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**Accumulated- and Distributed-Reinforcer Arrangements in the Treatment of Challenging
Mealtime Behavior**

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Abstract

Treatment for inappropriate mealtime behavior often includes extinction and differential reinforcement of alternative behavior (DRA) in a distributed arrangement in which delivery of brief reinforcer access immediately follows each appropriate mealtime response. Alternatively, DRA may be arranged using accumulated reinforcement wherein delivery of longer, continuous access to reinforcers follows the consumption of multiple consecutive bites. Research has suggested that individuals prefer and perform better under accumulated arrangements in academic settings; however, no research to date has evaluated the efficacy of accumulated arrangements with children with feeding disorders. We compared preference for and efficacy of distributed and accumulated (with and without tokens) reinforcement with nonremoval of the spoon. All three treatments effectively reduced inappropriate mealtime behavior and increased acceptance for 2 participants and decreased packing and increased mouth clean for 1 participant. Two participants preferred distributed reinforcement and one preferred accumulated reinforcement without tokens. Findings differ from some previous research, which demonstrated that participants favored accumulated arrangements in academic contexts.

Keywords: accumulated reinforcement, choice, differential reinforcement of alternative behavior, distributed reinforcement, nonremoval of spoon, pediatric food refusal

Accumulated- and Distributed-Reinforcer Arrangements in the Treatment of Challenging Mealtime Behavior

Many individuals with intellectual and developmental disabilities (IDD) exhibit feeding difficulties, such as food selectivity and refusal (e.g., Rezaei et al., 2011). These behaviors place the individual at increased risk for malnutrition as well as reliance on enteral feeding or hospitalization (e.g., Williams et al., 2007). Furthermore, significant feeding problems among children are associated with high levels of caregiver stress (e.g., Garro et al., 2005). Fortunately, behavioral interventions have proven highly effective in reducing feeding problems among individuals with IDD (e.g., Sharp et al., 2017; Volkert & Vaz, 2010; Williams et al., 2007).

One behavioral intervention frequently used to increase acceptance of bites of food and decrease inappropriate mealtime behavior is differential reinforcement of alternative behavior (DRA) with escape extinction. With DRA and escape extinction, reinforcement is provided following an appropriate mealtime behavior, such as acceptance of a bite of food or having a clean mouth where food is no longer present, while escape from the feeding context is no longer permitted following inappropriate behavior (e.g., LaRue et al., 2011; Patel et al., 2002; Piazza et al., 2003; Valdimarsdottir et al., 2010). Differential reinforcement of alternative behavior typically arranges for the delivery of reinforcers using distributed reinforcement. That is, a reinforcer is delivered immediately for a relatively brief period contingent on each appropriate mealtime response. For example, a child may accept one bite of food and then receive 15-s access to a preferred video.

Although previous studies have demonstrated that DRA with escape extinction arranged using distributed reinforcement can reduce inappropriate mealtime behavior and increase bite acceptance (e.g., Ahearn et al., 1996; Piazza et al., 2003), recent related research has suggested

that many individuals with IDD may prefer, and perform better under, accumulated-reinforcement arrangements (e.g., Bukala et al., 2015; DeLeon et al., 2014; Fienup et al., 2011; Frank-Crawford et al., 2019). In accumulated reinforcement, learners receive longer, more continuous access to reinforcers after completing a larger response requirement. Under such an arrangement, a child may accept five bites of food and then receive 75 s of uninterrupted access to a video.

To date, research comparing accumulated and distributed reinforcement has largely examined preference for and efficacy of these arrangements in the context of teaching new skills (e.g., Frank-Crawford et al., 2019; Kocher et al., 2015; Joachim & Carroll, 2017) and treating escape-maintained problem behavior, such as aggression (e.g., Frank-Crawford et al., 2021; Fulton et al., 2020; Robinson & St. Peter, 2019). Overall, results of these studies have largely indicated that many learners with IDD prefer to accumulate access to reinforcers, and that accumulated reinforcement produces more efficient responding. Furthermore, accumulated reinforcement is often as effective as, or more effective than, distributed reinforcement in facilitating the acquisition of new skills and reducing problem behavior. For example, Fulton et al. (2020) compared the efficacy of accumulated and distributed reinforcement with extinction in reducing escape-maintained aggression and destructive behaviors for three individuals with IDD. For two of the three participants, accumulated reinforcement was more effective than the distributed arrangement; for the third participant, both interventions were equally effective. Frank-Crawford et al. (2021) extended this line of work by examining these arrangements in the absence of extinction. Again, in most cases, the accumulated arrangement was as effective as the distributed arrangement when the reinforcement schedule was dense.

Although some studies have evaluated distributed and accumulated reinforcement without the use of extinction for problem behavior (e.g., Frank-Crawford et al., 2021), escape extinction has been demonstrated to be an integral component of treatment packages addressing food refusal (e.g., LaRue et al., 2011; Piazza et al., 2003). Interestingly, although overall results of such studies often indicate that both DRA with escape extinction and escape extinction alone are effective, DRA with escape extinction may be associated with various benefits not seen with escape extinction alone. For example, the addition of DRA has been associated with reduced negative vocalizations to a greater degree than extinction alone (e.g., Piazza et al., 2003). In addition, DRA with escape extinction may be associated with less variability in acceptance, mouth cleans, and inappropriate mealtime behavior for various participants (e.g., LaRue et al., 2011; Piazza et al., 2003). However, no study to date that we are aware of has specifically compared distributed and accumulated reinforcement for treating inappropriate mealtime behaviors. Findings such as those described by Fulton et al. (2020) and Frank-Crawford et al. (2021), combined with those examining these arrangements in skill acquisition, suggest that there are many advantages associated with accumulated reinforcement for increasing skills and decreasing problem behavior. Such advantages may also extend to treatment of feeding problems. For example, and as previously noted, distributed reinforcement in the context of DRA with escape extinction is frequently used for individuals with feeding problems. Given the results from recent research supporting the use of accumulated arrangements in the treatment of escape-maintained problem behavior, it is possible that accumulated reinforcement may also prove as, or even more, effective than distributed reinforcement in treating inappropriate mealtime behavior and might be preferred by individuals who exhibit feeding problems. Importantly, such a finding would permit clinicians more flexibility in treatment selection and enable them to better balance

treatment efficacy with client rights (e.g., Frank-Crawford et al., 2019). Accumulated reinforcement may also lead to more efficient responding; that is, accumulated arrangements may result in more rapid completion of meals which would allow for more time for the child to engage in more preferred activities outside of meals. Furthermore, accumulated reinforcement may more closely resemble naturally occurring meals. Distributed reinforcement arranges for frequent reinforcer deliveries which may disrupt ongoing responding and require the caregiver stop his or her own meal to deliver arbitrary reinforcers, such as access to a tablet, at the table in the middle of the meal. Accumulated reinforcement, on the other hand, arranges for reinforcer delivery following the completion of the entire response requirement. Thus, the caregiver could complete his or her meal with fewer interruptions and reinforcement could be provided away from the table after the child has finished eating. It is possible that for these reasons, caregivers might also prefer the accumulated arrangement. If that is the case, they may also have higher treatment fidelity with this arrangement. Thus, research examining *both* distributed and accumulated reinforcement for individuals who engage in inappropriate mealtime behavior is warranted.

It is important to understand how different reinforcement arrangements, used with escape extinction, affect mealtime behavior to maximize the effectiveness of reinforcement-based intervention for food refusal. Whether distributed- and accumulated-reinforcement arrangements plus nonremoval of the spoon differentially affect mealtime responses is unclear. It is also possible that they produce similarly efficacious outcomes; this would be important to ascertain as it would allow clinicians more flexibility with respect to treatment selection. Thus, the purpose of the present study was to (a) compare the efficacy of distributed- and accumulated-reinforcement arrangements plus nonremoval of the spoon for increasing acceptance and mouth

clean and decreasing inappropriate mealtime behavior and packing, and (b) evaluate preference for distributed- and accumulated-reinforcement arrangements plus nonremoval of the spoon among children who exhibited inappropriate mealtime behavior or packing. Additionally, the effects of and preference for accumulated-reinforcement arrangements were evaluated with and without tokens to determine whether the addition of conditioned reinforcement improved the efficacy of or preference for the accumulated arrangement.

Method

Participants

Three children admitted to an intensive pediatric feeding disorders program for treatment of inappropriate mealtime behavior (e.g., food refusal) and food packing (i.e., holding food in mouth) participated. Inclusion criteria were the child (a) had a history of consuming food orally via caregiver report or direct observation and (b) engaged in more than 0.5 inappropriate mealtime behaviors per minute or packed more than 20% of presented bites. Julian was a 5-year-old male diagnosed with Ehlers-Danlos syndrome, attention deficit hyperactivity disorder, gastroparesis, and multiple food allergies. Julian was referred for the assessment and treatment of inappropriate mealtime behavior (i.e., turning his head and batting at the spoon). Fletcher was a 5-year-old male diagnosed with chromosome 4q deletion syndrome, dysphagia, receptive expressive language disorder, developmental delays, and eosinophilic esophagitis. He was also referred for the assessment and treatment of inappropriate mealtime behavior. Functional analyses were conducted for Julian and Fletcher using the procedure outlined by Piazza et al. (2003). Results indicated that inappropriate mealtime behavior for both Julian and Fletcher was negatively reinforced by escape from the presentation of bites and positively reinforced by tangibles. Tina was a 5-year-old female diagnosed with oral-phase dysphagia who was referred

for the assessment and treatment of packing. A functional analysis was not conducted with Tina because inappropriate mealtime behavior was not observed during parent-fed meals and edible preference assessment. The interview portion of the interview-informed synthesized contingency analysis (Hanley et al., 2014) was conducted and suggested that packing may have been negatively reinforced by avoidance of swallowing nonpreferred foods. Additionally, packing was observed during parent-fed meals. During these meals, her parents responded to packing by providing escape (i.e., removing the bite from her mouth) and by providing access to tangibles and attention. Based upon the results of caregiver interviews and direct observations during the parent-fed meals, we concluded that escape and access to tangibles and attention reinforced Tina's packing.

