (range, 9-18), respectively. These results suggest that for Asher, in terms of sessions to mastery criterion, the distributed arrangements are the most efficient.

The duration of time to mastery and the percentage of session time to mastery with disruptive behavior are displayed in Tables 3 and 4, respectively. When time spent in reinforcer consumption is included, Liam required a mean of 17.8 min (range, 15.1 min-20.4 min) to meet mastery in the distributed with edible arrangement condition, 25.1 min (range, 18.9 min-34.1 min) in the accumulated with edibles condition, 31.5 min (range, 24.7 min-39.3 min) in the distributed with activity condition, and 55.3 min (range, 37.2 min - 87.2 min) in the accumulated with activity arrangement, including the sessions completed with the alternative reinforcer arrangement. However, when excluding time spent in reinforcer consumption, the distributed with edible arrangement condition lasted a mean of 7.3 min (range, 5.1 min-9.9 min), the distributed with activity 9.4 min (range, 4.9 min-15.7 min), the accumulated with edibles 14.9 min (range, 7.8 min-25.1 min), and the accumulated with activity arrangement, including sessions in the new reinforcer arrangement, 29.3 min (range, 14.3 min-42.4 min). For Asher, mean duration of time to mastery including time spent in reinforcer consumption for the distributed with edibles arrangement was 13.7 min (range, 10.9 min-18.3 min), the distributed with activity 27.1 min (range, 22.8 min-29.8 min), and the accumulated with edibles and activity arrangements, including sessions with the alternative reinforcer arrangement, was 27.8 min (range, 13.5 min-47.2 min) and 66.6 min (range, 35.3 min-89.7 min), respectively. However, when time spent in reinforcer consumption is excluded, to meet mastery Asher required a mean of 4.8 min (range, 4.5 min-4.9 min) during the distributed with activity arrangement condition, 5.7 min (range, 3.8 min-8 min) during the distributed with edibles condition, and 11.3 min (range, 5.8 min-15.5 min) and 16.2 min (range, 11.3 min – 20.3 min) for the accumulated with edibles and activity arrangements including sessions in the alternative reinforcer arrangement, respectively. For both participants, in terms of duration to mastery, the most efficient arrangement was the distributed with edibles.

Table 3

Mean Number of Training Sessions and Duration to Mastery

Participant	Distributed (Edibles) *Mean (Range)*	Distributed (Activity)	Accumulated (Edibles)	Accumulated (Activity)
Liam				
Sessions (#)	**5.4** (5-6)	6.3 (6-8)	7.6 (6-10)	11.7[a] (8-18[a])
Duration w/ reinforcement (min)	**17.8** (15.1-20.4)	31.5 (24.7-39.3)	25.1 (18.9-34.1)	55.3[a] (37.2-87.2[a])

Table 3 (Continued)

Duration w/o reinforcement (min)	**7.3** (5.1-9.9)	9.4 (4.9-15.7)	14.9 (7.8-25.2)	23.9[a] (14.3-42.4[a])
Asher				
Sessions (#)	6.3 (5-8)	**6** (5-7)	10.7[a] (6-16[a])	14.3[a] (9-18[a])
Duration w/ reinforcement (min)	**13.7** (10.9-18.3)	27.1 (22.8-29.8)	27.8[a] (13.5-47.2[a])	66.6[a] (35.3-89.7[a])
Duration w/o reinforcement (min)	**5.7** (3.8-8)	4.8 (4.5-4.9)	11.3[a] (5.8-15.5[a])	16.2[a] (11.6-20.3[a])

[a] Includes sessions in which the reinforcer arrangement was modified.
[b] Bold indicates most efficient condition.

In terms of percentage of session time to mastery with disruptive behavior including reinforcer consumption, Liam engaged in disruptive behavior during a mean of 1.2% (range, 0.2%-2.5%) of session time for the distributed with edibles condition, 4.4% (range, 1.4%-7.6%) of the session time for the accumulated with edibles condition, 4.4% (range, 3.1%-5.8%) of the session time for the distributed with activity condition, and 14.5% (range, 7.5%-20.6%) of the session time for the accumulated with activity condition. Excluding time spent in reinforcer consumption, Liam engaged in disruptive behavior during a mean of 3% (range, 0.7%-6.5%) of session time for the distributed with edibles arrangement, 7.7% (range, 2.6%-10.3%) of the session time for the accumulated with edibles condition, 16.6% (range, 11.1%-25.2%) of the session time for the distributed with activity condition, and 26.8% (range, 17.8%-39.7%) of the session time for the accumulated with activity condition. Asher engaged in disruptive behavior during a mean of 0.5% (range, 0%-1.1%) of the session time for the distributed with edibles condition, 0.7% (range, 0%-9.3%) of the session time for the distributed with activity condition, 7% (range, 5.7%-8%) of the session time for the accumulated with edibles condition, and 8.7% (range, 6.9%-9.6%) of the session time for the accumulated with activity condition. Excluding time spent in reinforcer consumption, Asher engaged in disruptive behavior during a mean of 1% (range, 0%-2.5%) of session time for the distributed with edibles condition, 3.1% (range, 0%-2%) of the session time for the distributed with activity condition, 16.7% (range, 12.4%-22.1%) of the session time for the accumulated with edible condition, and 23.6% (range, 22.1%-26.1%). of the session time for the accumulated with activity condition. For both participants, the reinforcer arrangement with the least amount of disruptive behavior, independent of whether time in reinforcer consumption was included, was the distributed with edibles arrangement. Additionally, for both participants, more disruptive behavior was observed in one of the accumulated arrangement conditions, independent of the exclusion of time in reinforcer consumption.

Table 4

Mean Percentage of Session Time to Mastery with Disruptive Behavior

Participant	Distributed (Edibles) *Mean (Range)*	Distributed (Activity)	Accumulated (Edibles)	Accumulated (Activity)
Liam				
Session with disruptive behavior (w/ reinforcement)	1.2 (0.2-2.5)	4.4 (3.1-5.8)	4.4 (1.4-7.5)	**14.5** (7.5-20.6)
Session with disruptive behavior (w/o reinforcement)	3 (0.6-6.5)	16.2 (11.1-25.2)	7.7 (2.6-10.3)	**26.8** (17.8-39.7)
Asher				
Session with disruptive behavior (w/ reinforcement)	0.5 (0-1.1)	0.7 (0-9.3)	**8.7** (6.9-9.6)	7 (5.7-7.9)
Session with disruptive behavior (w/o reinforcement)	1 (0-2.5)	3.1 (0-2)	16.7 (12.4-22.1)	**23.6** (22.1-26.1)

[a] Data do not include sessions in which the reinforcer arrangement was modified.
[b] Bold indicates highest percentage per measure.

Figure 7 displays the results of the concurrent-chain preference assessment. Liam selected the accumulated with edibles arrangement on 11.1% of the opportunities, the distributed with activity arrangement on 88.9% of the opportunities, and never selected the accumulated with activity or distributed with edible arrangements. Given that he selected the distributed with activity arrangement on five consecutive trials (trials 5-9) the assessment ended on trial 9. These data indicate that Liam preferred the distributed with activity arrangement. Asher selected the distributed with edibles arrangement on 60% of the opportunities, the distributed with activity arrangement on 40% of the opportunities, and never selected the accumulated arrangements. These data indicate that for Asher the most preferred arrangement was distributed with edibles.