Upon admission, participants received most of their nutritional and caloric needs via jejunostomy-tube (Julian) or gastrostomy-tube (Fletcher and Tina). Julian primarily consumed fries and peaches. His BMI was at the 72nd percentile. Julian inconsistently consumed very small amounts of regular texture food including peaches, French fries, and broccoli. Fletcher consumed small amounts of baby foods (e.g., Earth's Best[®] organic Stage 2 sweet potatoes and bananas) and additional foods at a regular texture. His BMI was in the 93rd percentile. Tina consumed many foods at a puree texture and drank milk and Pediasure; however, parents reported that she packed most bites during meals. Nutritionists indicated no nutritional deficiencies and her BMI was in the 95th percentile for weight for height. Although that percentile was high, the goal was to modify mealtime volume to appropriate portions of solids and drinks during the admission. Participants communicated vocally (i.e., spoke in three- to four-word sentences) and followed one- or two-step instructions. Participants were evaluated and monitored by the interdisciplinary team. Specifically, a pediatrician, nurse practitioner, and speech and occupational therapists

assessed the oral-motor and swallowing skills for each individual and confirmed that they had the prerequisite skills to chew regular texture foods prior to introducing them to meals.

Interdisciplinary team members identified the participants as safe oral eaters at the textures and bite sizes included in the current study.

Setting and Materials

Sessions took place in 3-m by 3-m treatment rooms equipped with a one-way observation window, chairs, a table, and a Rifton® chair for the participant. Other materials included foods, spoons, plates, napkins, timers, a highly preferred leisure item (e.g., iPad®, Dora the Explorer™ videos), four 6.3-cm by 6.3-cm cards of different colors, tokens, and a token board (laminated paper affixed with Velcro).

Response Measurement

Trained observers used Instant Data®, a computerized data-collection system, to record participant and therapist behavior during the reinforcer efficacy evaluation and the preference evaluation; therapists collected data on participant preferences using paper data collection sheets. For Julian and Fletcher, the dependent variables were frequency of inappropriate mealtime behavior, frequency of acceptance, frequency of bites taken, and latency to bite deposit. For Tina, observers recorded the frequency of packed bites, frequency of mouth clean, and latency to mouth clean. The frequency of inappropriate mealtime behavior was converted to responses per minute by dividing the frequency of responses by the session duration. We obtained the percentage of acceptance, bites taken, packed bites, and mouth cleans by dividing the frequency of each response by the number of bite presentations and multiplying the resultant quotient by 100. Finally, observers recorded the seconds to bite deposit and mouth clean (from the onset of the bite presentation) to obtain the latency to these responses.

We defined *inappropriate mealtime behavior* (Julian and Fletcher) as pushing the spoon or the feeder's hand, the participant turning his head at least 45° away from the spoon or covering his mouth. Observers scored *acceptance* if the participant deposited the entire bite in the mouth within 5 s of the bite presentation and an *expulsion* if any food larger than the size of a pea passed the plane of their lips after acceptance or deposit (expulsions did not occur). *Bite presentation* included placing the spoon within 3 cm of Julian and Fletcher's lips or placing the bite on the spoon on a plate on the tray in front of Tina. Observers also recorded *bite taken* when the therapist or participant deposited the entire bite into the participant's mouth, regardless of time following bite presentation. Thus, if the participant deposited the bit into their mouth within 5 s of the bite presentation, the observer scored both acceptance and bite taken simultaneously. Observers measured *latency to bite deposit* by pressing the key on the data collection program that started the timer when the bite was presented and pressing the key that stopped the timer when the therapist or participant deposited the entire bite in the participant's mouth or the end of the session. For example, if no bites entered the mouth (or if the participant engaged in inappropriate mealtime behavior during baseline), the latency to bite deposit equaled the duration from the first bite the therapist presented in the session to the termination of the session. For Tina, dependent variables included the percentage of bites packed and with mouth clean and latency to mouth clean. Observers recorded *packing* when Tina had food larger than a size of a pea in her mouth 30 s after the therapist or participant initially deposited the entire bolus. *Mouth clean* (a product measure of swallowing) was scored if the participant had no food larger than the size of a pea in the mouth 30 s after the therapist or participant deposited the bite into the participant's mouth. *Latency to mouth clean* was defined as the amount of time that elapsed after the bite deposit to when the mouth had no food at the mouth check or session termination. Like

data collection for Julian and Fletcher, latency to mouth clean could equal the entire session duration if Tina packed and never swallowed the first bite presented in the session. The *target response* for Julian and Fletcher was bite taken and mouth clean for Tina.

Observers recorded therapist behavior to measure accuracy of treatment implementation. During the reinforcer efficacy evaluation and preference evaluation, observers used Instant Data® to record bite presentation (previously defined), therapist delivery of a vocal prompt to take a bite (programmed to occur within 3 s of the bite presentation), praise (e.g., “Good job taking that bite”), token delivery (placing a token on the token board), and reinforcer access (providing access to a high-preferred tangible). Praise, token delivery, and reinforcer access were programmed to occur within 3 s of an acceptance or mouth clean. However, observers recorded these responses as they occurred in real time during the session regardless of whether or not the therapist implemented the treatment components correctly. The researchers evaluated treatment integrity separately, reported below.

During the preference evaluation, observers also collected pencil-and-paper, trial-based data on the participant’s selection (i.e., touching, pointing to, or vocally selecting the colored card associated with a condition within 5 s of initial presentation of the cards). Each data sheet listed the three reinforcement conditions and baseline, and data collectors circled the condition the participant selected for each trial.

Reliability

Two observers independently collected data on the occurrence of participant and therapist responses during 45%, 22%, and 44% of sessions for Julian, Fletcher, and Tina, respectively, to assess reliability. As noted above, observers recorded therapist responses as they occurred during session irrespective of whether or not they occurred as programmed, with integrity. Therefore,

the data reported in this section reflect the degree to which the two independent observers agreed upon the occurrence of the therapist response. We report on the integrity of the therapist's responses in the section that follows.

For the efficacy evaluation, interobserver agreement was calculated automatically by the Instant Data® program used to collect data using the block-by-block method Mudford et al. (2009) described. Each session was divided into 10-s intervals; responses scored by both observers were compared in each interval. Specifically, in each interval, the smaller number of occurrences scored for each response was divided by the larger number of occurrences scored (if both observers scored a 0, the interval was assigned a value of 1). The scores for each interval were summed, divided by the total number of intervals, and converted to a percentage. Mean agreement for the efficacy evaluation was 97% (range, 89% to 100%) for acceptance, 94% (range, 86% to 100%) for latency to bite deposit, 97% (range, 94% to 100%) for inappropriate mealtime behavior, 100% for packing, 98% (range, 85% to 100%) for mouth clean, and 93% (range, 81% to 100%) for latency to mouth clean. Mean agreement for therapist behavior was 98% (range, 90% to 100%) for bite presentation, 96% (range, 90% to 100%) for vocal prompts, 96% (range, 85% to 100%) for brief praise, 99% (range, 97% to 100%) for token delivery, and 95% (range, 74% to 100%) for reinforcer delivery. For the selection data collected in the preference evaluation, the researchers calculated interobserver agreement for each session by comparing which reinforcement or baseline condition each observer circled on a pencil-and-paper data sheet. An agreement included both observers circling the same condition. The total number of agreements was divided by the total number of trials and converted to a percentage. Mean agreement equaled 100% across participants.

Treatment Integrity

Treatment integrity was assessed for 33% of sessions in the efficacy evaluation and preference evaluation for each participant. As noted, observers recorded the therapist's behavior as it occurred in each session. The researchers then reviewed the raw data output that included the time the observer recorded each response in each trial to determine if the therapist (a) delivered the vocal prompt within 3 s of the bite presentation, (b) provided praise, a token, and/or access to a preferred tangible within 3 s of the participant's bite acceptance (Julian and Fletcher) or mouth clean (Tina), (c) and provided the tangible reinforcer for the correct time (total duration varied according to the condition in effect, correct implementation included delivery for the prescribed time, ± 3 s). During the preference evaluation, the researcher also evaluated the integrity of implementing the selected condition, which included the therapist initiating the contingencies corresponding to the selected condition within 3-5 s of the participant selecting the condition while leaving the appropriate colored card in view throughout the session. The observers recorded therapist's behavior as correct (i.e., when a response matched the response programmed in the condition) or incorrect (i.e., when a response did not match the response programmed in the condition). The researchers calculated treatment integrity coefficients trial-by-trial. The total number of correct trials for vocal prompts, delivery of the correct reinforcers (praise, tokens, and the tangible), and reinforcer access time was divided by the total number of trials and converted to a percentage. The percentages across sessions were averaged. Mean correct procedural integrity in the efficacy evaluation was 94% for Julian, 95% for Fletcher, and 93% for Tina across conditions. Mean integrity in the preference evaluation was 86% for Julian, 95% for Fletcher, and 94% for Tina. Integrity errors primarily consisted of therapists providing access to the reinforcer for durations that exceeded the programmed reinforcer-access duration by a few seconds or not placing a token on the token board within 3 s of the target response (i.e.,

bite acceptance for Julian and Fletcher and mouth clean for Tina). Integrity of implementing the selected contingencies in the preference evaluation and leaving the corresponding condition card in view for the duration of the session equaled 100% across participants.

Experimental Design

A combined reversal and multielement design (ABABC) was used to evaluate the efficacy of and preference for distributed- and accumulated-reinforcement arrangements plus nonremoval of the spoon (hereafter referred to as distributed reinforcement, accumulated token reinforcement, and accumulated no token reinforcement). Phases A and B comprised the efficacy evaluation and Phase C included the preference evaluation. In the efficacy evaluation, Phase A was baseline and Phase B was a multielement comparison of distributed, accumulated tokens, and accumulated no tokens conditions. During Phase B, the therapist conducted one session of each of the three reinforcement conditions in a random but counterbalanced order before conducting a session with any one reinforcement condition again. For the preference evaluation (Phase C), a concurrent-chains arrangement was used to evaluate the participant's preference for distributed, accumulated tokens, accumulated no tokens, and baseline conditions.

Preexperimental Assessments

Preexperimental procedures included a tangible preference assessment, an edible preference assessment, a color preference assessment, and token training. The tangible preference assessment was conducted to identify a highly preferred tangible to use as a reinforcer in the efficacy and preference evaluations. For Julian and Fletcher, this consisted of a paired-choice preference assessment (Fisher et al., 1992). For Tina, a multiple stimulus without replacement preference assessment (DeLeon & Iwata, 1996) was used. For all participants, the top ranked item was videos viewed on an iPad or television, which were then used as

reinforcement in the efficacy evaluation and preference evaluation. A paired-choice preference assessment (Fisher et al., 1992) was conducted with various foods to ensure that nonpreferred foods were presented across conditions during the efficacy evaluation. Foods consumed between 0% and 24% of trials during the edible preference assessment were selected for inclusion in the subsequent efficacy and preference evaluations. For Julian, 2 foods met criterion (French fries, broccoli), for Fletcher all 8 foods met this criterion (banana, kidney beans, white potatoes, sweet potatoes, green beans, carrots, peas and peaches), and for Tina 3 foods met criterion (pears, banana, and strawberry). A multiple stimulus without replacement assessment (DeLeon & Iwata, 1996) was conducted to identify four moderately preferred colors and to establish that participants could discriminate colors. The third-, fourth-, fifth, and sixth-ranked colors were used in the participant preference evaluation to minimize the potential effects of color bias (Hangen et al., 2021). The therapist then randomly assigned colored cards to represent baseline and each of the three reinforcement conditions. Finally, therapists conducted token training with each participant to teach the participants how to earn tokens to access the video. Procedures for token training were like those Leon et al. (2016) described except that each session consisted of five trials in which participants could earn and trade tokens.

Reinforcement Efficacy Evaluation

General Procedure

The efficacy evaluation examined the effects of distributed, accumulated tokens, and accumulated no tokens reinforcement plus nonremoval of the spoon on inappropriate mealtime behavior, acceptance, packing, and mouth clean. A therapist conducted sessions during 60-min session blocks based on a typical meal schedule (i.e., breakfast, lunch, and dinner), with approximately 2.5 hr from the beginning of one meal to the start of another. The therapist

conducted three to six sessions per meal on 5 or 7 days per week. The therapist presented bites on a large spoon for Julian and Tina, and a small spoon for Fletcher. Our team selected the texture of presented food based on each participant's skill level and prior experience with eating. The texture of presented foods was table texture cut into dime-sized bites (approximately 17.9 mm by 6.35 mm each) for Julian and Tina and puree (i.e., table food blended with liquid as necessary until smooth) for Fletcher. The amount of food on the spoon, the bolus size, per presentation was 17.9 mm for table textured foods for Julian and Tina and a level bolus of puree-textured food (2.4 cc) for Fletcher. For each session, the therapist randomly selected four foods from each food group (i.e., fruit, starch, protein, and vegetables) to present; the therapist presented the same foods randomly across all sessions for that meal slot.

During the efficacy evaluation, the therapist presented the colored card on the table in front of the participant (but out of the participant's reach) that represented the upcoming session condition before the session started. The card stayed in this position throughout the session. The therapist presented the bite and a vocal prompt to take a bite. The therapist presented the bite on a spoon approximately 3 cm from Julian and Fletcher's lips. The therapist presented the bite on a spoon on a plate in front of Tina for 5 s. If Tina did not pick up the spoon and place the bite in her mouth within 5 s of the vocal prompt, the therapist held the spoon 3 cm from her lips and the spoon remained in that position.

Once the therapist or participant deposited the bite in the participant's mouth, the therapist immediately started a timer and waited for 30 s to elapse to check for mouth cleans. Therapists vocally prompted participants to open their mouths to determine if food was in the mouth (participants always complied with the vocal prompt to open their mouths). During the reinforcement conditions, clean mouth resulted in delivery of the reinforcer. If packing occurred,

the bite was not removed from the participant's mouth; instead, the therapist presented another bite. If the participant continued to accept, but pack, bites, up to three bites were deposited inside the participant's mouth. After acceptance and packing of three bites, bite presentations were discontinued until the child swallowed the bites or the session duration expired.

Baseline

At the start of the session, the therapist said, "Here are some bites. Sometimes you will get breaks and watch videos." The therapist then presented a bite. For Julian and Fletcher, the therapist held the spoon in front of the participant (i.e., the spoon was positioned 3 cm away from the participant and it did not move) and for Tina, the therapist placed the bite on a plate in front of her. The therapist removed the spoon when (a) the therapist or participant deposited a bite in the mouth, (b) the participant engaged in inappropriate mealtime behavior (Julian and Fletcher) or packing (Tina), or (c) 30 s elapsed without an acceptance or inappropriate mealtime behavior or packing. Expulsions were re-presented until the bolus was accepted or until the 30 s elapsed for the mouth clean check (expulsions did not occur). If the participant engaged in the target response, the therapist did not provide any programmed consequence; instead, the therapist presented the next bite. Contingent on inappropriate mealtime behavior exhibited by Julian and Fletcher, the therapist removed the bite and provided 20 s of access to the video. If Tina packed food at the mouth check, the therapist removed the packed bite from Tina's mouth, provided brief attention related to swallowing (e.g., "Please swallow next time"), and provided access to the video for 20 s. Following the 20 s reinforcement interval, the therapist removed the video and presented the next bite. If 30 s elapsed without an acceptance or inappropriate mealtime behavior or packing, the therapist removed the bite, and then presented the next bite. Sessions included the presentation of five bites. Session duration varied according to participant responding, however,

if the participant never deposited a bite across those five bite presentations, the maximum session duration in baseline equaled 150 s. For all participants, the therapist did not provide any programmed consequence if the participant accepted the bite, had a mouth clean, or engaged in any other mealtime behavior (e.g., negative vocalizations, coughs, gags, vomit).

Distributed- and Accumulated-Reinforcement Comparison

The therapist initiated treatment after observing stable responding during baseline. For Julian and Fletcher, the therapist held the spoon stationary in front of the participant's mouth (i.e., the spoon was positioned, and it did not move; if they moved their heads, the spoon was moved with them) and for Tina, the therapist placed the bite on a plate in front of the participant and did not remove it following inappropriate mealtime behavior. Sessions were terminated after five bite presentations or if 10 min elapsed, whichever came first. Expulsions were re-presented until the bolus was accepted or until the 10 min session duration elapsed (expulsions did not occur). The programmed reinforcers were provided any time the participant took the bite to facilitate treatment success. The more lenient criterion to take the bite at any time, compared to accepting the bite within 5 s of the bite presentation, provided more opportunities for the participant to contact reinforcement.

Like baseline, the therapist initiated treatment sessions by providing an instruction related to earning breaks and videos for taking bites or having a clean mouth, and then the therapist presented the bite. Unlike baseline, the therapist only removed the spoon during the treatment conditions when the therapist or the participant deposited the bite in his or her mouth. Thus, the spoon remained in front of the participant or on the plate (Tina only) until (a) the therapist or participant deposited the bite or (b) the session duration elapsed. The therapist conducted a mouth check 30 s after a bite deposit (all participants). If the participant engaged in the target

response, the therapist implemented the DRA procedure as described below. If the participant packed food during the mouth check, the therapist continued to present bites until the participant had up to three bites in his or her mouth. The therapist then discontinued bite presentations and conducted mouth checks every 30 s. Mouth checks continued every 30 s until the session duration elapsed or the participant had no food larger than a pea in his or her mouth. If the participant had a clean mouth at the mouth check, the therapist implemented the DRA procedure and then resumed bite presentations if fewer than five bites had been presented in the session or terminated the session if five bites had already been presented. To ensure packing did not result in accumulated reinforcement in the distributed condition, participants only received one reinforcer delivery following a clean mouth check even if they had packed and then consumed up to three bites of food.

Distributed-Reinforcement. The therapist presented the colored card associated with the distributed condition to the participant and said, “Each time you take (or swallow) your bite, you will get your video right away.” Following each instance of the target response, the therapist immediately delivered the video for 15 s. The therapist removed the video and presented the next bite after 30 s.

Accumulated Tokens. The therapist presented the colored card associated with the condition to the participant and said, “When you take your bite (or swallow), you will get a token right away. Each token is worth 15 seconds of your video, and you can watch your video after you finish all of your bites.” Following each target response, the therapist placed a token on the token board. Each token was associated with 15 s of access to the video, culminating in up to 75 s continuous access to the video. After the session ended, the therapist told the participant how

many tokens he or she earned and then provided the participant with accumulated access to the video (e.g., if the participant earned four tokens, she or he was given 60 s of access to the video).

Accumulated No Tokens. The accumulated no tokens condition was identical to the accumulated tokens condition, except the therapist did not provide tokens; however, the therapist did provide a vocal statement indicating how much time they had earned with their video after each target response. The therapist presented the colored card associated with the condition to the participant and said, “You will earn 15 s of your video for each bite you take (or swallow), and you can watch your video after you finish all of your bites.” The therapist delivered the reinforcer for the total accumulated duration after the session ended.

Social Validity: Participant Preference Evaluation

The therapist conducted a preference evaluation to assess participant preference for distributed, accumulated tokens, accumulated no tokens, or baseline conditions using a concurrent-chains arrangement (Becraft et al., 2017). The colored cards presented during each condition of the efficacy evaluation served as initial links of the concurrent-chains arrangement in the preference evaluation. The therapist randomized the position of the cards on the table on each trial. Sessions were conducted in the same locations as the reinforcement efficacy assessment.

The therapist conducted four guided-choice trials to expose the participant to the terminal link contingencies. During each trial, the therapist placed the four colored cards approximately 12 cm apart and 12 cm in front of the participant. The therapist said, “Pick one” and simultaneously guided the participant to pick one of the four cards. The therapist then conducted a five-bite session of the condition associated with the card the therapist guided the participant to select. The procedure for each condition was identical that described in the reinforcement

efficacy evaluation. When the session ended, the therapist then prompted the participant to select one of the colored cards associated with the other three conditions and conducted a session of the selected condition. The therapist randomized the order of card selection across sessions until the participant experienced each condition once.

After completing guided exposure to each condition, the therapist conducted free-choice trials. Free-choice trials were identical to the guided-choice trials except the therapist said, “Pick one” and did not guide the participant to select a card. Instead, the participant was free to select whichever they wanted. Participants made a selection in all free-choice trials; however, if they had not, additional vocal prompts to select a card would have been issued until a response was made. Sessions continued until the therapist conducted 15 free-choice trials with Julian and Fletcher and five with Tina.