Finally, Table 5 shows the results of the social validity assessment completed with the caregiver and clinical team (i.e., BCBA® or BCaBA®). The score from both participant's caregivers across questions was 5; however, one caregiver did not respond to the first question. The mean score from clinical team members was 4.7 (range, 3-5). These results indicate that, according to these respondents, the teaching method, types of reinforcers, and reinforcer arrangements employed in this study were all appropriate (i.e., socially acceptable). Additionally, all caregivers and clinical team members strongly agreed that using the most efficient method and most preferred method are important. Lastly, when asked what procedure should be used in cases where efficiency does not correspond with preference, one caregiver and one clinical team member selected efficiency and one caregiver and two clinical team members selected preference.

Table 5

Social Validity Assessment Questions and Scores

Questions	Clinical Team Mean (range)	Caregiver
Teaching skills through a simplified, systematic, tabletop approach (discrete trial training) is appropriate.	4.3 (R, 3-5)	5 (N/A)
Using small pieces of preferred food following correct responding is appropriate.	4.3 (R, 4-5)	5
Allowing access to a preferred activity (e.g., iPad, computer, etc.) for a short period following correct responding is appropriate.	4.3 (R, 4-5)	5
Allowing access to earned reinforcer immediately is appropriate (edible or activity right away).	4.6 (R, 4-5)	5
Allowing access to accumulated earned reinforcer after a set of learning trials have occurred is appropriate (getting the amount of edibles or activity time earned at the end of work)	5	5
Using the teaching method that is most efficient (the one that lead to learning the fastest) is important.	5	5
Using the teaching method that the child prefers the most is important	5	5
If the most efficient and the most preferred teaching method are not the same which should be used?	Preferred (n=2) Efficient (n=1)	Preferred (n=1) Efficient (n=1)

Note. Likert scale used in questionnaire 1: Strongly disagree 2: Somewhat disagree 3: Neither agree or disagree 4: Somewhat agree 5: Strongly agree

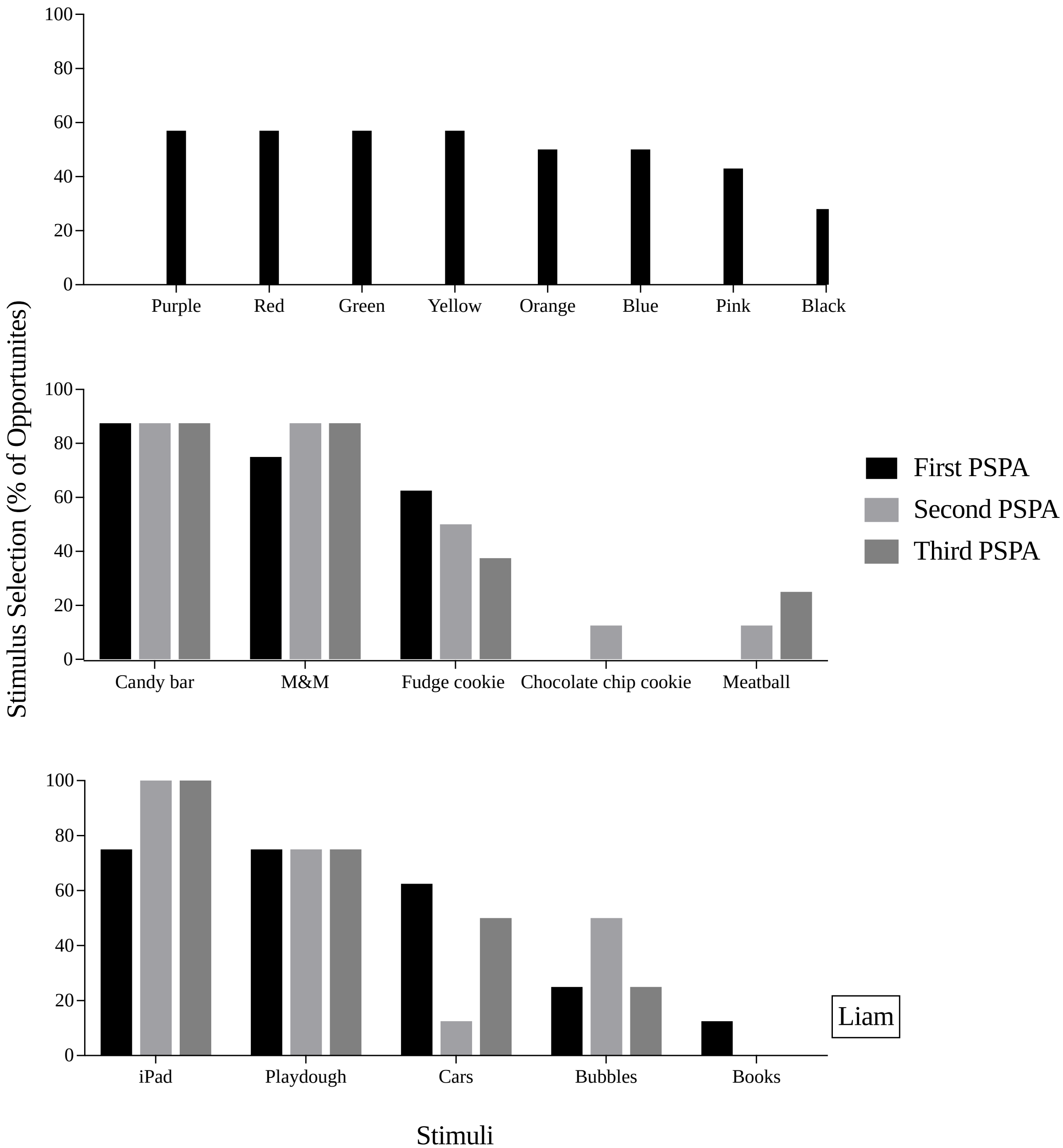

Figure 1. Results of the color, edible, and activity preference assessments for Liam.

Note. PSPA refers to paired stimulus preference assessment.

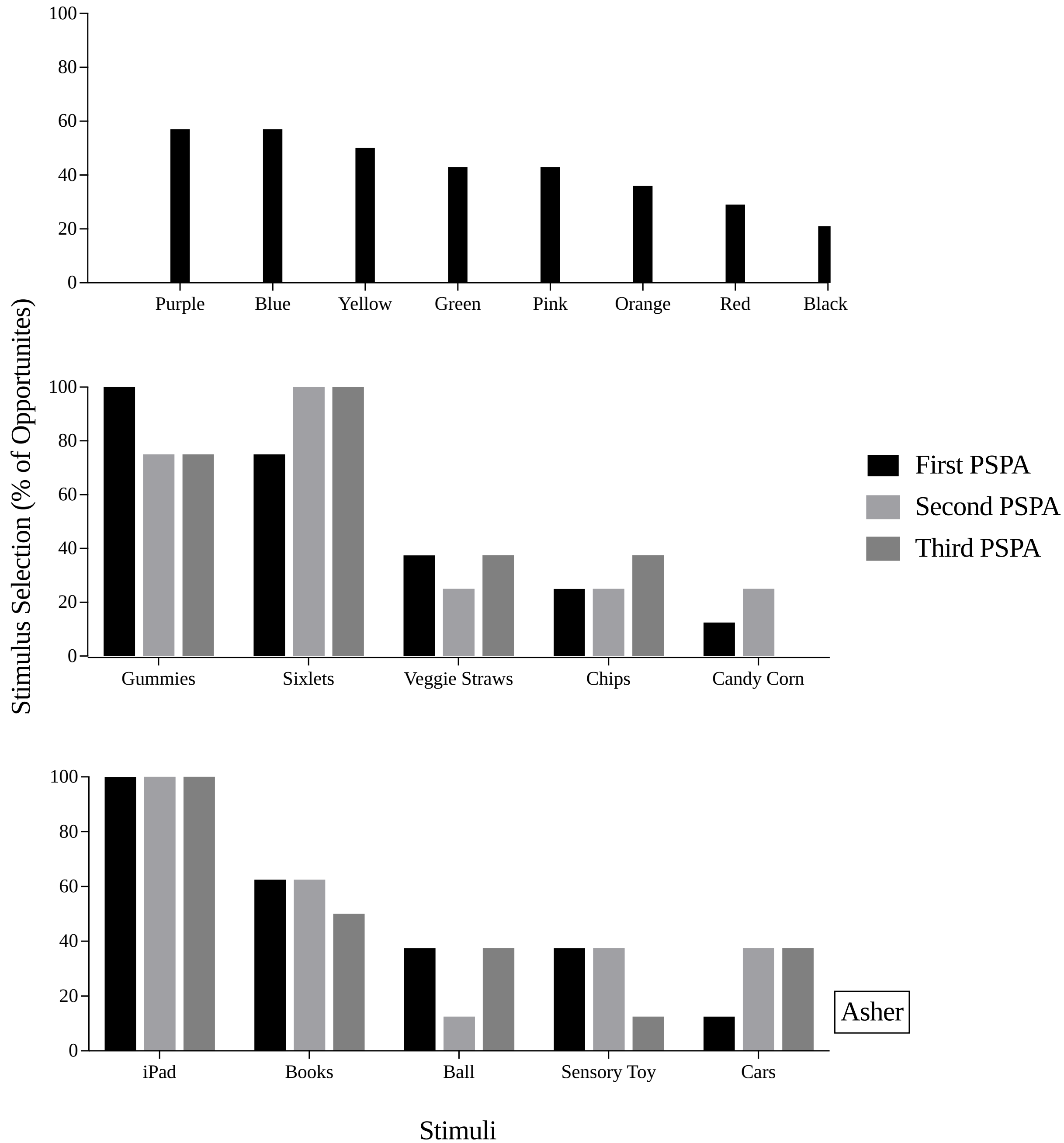

Figure 2. Results of the color, edible, and activity preference assessments for Asher.

Note. PSPA refers to paired stimulus preference assessment.

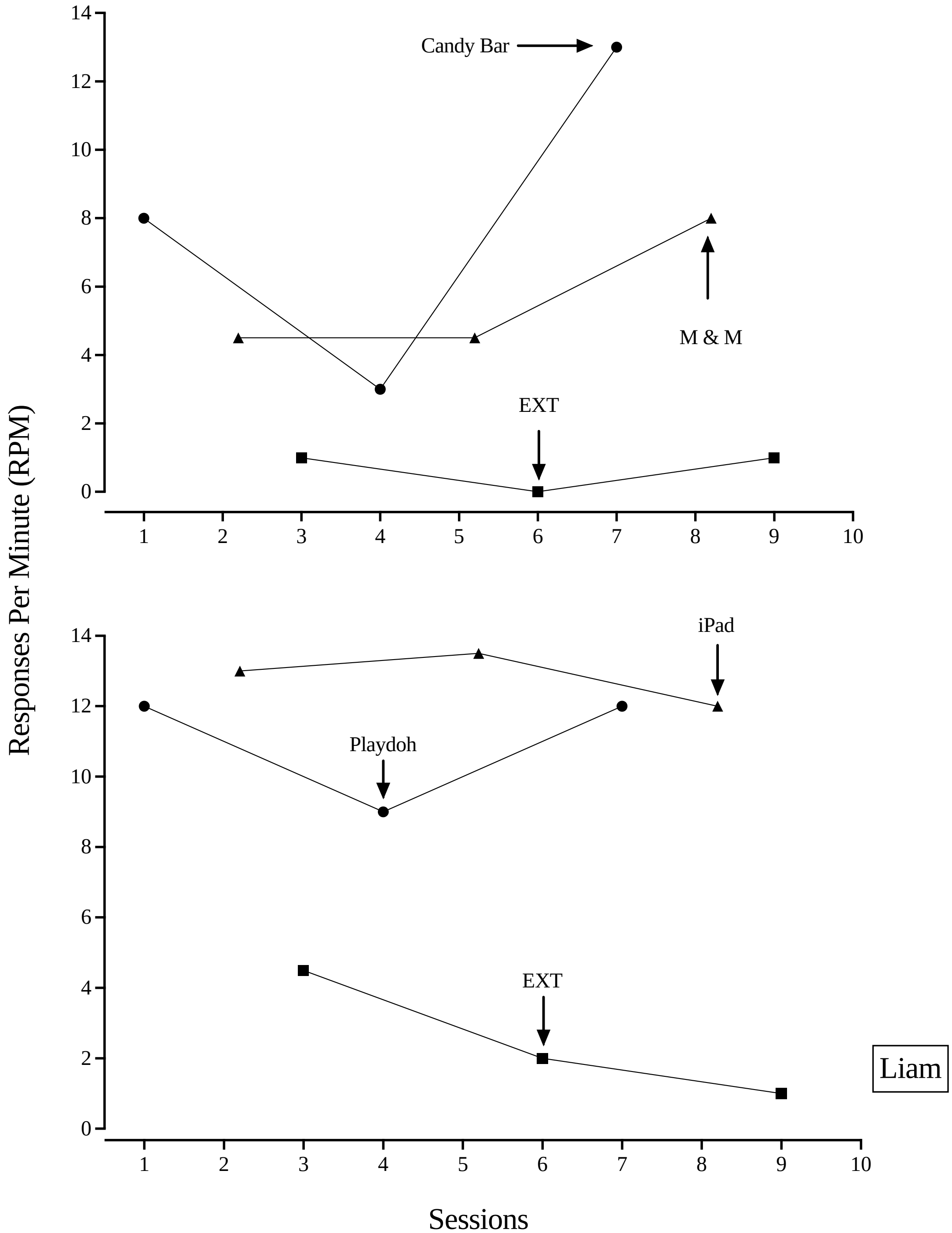

Figure 3. Results of the edible and activity reinforcer assessments for Liam.