Social Validity: Caregiver Preference Evaluation

Therapists described each treatment, including nonremoval of the spoon, to each caregiver. In addition, caregivers observed all sessions during the efficacy and preference evaluations. Thus, caregivers understood that the treatments included nonremoval of the spoon and they observed the efficacy of each treatment package with their child. Additional data (e.g., graphs or summary tables) were not presented to the caregivers. After the participants completed the efficacy and preference evaluations, the therapist asked the participants’ caregivers to complete a social-validity questionnaire to evaluate the acceptability of the different reinforcement plus nonremoval of the spoon arrangements (see supplemental documents for survey questions). The questionnaire used a 5-point Likert scale with responses ranging from “Always” to “Rarely” and asked caregivers to indicate the conditions under which their child performed best, whether they were satisfied with each treatment, whether they found each

treatment easy to implement, and whether they were likely to implement each treatment at home. Caregivers could provide additional comments at the end of the questionnaire.

Results

Reinforcement Efficacy Evaluation

In Figures 1 and 2, we report acceptance for Julian and Fletcher to provide a more conservative measure of treatment effects (Julian's and Fletcher's bite-taken data are available upon request). Although these participants could produce reinforcement for bite taken (depositing a bite at any time after the bite presentation) at any time, from a clinical perspective we wanted to monitor acceptance to ensure that bites were being taken relatively quickly. For Julian (Figure 1), rates of inappropriate mealtime behavior (top) were high during baseline ($M = 21.3$ responses per min). Implementation of treatment resulted in a large decrease in the rates of inappropriate mealtime behavior compared to baseline (distributed $M = 0.9$ responses per min; accumulated tokens; $M = 0.3$ responses per min; accumulated no tokens $M = 1.1$ responses per min). These findings were replicated during the reversal and return to treatment. Acceptance (middle) did not occur in the initial baseline ($M = 0\%$). Upon implementation of the reinforcement conditions, acceptance increased to above 80% for the three conditions (distributed $M = 87.3\%$; accumulated tokens 100%; accumulated no tokens $M = 94.3\%$). Following the reversal to baseline, levels of acceptance decreased to zero and then returned to previous levels when the treatments were reintroduced. During baseline, no bites were deposited in his mouth; thus, Julian exhibited long latencies to bite deposit (bottom) during baseline (i.e., the latency in each baseline session equaled the duration from the initial bite presentation to the termination of the session; $M = 138.4$ s). However, his latency to bite deposit decreased across the three reinforcement conditions and generally occurred within 5 s of each bite presentation

(distributed $M = 3.9$ s; accumulated tokens $M = 2.4$ s; accumulated no tokens $M = 3.9$ s). These data were replicated in the reversal and return to treatment. Julian's responding did not differ between the three treatment conditions, suggesting that they were equally effective at decreasing inappropriate mealtime behavior, increasing bite acceptance, and decreasing latency to bite deposit.

For Fletcher (Figure 2), rates of inappropriate mealtime behavior (top) during baseline were on an increasing trend ($M = 2.5$ responses per min). Upon the implementation of reinforcement conditions, Fletcher initially engaged in high rates of inappropriate mealtime behavior in the distributed and accumulated (no tokens) conditions, which was followed by lower, but variable responding for all three conditions (distributed $M = 0.5$ responses per min; accumulated tokens $M = 1.0$ responses per min; accumulated no tokens $M = 1.0$ responses per min). However, in the last six sessions of the first reinforcement phase, Fletcher engaged in lower rates of inappropriate mealtime behavior in the distributed condition relative to baseline and the accumulated conditions, suggesting that the distributed condition was slightly more effective in reducing inappropriate mealtime behavior. During baseline, level of acceptance (middle) were variable ($M = 73.0\%$). Implementation of reinforcement resulted in increases in levels of acceptance (middle); however, acceptance in both accumulated conditions (tokens $M = 81.0\%$; no tokens $M = 82.0\%$) remained slightly lower and more variable than the distributed ($M = 90\%$). These data were replicated in the reversal and return to treatment. Latency to bite deposit (bottom) was lower and slightly less variable in all three reinforcement conditions (distributed $M = 25.3$ s; accumulated tokens $M = 9.0$ s; accumulated no tokens $M = 19.1$ s) relative to baseline ($M = 14.8$ s). The median latency to bite deposit in baseline was 10.3 s and was lower and similar across the distributed ($Mdn = 3.0$ s), accumulated tokens ($Mdn = 4.6$ s),

and accumulated no tokens ($Mdn = 3.8$ s) conditions. The median latency was calculated instead of mean values because median is less affected by the extreme outliers. The efficacy evaluation was ended after completing Session 90 due to the caregiver's request to focus on increasing texture and food volume and other admission goals.

Tina's data are depicted in Figure 3. The top panel depicts the percentage of bites packed, the middle panel depicts the percentage of mouth cleans, and the bottom panel depicts the mean latency to mouth clean. During baseline, variable levels of packed bites ($M = 38.7\%$) and mouth cleans ($M = 61.3\%$) were observed. Although packing and mouth cleans were within clinically acceptable levels for some sessions, packing and mouth cleans were outside of the clinically acceptable range for approximately half of the sessions. Additionally, except for one baseline session, Tina's latencies to mouth clean were above the clinically acceptable level ($M = 59.4$ s). Following the implementation of treatment, responding became much less variable and levels of packing decreased (distributed $M = 4.7\%$; accumulated tokens $M = 2.7\%$; accumulated no tokens $M = 7.3\%$), levels of mouth cleans increased (distributed $M = 95.3\%$; accumulated tokens $M = 97.3\%$; accumulated no tokens $M = 92.7\%$), and latencies to mouth clean decreased (distributed $M = 16.7$ s; accumulated tokens $M = 21.0$ s; accumulated no tokens $M = 17.7$ s) relative to baseline. Tina's responses fell outside of the clinically acceptable range in very few treatment sessions. These data were replicated in the reversal and return to treatment. No differentiation between reinforcement conditions was observed, which suggests that distributed, accumulated tokens, and accumulated no tokens conditions were equally effective in decreasing packing, increasing mouth cleans, and decreasing latency to mouth clean. We hypothesize that the similar responding observed across reinforcement conditions was evidence of equivalent efficacy and not weak experimental control.

Social Validity: Child Preference Evaluation

The levels of the dependent variables during guided- and free-choice phases of the preference evaluation are depicted in the final two phases in Figures 1-3. For Julian, levels of inappropriate mealtime behavior and latency to bite deposit remained relatively similar to those observed during the preceding treatment phase of the efficacy evaluation. Although variable levels of bites accepted were observed when the preference evaluation was initiated, acceptance became increasingly more stable as the evaluation continued. For Fletcher, rates of inappropriate mealtime behavior were initially similar to those observed during the efficacy evaluation; however, levels of inappropriate mealtime behavior were on an increasing trend as the preference evaluation was concluded. For Tina, results of the preference evaluation largely mirrored those of the treatment phases in her efficacy evaluations.

Figure 4 depicts participants' cumulative number of initial-link selections during free-choice trials in the concurrent-chains arrangement. Julian and Tina almost exclusively selected the distributed condition; Fletcher almost exclusively selected the accumulated no tokens condition.

Social Validity: Caregiver Preference Evaluation

Figure 5 depicts the outcomes from the caregiver social validity questionnaire. Julian's mother reported that Julian occasionally performed best in the distributed condition but always performed best in the two accumulated conditions. Fletcher's mother indicated he often performed best in the distributed and accumulated no token conditions, but only occasionally performed best in the accumulated condition. Finally, Tina's mother reported Tina fairly often performed best in the distributed and accumulated no token conditions and always performed best in the accumulated condition. Thus, two of three caregivers rated their child as performing

best in one of the accumulated conditions. Regarding treatment satisfaction, Julian and Tina's caregivers rated all three treatments as always satisfactory; and Fletcher's mother reported that she was always satisfied with the use of the accumulated no tokens condition (and only fairly often or occasionally satisfied with the distributed and accumulated conditions, respectively). All three caregivers reported that the accumulated no tokens condition was always the easiest to implement; Julian and Tina's caregivers indicated that the distributed condition was rarely the easiest to implement. Finally, all three caregivers indicated that they would often or always implement the accumulated no token condition at home, whereas Tina and Julian's caregivers indicated that they were less likely to implement the distributed and accumulated conditions (i.e., "Rarely" or "Fairly Often"). Overall, ratings with regard to the accumulated condition and the distributed condition varied considerably across respondents; however, all three caregivers generally rated the accumulated no token condition highly (i.e., "Always" to "Often") across each question.

Discussion

The present study extends prior research by evaluating distributed and accumulated reinforcement with children with inappropriate mealtime behavior and food packing. The results of the current investigation suggest that accumulated reinforcement arrangements were as effective as distributed arrangements for two participants (Julian, Tina) and slightly less effective for one (Fletcher) in impacting mealtime behavior.

Although all treatment conditions were equally effective for Julian and Tina during the efficacy evaluation, both demonstrated a clear preference for the distributed arrangement in the preference evaluation. For Fletcher, inappropriate mealtime behavior was lower and bite acceptance was slightly higher in the distributed condition relative to the accumulated

conditions; however, the results of the preference evaluation showed that Fletcher favored the accumulated no tokens condition in which tokens were not used. These results suggest that participants with histories of feeding disorders elected to eat in a reinforcement condition when they had a concurrent choice to avoid eating and receive reinforcement for inappropriate mealtime behavior or packing in the baseline condition. These results are very promising, but should be interpreted with caution. Although guided exposure was conducted with each condition, including baseline, inappropriate mealtime behavior or packing were generally low and acceptances and mouth cleans were high. Thus, participants did not contact baseline contingencies frequently; from their perspective, the baseline condition may have more closely resembled a no reinforcement condition instead. Thus, is it possible that selection of one of the reinforcement conditions over the baseline was due, in part, to the participants not discriminating that escape was available for inappropriate mealtime behavior or packing.