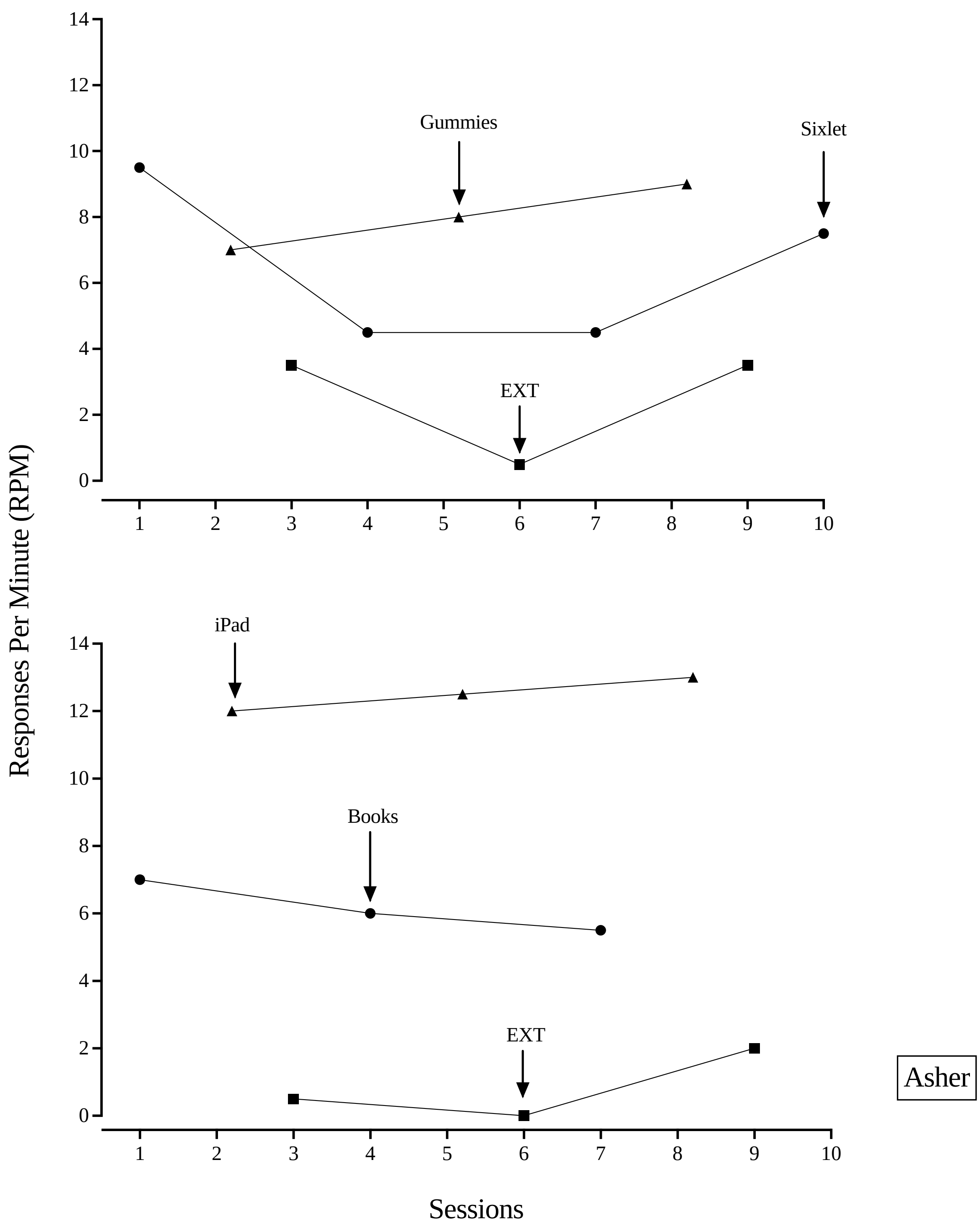

Figure 4. Results of the edible and activity reinforcer assessments for Asher.

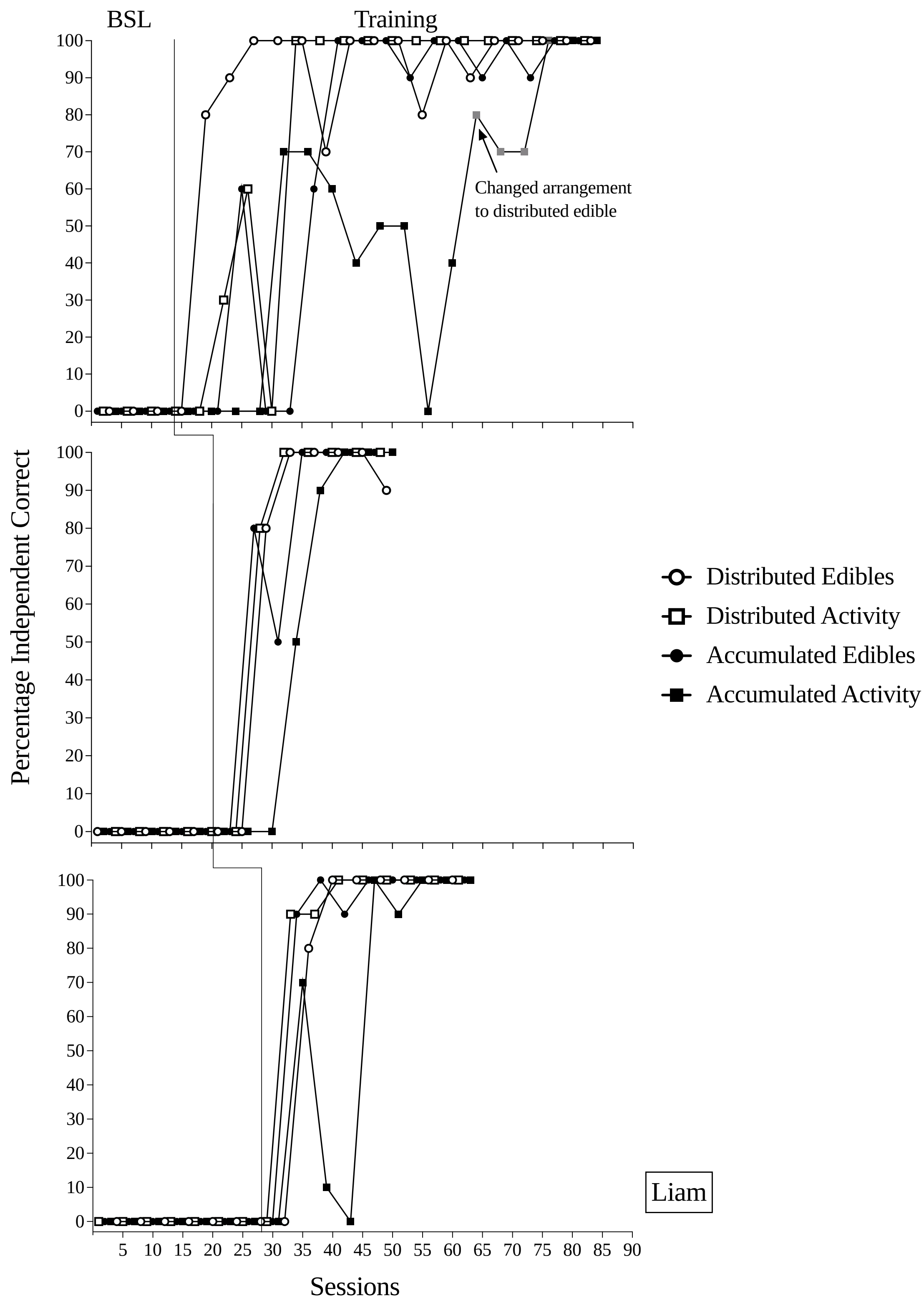

Figure 5. Results of the skill acquisition evaluation for Liam.