It is possible that token reinforcement may differentially impact performance in the accumulated condition. Measures of efficacy for Julian and Tina showed that the accumulated condition in which tokens were included was more effective than the accumulated condition with no tokens. For Fletcher, both accumulated conditions seemed to be equally effective. Frank-Crawford et al. (2019) obtained similar results for token reinforcement in the accumulated condition. Specifically, in four of the seven analyses conducted in Experiment 2 of that study, participants performed better under the accumulated with tokens condition than the accumulated without tokens condition. Token reinforcement did not appear to influence preference for accumulation as Fletcher preferred the condition that did not include tokens, and the other two participants almost exclusively selected the distributed condition. For Fletcher, it is possible that his previous history with tokens contributed to his preference for the accumulated (no tokens)

condition. Specifically, Fletcher appeared to have a strong aversion to tokens as therapists reported that Fletcher engaged in negative vocalizations (e.g., “no tokens”) during the accumulated tokens condition. Neither the distributed nor the accumulated no tokens condition included tokens; Fletcher selected the accumulated no tokens condition over the distributed condition suggesting that he did prefer reinforcer accumulation over distribution. Leon et al. (2016) conducted a parametric analysis of delayed primary and conditioned reinforcers. The primary reinforcer condition included distributed access to food and the conditioned reinforcer condition included tokens exchangeable for accumulated access to food. In both conditions, the researchers gradually increased the delay to either the immediate food delivery or delivery of the token. Results indicated that even brief delays to token delivery produced greater decreases in responding than did delays to the delivery of the food. Thus, it appears that delays might devalue delayed conditioned reinforcers to a greater degree than direct reinforcer delivery. It is possible that the time required to deliver the token in the current study, although minimal, increased the delay to reinforcer access which devalued the accumulated with tokens condition for Fletcher, a finding that would correspond to those of Leon et al. It is also possible that the vocal statement provided in the accumulated no tokens condition in which the therapist described how much reinforcement had been amassed functioned as a conditioned reinforcer. If that is the case, that may also explain, in part, why no differences were obtained with regard to how effective the two accumulated conditions were.

That two of three participants preferred the distributed condition is inconsistent with previous research that showed a preference for accumulated reinforcement for academic and daily living skills (e.g., Bukala et al., 2015; DeLeon et al., 2014; Fienup et al., 2011; Frank-Crawford et al., 2019). However, research examining preference for these arrangements amongst

individuals with escape-maintained problem behavior has generally demonstrated more variability in preference for these arrangements. Specifically, 16 analyses of preference for accumulated and distributed arrangements for this population have been conducted across three studies (Frank-Crawford et al., 2021; Fulton et al., 2020; Robinson & St. Peter, 2019). Results across these studies indicated a clear and consistent preference for accumulated reinforcement in only seven assessments, six participants clearly preferred the distributed condition, and three exhibited indifference. Thus, it appears that function of problem behavior may influence preference for reinforcer accumulated versus distribution. It is possible that individuals whose problem behavior is negatively reinforced would prefer the distributed arrangement in which they received frequent, immediate access to reinforcement in the form of escape from aversive contexts. Prior research has indicated that children tend to exhibit greater impulsivity when provided a choice that includes nonpreferred tasks, which suggests that preference for different reinforcement arrangements may vary with the aversiveness of the task (Lerman et al., 2006). It is plausible to conclude that persons who exhibit negatively reinforced behavior may prefer distributed reinforcement that produces periodic escape from the nonpreferred task than persons who engage in positively reinforced behavior. However, additional research is needed to assess whether the function of problem behavior plays a role in the preference for and performance under these reinforcement arrangements.

An alternative explanation is that the participants in the current study may be more prone to impulsive responding. The present study examined 5-year-old children with histories of severe food refusal, whereas most previous research in this area included adolescents with intellectual disabilities and developmental delays (e.g., Frank-Crawford et al., 2019; Ward-Horner, Cengher, et al., 2017). Research has shown that younger participants may respond more impulsively, and

thus, prefer to receive immediate and more frequent access to a smaller magnitude of the reinforcer rather than to obtain delayed but longer and continuous access to the reinforcer (Green et al., 1999). Though the preparations used to study efficacy of and preference for distributed versus accumulated arrangements (e.g., DeLeon et al., 2014) are not designed to test for impulsivity (*cf.* Rachlin & Green, 1972), preference for distributed arrangements *may* relate to impulsivity. To assess this possibility, several studies have replicated this line of research with individuals who historically respond more impulsively to determine whether their preferences differ. Specifically, Ward-Horner, Muehlberger, et al. (2017) assessed the preferences of two preschoolers as they hypothesized that young children were more likely to behave impulsively than older individuals. Robinson and St. Peter (2019) took a similar approach in their assessment of preference for and efficacy of accumulated and distributed arrangements for three students diagnosed with attention deficit hyperactivity disorder who also frequently engaged in problem behavior during academic instruction. Across both studies, four of the five participants preferred the distributed arrangement. However, whether participants' ages or diagnoses of attention deficit hyperactivity disorder influenced the outcomes is unclear. Future research may involve explicit tests of impulsivity before and after evaluations of preference for distributed versus accumulated arrangements.

The results of the social validity questionnaire suggest that caregivers favored accumulated reinforcement arrangements. Conversely, Julian and Tina selected the distributed condition. Clinicians may face an ethical dilemma when client and caregiver preferences misalign. When faced with this dilemma, one likely first step may be to examine which intervention was more effective in treating the problem. However, in the present study, the arrangements were effective equally for Julian and Tina. In these situations, the clinician must

carefully weigh the costs and benefits of recommendations that align with the client's preferences relative to the caregiver preferences. Providing a client with the opportunity to make choices related to treatment may enhance the therapeutic environment (Hanley, 2010). However, it is also important to consider the caregiver's preference, given that the caregiver will implement the intervention. The caregivers' preferences for accumulated reinforcement may not be surprising, as this procedure may be easier for caregivers to implement, and mealtimes may appear more natural. It is important to note that most research on DRA for inappropriate mealtime behavior has historically included distributed reinforcement arrangements. The current study is the first to directly evaluate outcomes for accumulated and distributed arrangements with this particular population; results are promising, showing that both arrangements can work well for children with feeding challenges. That all three interventions worked well should not necessarily be viewed as a limitation to the study; rather these outcomes align nicely with caregiver preferences. Such a finding is noteworthy as it allows clinicians flexibility in treatment selection. When caregivers feel that their opinions are valued, they may be more likely to find the procedures appropriate for their child. Caregiver cooperation and agreement may enhance treatment integrity and maintenance of treatment implementation over time.

There are several limitations that should be considered. Each session consisted of five bites during the efficacy and preference evaluations. Limiting the session to five bites could have masked the effects of treatment conditions on mealtime behavior; individuals may be more likely to tolerate delays to reinforcement after consuming five bites versus larger response requirements (e.g., across a full meal). However, the threshold of five bites is not atypical given that previous studies in this area selected five (e.g., Ward-Horner et al., 2014), six (e.g., Fienup et al., 2011), and 10 trials (Frank-Crawford et al., 2019; Ward-Horner, Muehlberger et al., 2017). Future

research could evaluate whether preference and performance under these arrangements maintain as the response requirement increases.

Future research should examine variables that may influence preference for and performance under different reinforcer arrangements. To date, researchers have investigated the effects of the type of reinforcer (food vs. activity reinforcers, e.g., DeLeon et al., 2014), the magnitude of reinforcement (e.g., Ward-Horner et al., 2014), the quality of reinforcement (e.g., Ward-Horner, Muehlberger, et al., 2017), and the type of task (mastered vs. unmastered tasks, e.g., Frank-Crawford et al., 2019). More recently, function of problem behavior, specifically escape-maintained problem behavior, has also been explored (e.g., Frank-Crawford et al., 2021; Fulton et al., 2020; Robinson & St. Peter, 2019). This study represents the first evaluation of these reinforcer and response characteristics in combination with nonremoval of the spoon in the treatment of food refusal. It is important to understand the influence of these parameters and others in the context of a mealtime situation as it may help direct clinicians to develop effective treatments to target food refusal. For example, regular-textured foods (i.e., bite-sized pieces of food) are more difficult to chew and swallow relative to lower texture foods (e.g., applesauce or blended foods). Preference may vary as a function of alterations in the effort associated with consuming different textured foods (Ward-Horner, Cengher, et al., 2017). In addition, the presentation of nonpreferred foods may be more aversive than the presentation of preferred foods; thus, the participant might favor the distributed arrangement when feeders present nonpreferred foods. Alternatively, it is possible that the consumption of preferred foods can be maintained under a thinner reinforcement schedule, making accumulated arrangements more appropriate with preferred foods. These are just a few questions that are occasioned by this burgeoning area of research.

Furthermore, the reinforcers maintaining Tina's packing were not clearly identified. Because functional analyses of packing have not previously been described in the literature, the function of Tina's packing was identified through a combination of indirect and direct assessments. Based on these assessments, it was hypothesized that the packing was maintained by escape, tangibles, and attention. A recent review of the literature published on reinforcers for mealtime problem behavior indicated that escape is the reinforcer in the vast majority of cases (Saini et al., 2019). While multiply maintained inappropriate mealtime behavior is less common, Saini et al. (2019) did find that multiple control was indicated in roughly 40% of cases. Nevertheless, a functional analysis was not conducted with Tina and the conclusions regarding the functions of her packing should be interpreted with caution. A multielement design was employed to compare the efficacy of the three treatment conditions, all of which included escape extinction arranged through nonremoval of the spoon. The treatments were roughly equally effective for all participants, with the distributed condition being slightly more effective for Fletcher. That there were no differences between the treatment conditions could be attributed to the use of nonremoval of the spoon, which was a component of each treatment, or do to multiple treatment interference due to the rapid alternation of the conditions. Because each treatment condition in the current study included escape extinction in the form of nonremoval of the spoon, the effects of distributed and accumulated reinforcement alone cannot be discerned. However, one goal of the current study was to compare the efficacy of accumulated reinforcement to the most commonly used arrangement of distributed reinforcement under conditions in which distributed reinforcement historically produced positive effects. Prior research has suggested that distributed reinforcement, arranged as DRA, is most effective in treating inappropriate mealtime behavior when escape extinction is arranged (e.g., LaRue et al., 2011; Piazza et al., 2003). Thus,

nonremoval of the spoon was included in the current study. Future research is warranted to examine whether accumulated reinforcement alone is more effective than distributed reinforcement. Such research may also consider the use of a different design, such as a reversal design.

The present study contributes to the growing literature on reinforcer arrangements and the treatment of pediatric food refusal. Unlike some prior studies (e.g., Bukala et al., 2015; DeLeon et al., 2014; Frank-Crawford et al., 2019), the current investigation showed that two of three children favored the distributed arrangement. However, like prior studies, the present study capitalized on the concurrent-chains procedure to increase the likelihood that the direct beneficiary of intervention can be in control of their behavior treatment. In short, participants were given the opportunity to vote with their feet (Hanley, 2010). Future research could attempt to disentangle contributing reinforcer parameters to determine socially valid methods of treatment that are both efficacious and preferred.