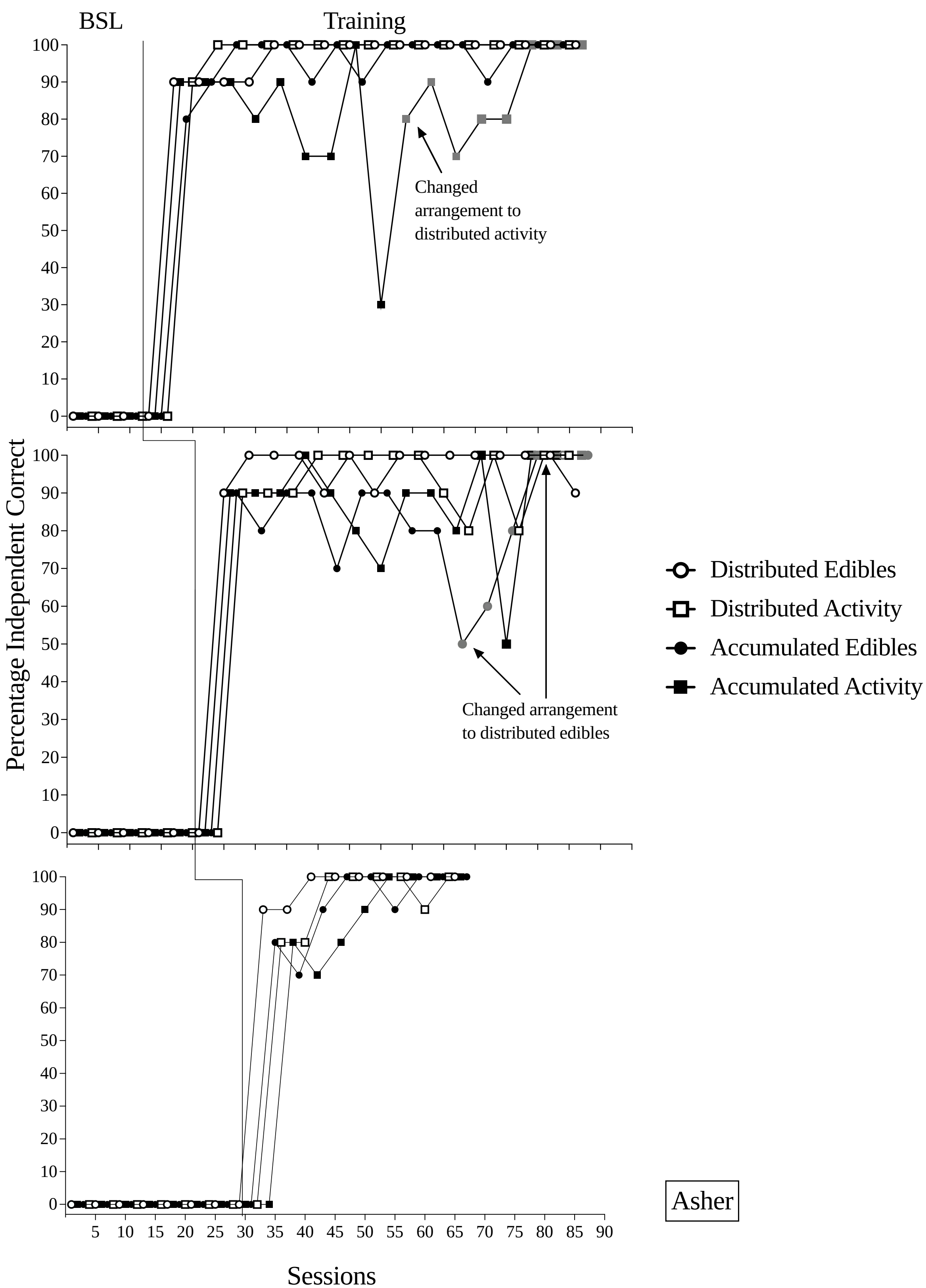

Figure 6. Results of the skill acquisition evaluation for Asher.

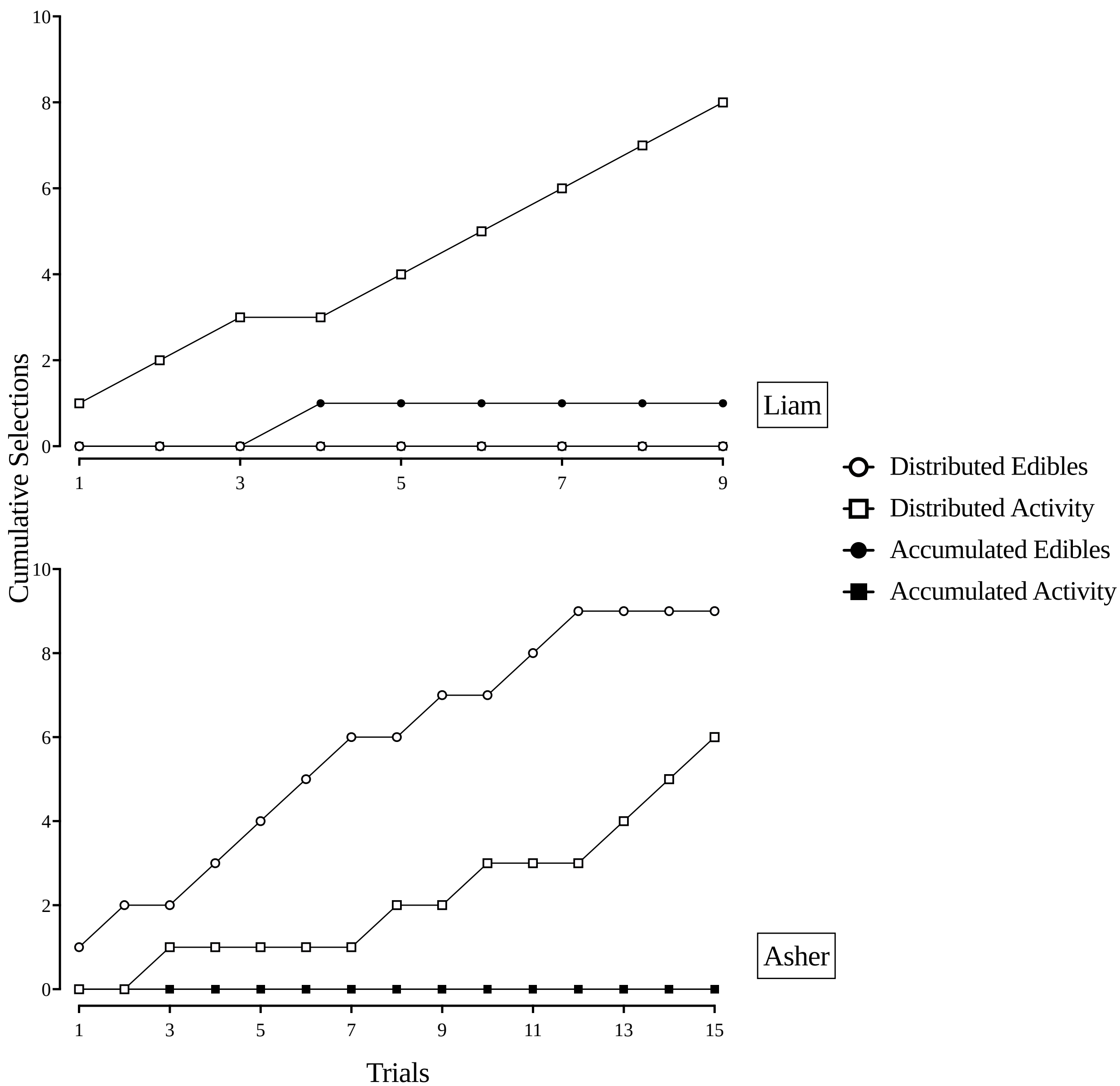

Figure 7. Results of concurrent-chains preference assessments.

CHAPTER SEVEN:

DISCUSSION

This study compared the relative efficacy and efficiency of distributed and accumulated reinforcer arrangements across activity and edible reinforcers during skill acquisition for young children with autism. For both participants, the distributed arrangements resulted in the greatest efficiency in terms of sessions and the distributed with edibles arrangement resulted in the shortest duration to mastery criterion. Furthermore, for both participants, the accumulated arrangements were the least efficient; specifically, to meet mastery, the accumulated with activity arrangement required the largest number of sessions and duration. Both participants required a similar number of sessions to reach mastery criterion across the two distributed reinforcer arrangements (i.e., Liam and Asher required a mean of 5.4 and 6.3 for edible; mean of 6.3 and 6 for activities, respectively) and we observed replication within and across participants as one of the distributed arrangements consistently required the least number of sessions to meet mastery criterion in each comparison. In terms of efficacy, both distributed arrangements resulted in acquisition across all comparisons and participants. In contrast, the accumulated with activity and edible arrangements resulted in acquisition for only 50% and 83% of comparisons, respectively. Additionally, the distributed with edibles condition was associated with the least amount of disruptive behavior for both participants. Finally, both participants indicated a preference for one or both distributed arrangements.

In our study, arrangements that included edibles required less duration to mastery criterion than the equivalent arrangements that included activities (i.e., distributed and accumulated with activity). Previous research that evaluated total training time found the accumulated arrangement to require less time than the distributed arrangement (Frank-Crawford et al., 2019; Joachim & Carroll., 2018). Frank-Crawford et al. (2019) used only activity-based reinforcers and for the participants that acquired skills in Joachim and Carroll (2018), only activity reinforcers were used for two participants and one participant had a choice between reinforcer classes, but activity and edible reinforcers were not evaluated separately. It is probable that it takes less time to consume an edible reinforcer than the allotted time with an activity and the difference in time to consume the reinforcers likely explains why our arrangements with edibles required less time. Furthermore, our conditions with edibles required fewer or a similar (i.e., distributed arrangements for Asher) number of sessions and were more efficacious than their equivalent arrangements with activities. Leaf et al. (2014) examined the effects of different reinforcer classes on tact acquisition using an FR1 schedule for independent responding; all participants acquired tacts in fewer teaching sessions when edibles were the reinforcer compared to tangibles, social reinforcers, or feedback. Thus, our results are similar to the findings of Leaf et al. Although effective and efficient, there are some ethical considerations for clinicians to consider with the use of edibles as a reinforcer; activity reinforcers may be more socially appropriate and have less of an impact on an individual's health (e.g., excessive calorie intake; Clark et al., 2020).

The results of this study did not replicate many of the findings from previous research (e.g., Kocher et al., 2015). Three studies (Frank-Crawford et al., 2019; Joachim & Carroll, 2018; Kocher et al., 2015) assessed the effects of accumulated and distributed reinforcer arrangements within skill acquisition programs completed in a DTT format. Kocher et al. (2015) found that for all participants, the cumulative duration of sessions was shorter and, across comparisons, mastery criterion was met most often for the accumulated arrangement. Additionally, regarding efficacy, for one participant, only the accumulated arrangement resulted in acquisition. Similarly, in Joachim and Carroll (2018), of the participants that acquired the target skills, the accumulated arrangement resulted in acquisition in fewer sessions for two of three participants. Additionally, in Frank-Crawford et al. (2019), when these arrangements were evaluated in terms of skill acquisition, fewer sessions and shorter total duration to mastery were required for one of their two accumulated conditions in six out of seven evaluations. Additionally, in terms of efficacy, the distributed arrangement did not result in mastery level acquisition in two comparisons, whereas the accumulated arrangement did not result in mastery for only one comparison. Overall, the results of previous research evaluating these arrangements on skill acquisition within a DTT format suggest an accumulated arrangement is more efficacious and efficient in comparison to a distributed arrangement (Frank-Crawford et al., 2019; Joachim & Carroll., 2018; Kocher et al., 2015); however, in the current study, the distributed arrangements were most efficacious and efficient for both participants.

Previous studies have also assessed participants' preference for distributed and accumulated reinforcer arrangements (e.g., DeLeon et al., 2014). Across all of the studies that we identified, in two all or most participants preferred the distributed arrangement (Robinson & St. Peter, 2019; Ward-Horner et al., 2017), in three studies preference was idiosyncratic across participants (Fulton et al., 2020; Joachim & Carroll, 2018; Kocher et al., 2015), in one study participants did not display a preference (Weston et al., 2020), and for the remaining seven studies most participants (Falligant et al., 2020; Frank-Crawford et al., 2019) or all participants (Bukala et al., 2015; DeLeon et al., 2014; Falligant & Kornman, 2019; Fienup et al., 2011; Ward-Horner et al., 2014) preferred the accumulated arrangement. It is also important to note that for the three studies that used distributed and accumulated reinforcer arrangements within skill acquisition (Frank-Crawford et al., 2019; Joachim & Carroll, 2018; Kocher et al., 2015), two attained idiosyncratic results (Joachim & Carroll., 2018; Kocher et al., 2015) and for one, the majority of participants preferred an accumulated arrangement (Frank-Crawford et al., 2019); in contrast, in our study, participants displayed a preference for one or both distributed arrangements. Thus, the results of our study are similar to those of Robinson and St. Peter (2019) and Ward-Horner et al. (2017) but conflict with the findings of the other studies.

Another dependent variable in the current study was disruptive behavior. Few studies investigated the impact of distributed and accumulated reinforcer arrangements on disruptive behavior (Fulton et al., 2020; Robinson & St. Peter, 2019). In the current investigation, the accumulated arrangements resulted in more disruptive behavior than the distributed arrangements of the same reinforcer class (i.e., edibles, activity). These results also differed from previous research. For example, Robinson and St. Peter (2019) assessed the impact of these arrangements with activity reinforcers on rates of academic responses (i.e., amount of math flashcards read from a stack in 3 min) and problem behavior for three participants diagnosed with ADHD; all participants engaged in less problem behavior during the accumulated arrangement in comparison to the distributed arrangement. Similarly, Fulton et al. (2020) evaluated the impact of these arrangements with activity reinforcers on compliance with an academic task (i.e., reinforcement contingency was in place for compliance rather than correct responding) with three participants who emitted escape-maintained problem behavior; for two of these participants, the accumulated arrangement resulted in lower levels of problem behavior. It is important to note that for the two main dependent variables in these previous studies, rate of academic responses (Robinson & St. Peter, 2019) and compliance with an academic task (Fulton et al., 2020), the accumulated arrangement resulted in superior or similar outcomes, whereas, in the current study, our results for all dependent variables favored the distributed arrangements.

There are several plausible reasons our results differed from those of previous research. First, previous studies included tokens (Frank-Crawford et al., 2019; Joachim & Carroll, 2018) within one or both reinforcer arrangements. Although we placed a symbol on a plate to signify time earned with the activity during the accumulated with activity arrangement, we did not conduct token training prior to the skill acquisition evaluation as done in these previous studies (Frank-Crawford et al., 2019; Joachim & Carroll., 2018). It is possible that the tokens delivered within these other studies were conditioned reinforcers and thus the accumulated arrangements actually included a FR1 schedule of reinforcement. This hypothesis is supported by results of Frank-Crawford et al. (2019), in which the accumulated arrangement was evaluated with and without tokens and fewer sessions to mastery were required for most evaluations when the accumulated arrangement included tokens.

Additionally, participants' characteristics (e.g., skills repertoire, history with various reinforcer arrangements) may have been responsible for the differing outcomes. The participants in the current study were 3.67 and 4.25 years old; however, in the related skill acquisition studies, one participant was 4.58 years (Joachim & Carroll., 2018), and all other participants were between ages 5 and 24 years (Frank-Crawford et al., 2019; Joachim & Carroll, 2018; Kocher et al., 2015). It is plausible that the effects of these reinforcer arrangements may differ across ages due to participants' skills repertoire or different histories with the reinforcer arrangements. For example, Louge et al. (1996) compared conditions in which children either obtained a smaller immediate edible reinforcer or a larger delayed edible reinforcer and found increased self-control (i.e., selecting the larger delayed reinforcer) in their 5-year-old participants in comparison to their 3-year-old participants. The increase in self-control observed in Louge et al. across even a small age difference may relate to why the distributed arrangements were more preferred, efficient, effective, and associated with less problem behavior for our participants. For instance, we observed more disruptive behavior in the accumulated arrangements whereas the accumulated arrangement was associated with the least amount of problem behavior in previous studies that included older participants (e.g., 8-11 years old; Fulton et al., 2020; Robinson & St. Peter, 2019). However, although slightly older, for the 4.58 year-old participant in Joachim and Carroll (2018), the accumulated arrangement was the most efficient whereas in our study, skills were mastered in fewer sessions with the distributed arrangement. Thus, to determine whether self-control mediates the efficacy and efficiency of these reinforcer arrangements, it is important that future studies directly assess participants' self-control at the on-set and throughout the study.