References

- Ahearn, W. H., Kerwin, M. E., Eicher, P. S., Shantz, J., & Swearingin, W. (1996). An alternating treatments comparison of two intensive interventions for food refusal. *Journal of Applied Behavior Analysis*, 29(3), 321-332. <https://doi.org/10.1901/jaba.1996.29-321>
- Becraft, J. L., Borrero, J. C., Mendres-Smith, A. E., & Castillo, M. I. (2017). Decreasing excessive bids for attention in early education classroom. *Journal of Behavioral Education*, 26(4), 371-393. <https://doi.org/10.1007/s10864-017-9275-6>
- Bukala, M., Hu, M. Y., Lee, R., Ward-Horner, J. C., & Fienup, D. M. (2015). The effects of work-reinforcer schedules on performance and preference in students with autism. *Journal of Applied Behavior Analysis*, 48(1), 215-220. <https://doi.org/10.1002/jaba.188>
- DeLeon, I. G., Chase, J. A., Frank-Crawford, M. A., Carreau-Webster, A. B., Triggs, M. M., Bullock, C. E., & Jennett, H. K. (2014). Distributed and accumulated reinforcement arrangements: Evaluations of efficacy and preference. *Journal of Applied Behavior Analysis*, 47(2), 293-313. <https://doi.org/10.1002/jaba.116>
- DeLeon, I. G., & Iwata, B. A. (1996). Evaluation of a multiple-stimulus presentation format for assessing reinforcer preferences. *Journal of Applied Behavior Analysis*, 29(4), 519-533. <https://doi.org/10.1901/jaba.1996.29-519>
- Fienup, D. M., Ahlers, A. A., & Pace, G. (2011). Preference for fluent versus disfluent work schedules. *Journal of Applied Behavior Analysis*, 44(4), 847-858. <https://doi.org/10.1901/jaba.2011.44-847>
- Fisher, W., Piazza, C. C., Bowman, L. G., Hagopian, L. P., Owens, J. C., & Slevin, I. (1992). A comparison of two approaches for identifying reinforcers for persons with severe and

- profound disabilities. *Journal of Applied Behavior Analysis*, 25(2), 491-498.
<https://doi.org/10.1901/jaba.1992.25-491>
- Frank-Crawford, M. A., Borrero, J. C., Newcomb, E. T., Chen, T., & Schmidt, J. D. (2019). Preference for and efficacy of accumulated and distributed response-reinforcer arrangements during skill acquisition. *Journal of Behavioral Education*, 28(2), 227-257.
<https://doi.org/10.1007/s10864-018-09312-7>
- Frank-Crawford, M. A., Borrero, J. C., Newcomb, E. T., Doan, T., & Fisher, A., & Rooker, G. W. (2021). Accumulated and distributed response-reinforcer arrangements during the treatment of escape-maintained problem behavior. *Journal of Applied Behavior Analysis*.
<https://doi.org/10.1002/jaba.870>
- Fulton, C. J., Tiger, J. H., Meitzen, H. M., & Effertz, H. M. (2020). A comparison of accumulated and distributed reinforcement periods with children exhibiting escape-maintained problem behavior. *Journal of Applied Behavior Analysis*, 53(2), 782-795.
<https://doi.org/10.1002/jaba.622>
- Garro, A., Thurman, S. K., Kerwin, M. E., & Ducette, J. P. (2005). Parent/caregiver stress during pediatric hospitalization for chronic feeding problems. *Journal of Pediatric Nursing*, 20(4), 268-275. <https://doi.org/10.1016/j.pedn.2005.02.015>
- Green, L., Myerson, J., & Ostaszewski, P. (1999). Discounting of delayed rewards across the life span: Age differences in individual discounting functions. *Behavioural Processes*, 46(1), 89- 96. [https://doi.org/10.1016/S0376-6357\(99\)00021-2](https://doi.org/10.1016/S0376-6357(99)00021-2)
- Hangen, M. M., Romero, A. N., Neidert, P. L., & Borrero, J. C. (2020) “Other” behavior and the DRO: The roles of extinction and reinforcement. *Journal of Applied Behavior Analysis*, 53(4), 2385-2404. <https://doi.org/10.1002/jaba.736>

- Hanley G. P. (2010). Toward effective and preferred programming: A case for the objective measurement of social validity with recipients of behavior-change programs. *Behavior Analysis in Practice*, 3(1), 13-21. <https://doi.org/10.1007/BF03391754>
- Hanley, G. P., Jin, C. S., Vanselow, N. R., & Hanratty, L. A. (2014). Producing meaningful improvements in problem behavior of children with autism via synthesized analyses and treatments. *Journal of Applied Behavior Analysis*, 47(1), 16–36.
<https://doi.org/10.1002/jaba.106>
- Joachim, B. T., & Carroll, R. A. (2017). A comparison of consequences for correct responses during discrete-trial instruction. *Learning and Motivation*, 62, 15-28.
<https://doi.org/10.1016/j.lmot.2017.01.002>
- Kocher, C. P., Howard, M. R., & Fienup, D. M. (2015). The effects of work-reinforcer schedules on skill acquisition for children with autism. *Behavior Modification*, 39(4), 600-621.
<https://doi.org/10.1177/0145445515583246>
- LaRue, R. H., Stewart, V., Piazza, C. C., Volkert, V. M., Patel, M. R., & Zeleny, J. (2011). Escape as reinforcement and escape extinction in the treatment of feeding problems. *Journal of Applied Behavior Analysis*, 44(4), 719-735.
<https://doi.org/10.1901/jaba.2011.44-719>
- Leon, Y., Borrero, J. C., & DeLeon, I. G. (2016). Parametric analysis of delayed primary and conditioned reinforcers. *Journal of Applied Behavior Analysis*, 49(3), 639-655.
<https://doi.org/10.1002/jaba.311>
- Lerman, D. C., Addison, L. R., & Kodak, T. (2006). A preliminary analysis of self-control with aversive events: The effects of task magnitude and delay on the choices of children with

- autism. *Journal of Applied Behavior Analysis*, 39(2), 227-232.
<https://doi.org/10.1901/jaba.2006.90-05>
- Mudford, O. C., Martin, N. T., Hui, J. K., & Taylor, S. A. (2009). Assessing observer accuracy in continuous recording of rate and duration: Three algorithms compared. *Journal of Applied Behavior Analysis*, 42(3), 527-539. <https://doi.org/10.1901/jaba.2009.42-527>
- Patel, M. R., Piazza, C. C., Martinez, C. J., Volkert, V. M., & Santana, C. M. (2002). An evaluation of two differential reinforcement procedures with escape extinction to treat food refusal. *Journal of Applied Behavior Analysis*, 35(4), 363-374.
<https://doi.org/10.1901/jaba.2002.35-363>
- Piazza, C. C., Patel, M. R., Gulotta, C. S., Sevin, B. M., & Layer, S. A. (2003). On the relative contributions of positive reinforcement and escape extinction in the treatment of food refusal. *Journal of Applied Behavior Analysis*, 36(3), 309-324.
<https://doi.org/10.1901/jaba.2003.36-309>
- Rachlin, H., & Green, L. (1972). Commitment, choice, and self-control. *Journal of the Experimental Analysis of Behavior*, 17(1), 15-22. <https://doi.org/10.1901/jeab.1972.17-15>
- Rezaei, M., Rashedi, V., Gharib, M., & Lotfi, G. (2011). Prevalence of feeding problems in children with intellectual disability. *Iranian Rehabilitation Journal*, 9(3), 56-59. <http://irj.uswr.ac.ir/article-1-214-en.html>
- Robinson, N., & St. Peter, C. C. (2019). Accumulated reinforcers increase academic responding and suppress problem behavior for students with attention-deficit hyperactivity disorder. *Journal of Applied Behavior Analysis*, 52(4), 1076-1088.
<https://doi.org/10.1002/jaba.570>

- Saini, V., Kadey, H. J., Paszek, K. J., & Roane, H. S. (2019). A systematic review of functional analysis in pediatric feeding disorders. *Journal of Applied Behavior Analysis*, 52(4), 1161-1175. <https://doi.org/10.1002/jaba.637>
- Sharp, W. G., Volkert, V. M., Scahill, L., McCracken, C. E., & McElhanon, B. (2017). A systematic review and meta-analysis of intensive multidisciplinary intervention for pediatric feeding disorders: how standard is the standard of care? *The Journal of Pediatrics*, 181, 116-124. <https://doi.org/10.1016/j.jpeds.2016.10.002>
- Valdimarsdóttir, H., Halldórsdóttir, L. Y., & Sigurádóttir, Z. G. (2010). Increasing the variety of foods consumed by a picky eater: Generalization of effects across caregivers and settings. *Journal of Applied Behavior Analysis*, 43(1), 101-105. <https://doi.org/10.1901/jaba.2010.43-101>
- Volkert, V. M., & Vaz, P. C. (2010). Recent studies on feeding problems in children with autism. *Journal of Applied Behavior Analysis*, 43(1), 155-159. <https://doi.org/10.1901/jaba.2010.43-155>
- Ward-Horner, J. C., Cengher, M., Ross, R. K., & Fienup, D. M. (2017). Arranging response requirements and the distribution of reinforcers: A brief review of preference and performance outcomes. *Journal of Applied Behavior Analysis*, 50(1), 181-185. <https://doi.org/10.1002/jaba.350>
- Ward-Horner, J. C., Muehlberger, A. O., Vedora, J., & Ross, R. K. (2017). Effects of reinforcer magnitude and quality on preference for response-reinforcer arrangements in young children with autism. *Behavior Analysis in Practice*, 10(2), 183-188. <https://doi.org/10.1007/s40617-017-0185-9>

Williams, K. E., Riegel, K., Gibbons, B., & Field, D. G. (2007). Intensive behavioral treatment for severe feeding problems: a cost-effective alternative to tube feeding? *Journal of Developmental and Physical Disabilities*, 19(3), 227-235.