An additional potential explanation for the differing results related to disruptive behavior, may be the inclusion of condition-specific stimuli (e.g., verbal contingency review; colored card). Specifically, we observed more disruptive behavior in the accumulated arrangements whereas in previous studies the distributed arrangement was associated with more disruptive behavior (Fulton et al., 2020; Robinson & St. Peter, 2019). As suggested by Mishel and Mishel (1983), children under 6-years-old tolerate only minimal delays; once 6-years-old, waiting skills typically improve. As the accumulated arrangements involve tolerating a delay, these arrangements may have had a different level of aversiveness for the participants from the current study, who were young, compared to the participants in related studies (e.g., 8-11 years old; Fulton et al., 2020; Robinson & St. Peter, 2019). Like the other studies, our study included antecedent stimuli (e.g., contingency statement and color card) to inform the participant of the contingencies in effect. It is plausible that our condition-specific stimuli functioned as a conditioned motivating operation reflexive (CMO-R). A CMO-R is an antecedent stimulus in which its presence or absence has been associated with a worsening condition, and as a result, removal of that stimulus has reinforcing value (Michael, 1993). Carbone et al. (2010) noted that a previously neutral stimulus (e.g., instruction, materials) can become a CMO-R during DTT and as a result, evoke disruptive behaviors that have been associated with task removal. In our study, the condition specific stimuli for the accumulated arrangements may have functioned as a CMO-R for participants and occasioned disruptive behaviors that were reinforced with task removal in the past (i.e., prior to the study); whereas, for the participants in previous studies who were older (Fulton et al., 2020; Robinson & St. Peter, 2019) this arrangement may have not been aversive therefore, it's likely that the antecedent stimuli did not function as a CMO-R.

Furthermore, participants' history with different reinforcer arrangements might impact their efficacy and efficiency and given that our participants were young children, it is possible they had limited experience with accumulated reinforcer arrangements prior to their participation in our study. In contrast, the adolescents that participated in previous studies may have had a longer history with accumulated reinforcers arrangements; for example, all participants in Frank-Crawford et al. (2019) had a history with tokens in their educational or behavioral programming indicating experience with accumulated schedules. However, although applied studies have not directly examined the effects of history on responding with ratio schedules (St. Peter & Vollmer, 2009), results of recent research indicate more exposure to certain procedures can impact acquisition outcomes (e.g., Coon & Miguel., 2012; Roncati et al., 2019). For example, Coon and Miguel (2012) assessed the effects of programmed increased exposure to a specific type of prompt on acquisition of intraverbals for TDC. The participants were taught six intraverbals with echoic and tact prompts, the type of prompt that was the least efficient (i.e., required the most sessions to mastery) underwent additional exposures (i.e., training additional intraverbals); post additional exposures, for all participants, the prompt type that had the most exposure, even though originally less efficient, was the most efficient. These results suggest an increased history with specific procedures can impact efficiency outcomes; however, this topic requires further evaluation with reinforcer arrangements.

Lastly, in our study the accumulated with activity arrangement seemed to become efficacious after repeated exposure to that arrangement (i.e., Liam met mastery in this condition in the second and third comparisons; Asher in the third only). There are a few plausible reasons this arrangement may have become efficacious. First, to equate this condition to accumulated with edibles, contingent on an independent correct response, a symbol was put on a plate to signify time earned with an activity. It is possible that this symbol may have acquired reinforcing properties due to being paired with the delivery of the activity reinforcer (e.g., stimulus-stimulus pairing; Miguel et al., 2001) or via operant discrimination training (ODT; Taylor-Santa et al., 2014) and thus a FR1 was in effect during the accumulated reinforcer conditions but only during the latter portion of the current study. In addition, the contingency stated at the onset of each session may have, after repeated exposure, increased the participants' ability to tolerate delayed access. For instance, Toner and Smith (1977) found that preschool children who stated a rule overtly waited for reinforcement longer than the children who were not instructed to state the same rule. It is possible that our participants, after hearing these contingencies repeatedly, began to repeat these verbal statements (i.e., rules) covertly which in return may have assisted in tolerating the delay to reinforcement and thus decreased problem behavior in the accumulated with activity arrangement. For example, during the accumulated with activity condition, when including time in reinforcement, Liam engaged in disruptive behavior in 20.6% of session time during the first comparison and only 7.5% of session time in the third comparison.

This study had some procedural limitations. Although we attempted to equate targets for difficulty, it is plausible that participants had more exposure with certain targets (e.g., seeing the target stimulus outside of sessions); as a result, acquisition for those targets may have occurred in fewer sessions. Additionally, we used symbols during the accumulated with activity condition to signify timed earned with the activity reinforcer; however, it is unclear if the addition of these symbols effected acquisition outcomes. Given that in clinical settings the delivery of additional stimuli signifying reinforcement may not be feasible (e.g., naturalistic teaching procedures), future research should consider evaluating this condition without delivering additional stimuli or tokens after independent correct responding. Another limitation of this study is the inconsistent procedures in place to control for establishing operations. In this study, participants did not have access to the items used as activity reinforcers or the specific edibles outside of sessions in their ABA clinic. However, due to participant and experimenter availability, sessions for both participants occurred after lunch; thus, it is plausible that due to the recent consumption of food the establishing operation for edible reinforcers were temporarily diminished. However, if the establishing operation for edibles was diminished, rate of acquisition would likely have been negatively impacted, yet in this study the distributed with edible arrangement was the most efficient condition for both participants. Future research should attempt to reduce the impact the environment may cause on the establishing operations for both types of reinforcers.

Additionally, in this study, we measured disruptive behavior across arrangements; the decision to measure disruptive behavior occurred after completion of data collection with both participants. As a result, consequences for disruptive behavior had not been specified and it is plausible the behaviors the experimenter emitted in response to disruptive behavior could have differed across sessions and impacted the probability of these responses occurring again. Future research should continue to investigate the impact of these reinforcer arrangements on disruptive behavior and specify consistent consequences for disruptive behavior across the different conditions. Additionally, as disruptive behavior was measured by review of video recordings and these videos ended after consumption of the final reinforcer in a session, any disruptive behavior that occurred after the activity reinforcer was taken away when the consumption period ended was not recorded. Clinically, it would be important to know if disruptive behavior is more likely to occur with a certain arrangement or reinforcer after a session is completed; therefore, future research should consider measuring disruptive behavior after consumption of the final reinforcer. Furthermore, there were only two participants in this study. Additional replications within and across participants are necessary to determine generality of these results.

The results of this investigation have an immediate implication for clinical practice. In this study, the distributed with edibles condition was the most efficient and resulted in the least amount of disruptive behavior. Results of a recent survey I conducted on current (i.e., within the past two years) practices for individuals receiving special education services or individuals with developmental, emotional, or behavior disorders indicated that 85.7% of respondents (n=189) reported using edibles as a reinforcer, 83% reported using a distributed reinforcer arrangement, and only 36.4% reported using a distributed reinforcer arrangement most frequently. Of note, for the respondents who reported working primarily with children younger than 5-years-old (n=41), 90.3% reported using edibles as a reinforcer, 85.4% reported using a distributed arrangement, and 51.2% reported that they most commonly implement a distributed arrangement. Given that in the current study, all participants were younger than 5-years-old, it seems that clinicians working with younger children could consider utilizing a distributed reinforcer arrangement.