<https://doi.org/10.1007/s10882-007-9051-y>

Figure 1

Inappropriate Mealtime Behavior, Percentage of Acceptance, and Latency to Bite Deposit in the Efficacy Evaluation, Guided Choice, and Free Choice Phases for Julian

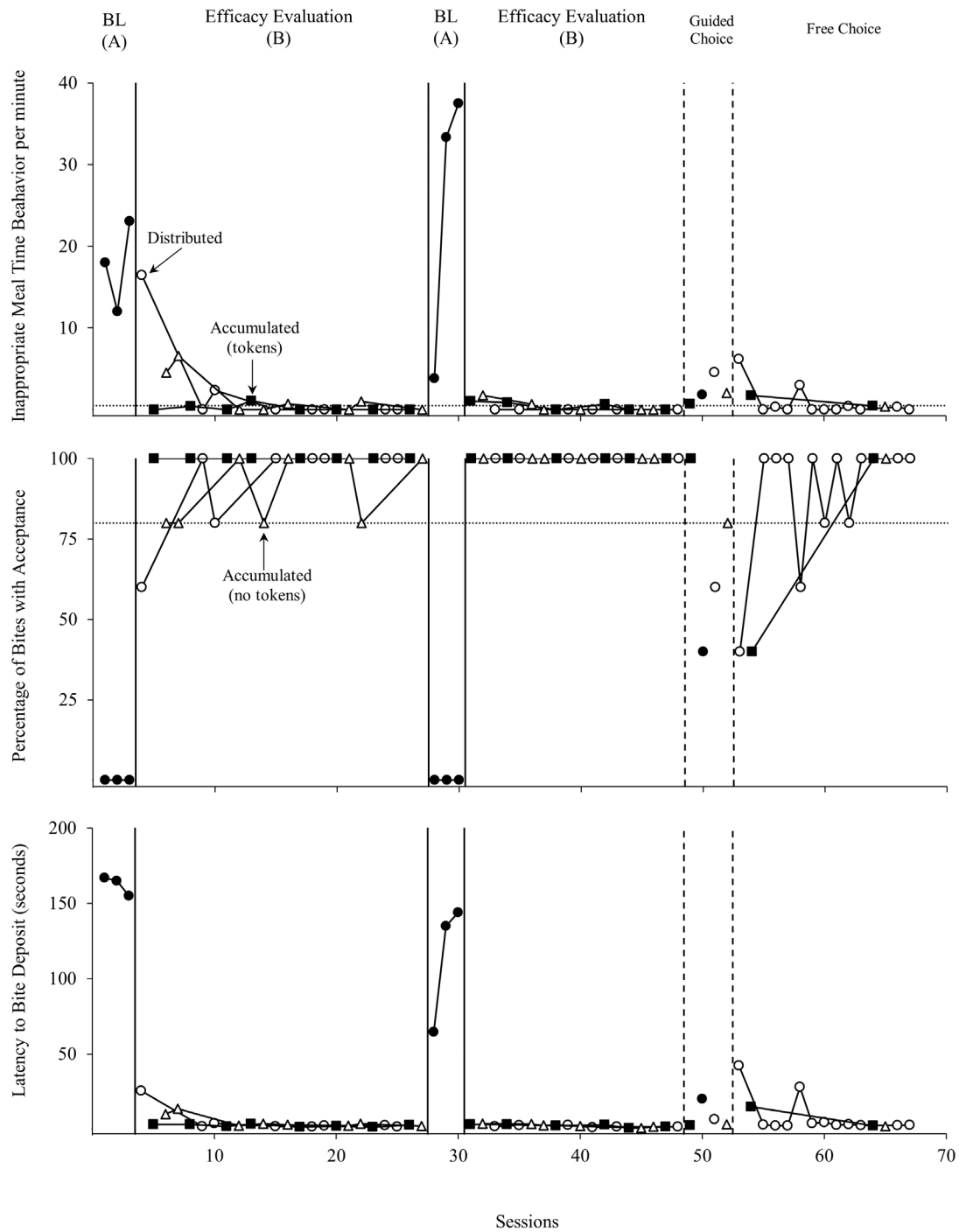


Figure 2

Inappropriate Mealtime Behavior, Percentage of Acceptance, and Latency to Bite Deposit in the Efficacy Evaluation, Guided Choice, and Free Choice Phases for Fletcher

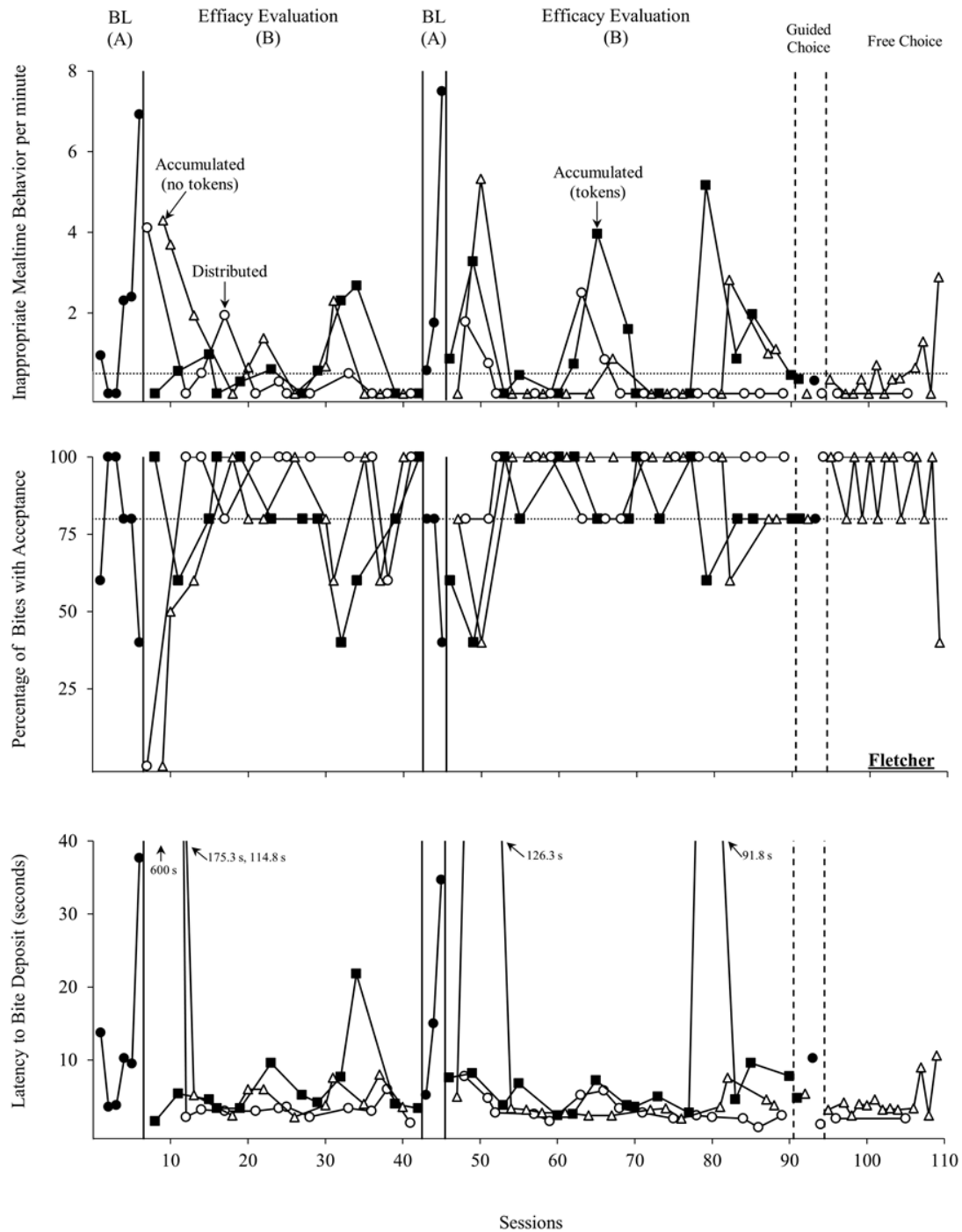


Figure 3

Inappropriate Mealtime Behavior, Percentage of Acceptance, and Latency to Bite Deposit in the Efficacy Evaluation, Guided Choice, and Free Choice Phases for Tina