In summary, this study found that when considering duration and sessions to mastery criteria, the most efficient condition for all participants was distributed with edibles. Thus, for clinicians working with young children, the use of a distributed arrangement with edibles should be considered, unless edible reinforcers are not appropriate. In these cases, the distributed with activity condition should be used because in the current study this was the second most efficient and effective. Additionally, when excluding time in reinforcement, the accumulated with activity condition resulted in the most disruptive behavior for both participants so, whenever possible, this reinforcer arrangement should be avoided with young children. Additionally, in this study, we observed correspondence between preference and the most efficient conditions. Although this may not always be the case, when possible, clinicians should attempt to include the participant's most preferred arrangement within their programming.

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APPENDICES

Appendix A: Caregiver Questionnaire

Participant:_____________ Date:________________

1) How old is your child?
   ____
   ____
   ____
2) What diagnoses does your child have?
   ____
   ____
   ____
3) What types of services does your child receive?
   ____
   ____
   ____
4) What are your child's favorite activities?
   ____
   ____
   ____
5) What are your child's favorite foods?
   ____
   ____
   ____
6) Who is your child's BCBA?
   ____
   ____
   ____
7) Does your child: (please put a check mark)

- ☐ Feed orally
- ☐ Sit at a table for two minutes
- ☐ Have normal hearing
- ☐ Engage in severe problem behavior that may pose risk of injury. If so, what does this look like?

Appendix B: BCBA Questionnaire

Participant:____________ BCBA:______________ Date:_______________

8) How long has _______ been receiving ABA services?

____
____
____

9) Approximately how many hours of ABA services does ________ receive a week?

____
____
____

10) Does ________ have a history with discrete trial training? If so, for how long?

____
____
____

11) Has _________ used tokens? If so, please report if they are currently being used, for how long they have been used, and if systemic token training was conducted?

____
____
____

12) Does ________ earn edibles as a reinforcer? If so, for what and on what schedule (i.e. FR1)

____
____
____

13) Does _______ earn activities (e.g., iPad, puzzle, videos) as a reinforcer? If so, for what and on what schedule (i.e., FR1)?

____
____
____

Appendix C: Target Identification Data Sheet/ IOA/ PI

Name:_____ Date: _______ Participant:________ IOA/Primary:_______

Note: + = fully independent correct response, - = incorrect response

Target	Probe 1	Probe 2	Probe 3	Percentage correct	Notes

*in the case of an approximation write out what was said

Data Collection:

Procedural Integrity:

	Tally opportunities:	Tally occurrences:
Experimenter established attending before each trial		
Behavior-specific praise for session behavior every 2-3 trials > that 3s after participants response		
Intertrial interval of 3 s		
Break offered after session		
Total		

Appendix D: Acquisition Evaluation Data Sheet/IOA/PI

Name:_____ Date: _______ Participant:________ Session: ______ Condition:_______
IOA/Primary:_______

Key: DA- 30 s of activity after every independent correct response DE- edible after every independent correct response AE- edible put on plate after every correct response AA- symbol for activity after every correct response.

1) Did the experimenter start the time when the first trial began: Y/N
2) Did the experimenter stop the timer after all reinforcers were consumed: Y/N
3) Was a break offered following session completion: Y/N

Attending (did PI ensure attending)	**Prompt**	**S^D delivered**	**Participant response**	**Consequence delivered** (did the instructor deliver the correct consequence)
Yes/No	0s/ 2s full/ 2s partial		+ / - +P/ -P	DA /DE/AE/AA Error Correction / N/A
Yes/No	0s/ 2s full/ 2s partial		+ / - +P/ -P	DA /DE/AE/AA Error Correction / N/A
Yes/No	0s/ 2s full/ 2s partial		+ / - +P/ -P	DA /DE/AE/AA Error Correction / N/A
Yes/No	0s/ 2s full/ 2s partial		+ / - +P/ -P	DA /DE/AE/AA Error Correction / N/A
Yes/No	0s/ 2s full/ 2s partial		+ / - +P/ -P	DA /DE/AE/AA Error Correction / N/A
Yes/No	0s/ 2s full/ 2s partial		+ / - +P/ -P	DA /DE/AE/AA Error Correction / N/A
Yes/No	0s/ 2s full/ 2s partial		+ / - +P/ -P	DA /DE/AE/AA Error Correction / N/A
Yes/No	0s/ 2s full/ 2s partial		+ / - +P/ -P	DA /DE/AE/AA Error Correction / N/A
Yes/No	0s/ 2s full/ 2s partial		+ / - +P/ -P	DA /DE/AE/AA Error Correction / N/A
Yes/No	0s/ 2s full/ 2s partial		+ / - +P/ -P	DA /DE/AE/AA Error Correction / N/A

Appendix E: Concurrent Chains Data Sheet/IOA/PI

Name: ___________ Date: _________ Reliability Y/N Reliability: ____/____ = _____%

Key: DE – distributed with edibles, DA- distributed with activity, AE- accumulated with edibles, AA- accumulated with activity

Trial	Placement	Correct Placement	Vocal instruction (i.e. choose one)	Therapist allows 5sec for participant to	Therapist implements a session of the	Trial represented once if no	Trial discontinued if no selection is made on	5-10 seconds between trials?	Data recorded after trial?
1	DE AA DA AE	Y N	Y N	Y N	Y N	Y N N/A	Y N N/A	Y N	Y N
2	AA DA AE DE	Y N	Y N	Y N	Y N	Y N N/A	Y N N/A	Y N	Y N
3	DA AE DE AA	Y N	Y N	Y N	Y N	Y N N/A	Y N N/A	Y N	Y N
4	AE DE AA DA	Y N	Y N	Y N	Y N	Y N N/A	Y N N/A	Y N	Y N
5	DE AA DA AE	Y N	Y N	Y N	Y N	Y N N/A	Y N N/A	Y N	Y N
6	AA DA AE DE	Y N	Y N	Y N	Y N	Y N N/A	Y N N/A	Y N	Y N
7	DA AE DE AA	Y N	Y N	Y N	Y N	Y N N/A	Y N N/A	Y N	Y N
8	AE DE AA DA	Y N	Y N	Y N	Y N	Y N N/A	Y N N/A	Y N	Y N

9	DE AA DA AE	Y N	Y N	Y N	Y N	Y N N/A	Y N N/A	Y N	Y N
10	AA DA AE DE	Y N	Y N	Y N	Y N	Y N N/A	Y N N/A	Y N	Y N
11	DA AE DE AA	Y N	Y N	Y N	Y N	Y N N/A	Y N N/A	Y N	Y N
12	AE DE AA DA	Y N	Y N	Y N	Y N	Y N N/A	Y N N/A	Y N	Y N

Appendix F: Caregiver and BCBA Social Validity Questionnaire

Circle your response:

1. Teaching skills through a simplified, systematic, tabletop approach (discrete trial training) is appropriate.

Strongly disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Strongly agree
1	2	3	4	5

2. Using small pieces of preferred food following correct responding is appropriate.

Strongly disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Strongly agree
1	2	3	4	5

3. Allowing access to a preferred activity (e.g., iPad, computer, etc.).for a short period following correct responding is appropriate.

Strongly disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Strongly agree
1	2	3	4	5

4. Allowing access to earned reinforcer immediately is appropriate (edible or activity right away).

Strongly disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Strongly agree
1	2	3	4	5

5. Allowing access to accumulated earned reinforcer after a set of learning trials have occurred is appropriate (getting the amount of edibles or activity time earned at the end of work).

Strongly disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Strongly agree
1	2	3	4	5

6. Using the teaching method that is most efficient (the one that lead to learning the fastest) is important

	Strongly disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Strongly agree
	1	2	3	4	5

7. Using the teaching method that the child prefers the most is important

	Strongly disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Strongly agree
	1	2	3	4	5

8. If the most efficient and the most preferred teaching method are not the same which should you use?

   Circle your response:

   Efficient   Preferred