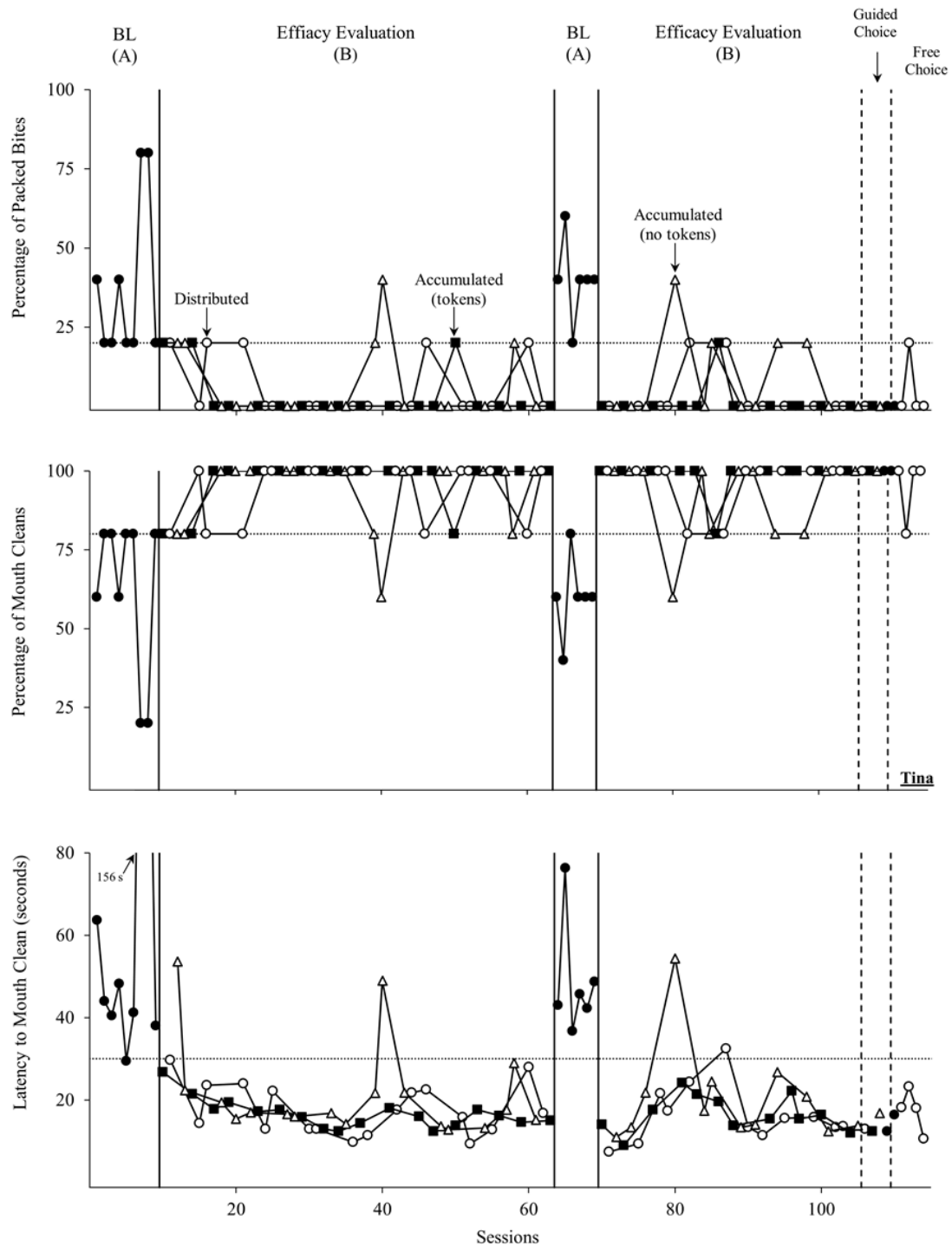


Figure 4

Cumulative Selections in Free Choice Sessions of the Preference Evaluation for Each Participant

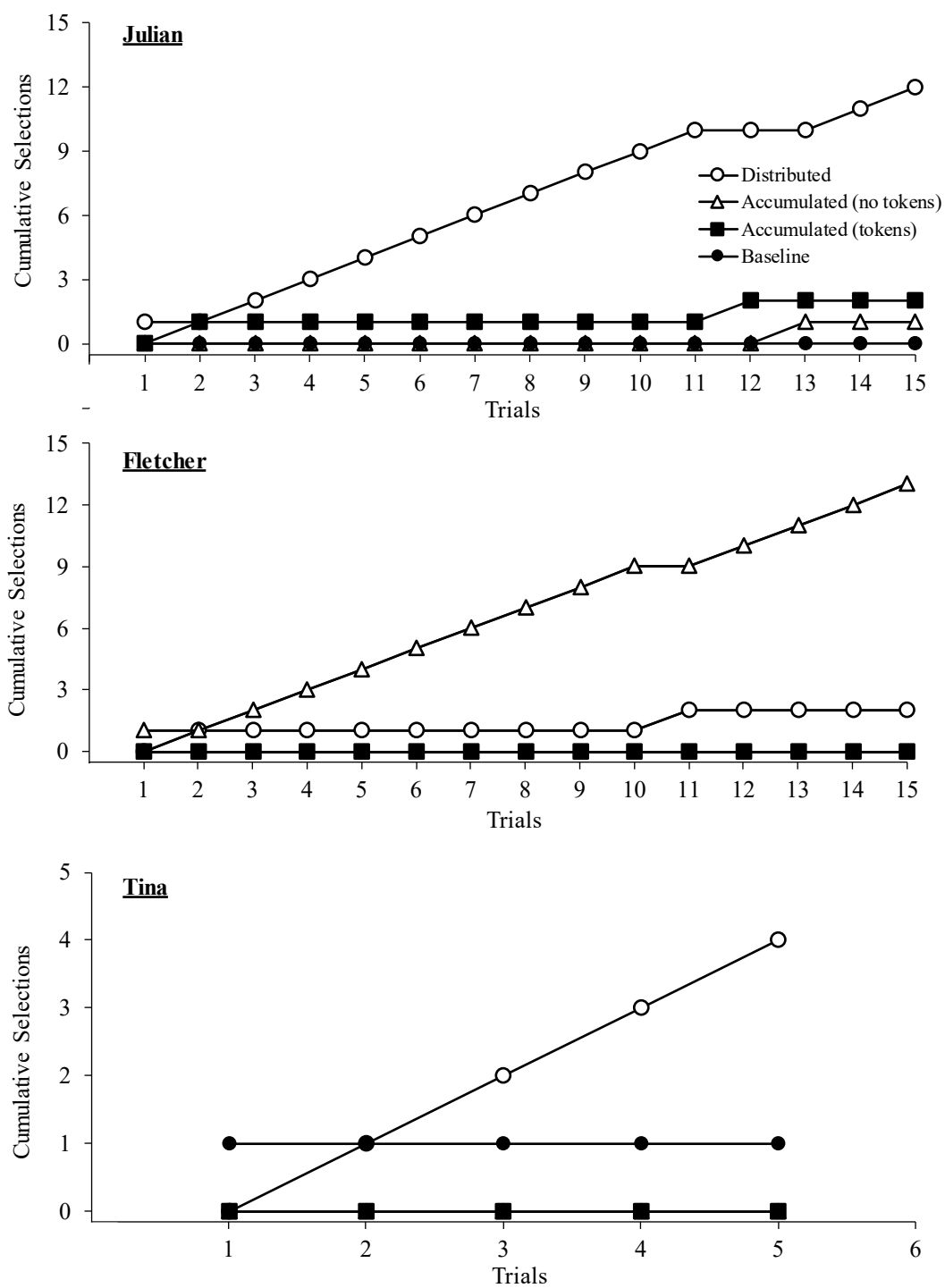
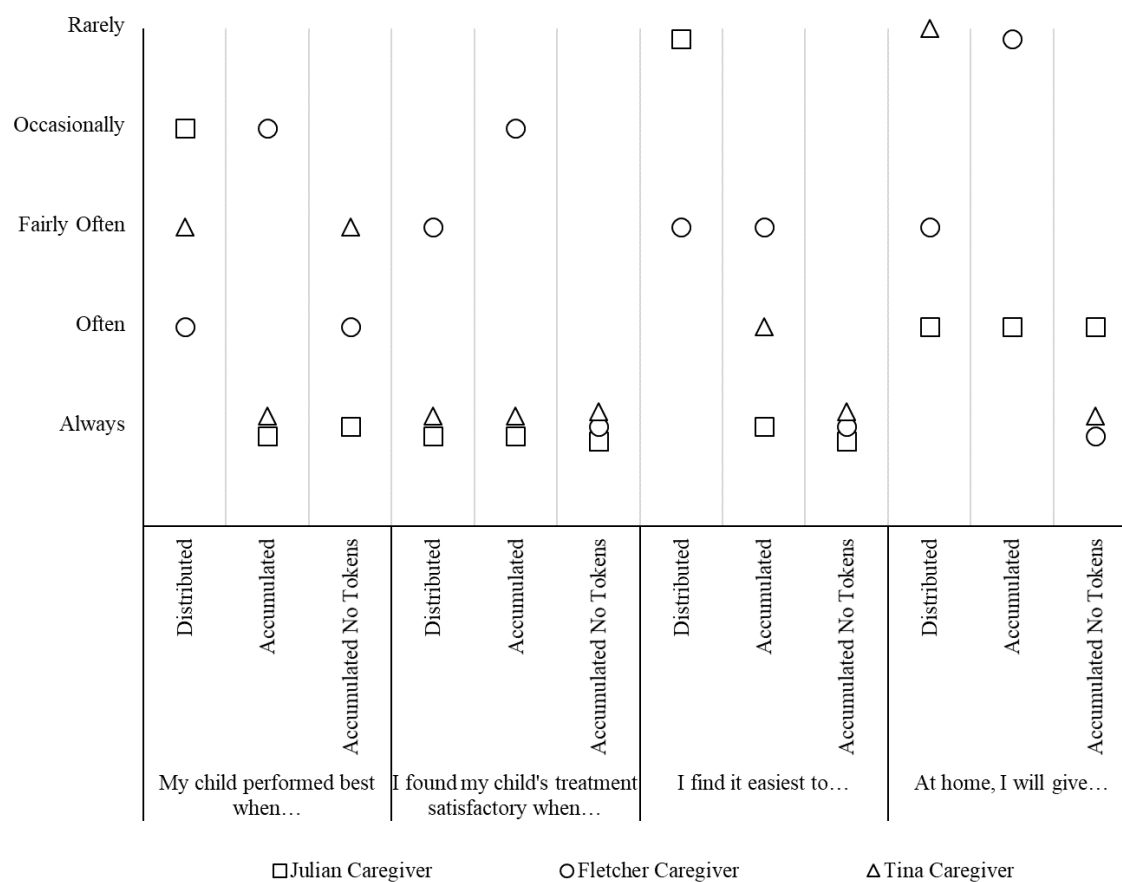


Figure 5
Caregiver Social Validity Questionnaire Outcomes


Conflict of Interest

The authors declare no conflict of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Supplemental Materials

Parent Questionnaire

Three treatment conditions have been compared during meals, one that involved providing a toy immediately following each appropriate response for a brief amount of time, and another that provided a toy after the completion of multiple appropriate responses for a longer period of time (with and without tokens). After observing these sessions, we would like for you to answer the following questions regarding your impressions and preferences:

(Please circle your answer)

1. My child performed best when he/she immediately received the toy following an appropriate response:

Always Often Fairly Often Occasionally Rarely

2. I found my child's treatment more satisfactory when he/she immediately received a toy following an appropriate response:

Always Often Fairly Often Occasionally Rarely

3. My child performed best when he/she immediately received a token following an appropriate response and then received the toy after completing multiple appropriate responses:

Always Often Fairly Often Occasionally Rarely

4. I found my child's treatment more satisfactory when he/she immediately received a token following an appropriate response and then received the toy after completing multiple appropriate responses:

Always Often Fairly Often Occasionally Rarely

5.. My child performed best when he/she received the toy after completing multiple appropriate responses:

Always Often Fairly Often Occasionally Rarely

6. I found my child's treatment more satisfactory when he/she received the toy after completing multiple appropriate responses:

Always Often Fairly Often Occasionally Rarely

7. I find it easiest to give a toy immediately after each appropriate response:

Always Often Fairly Often Occasionally Rarely

8. I find it easiest to give a token after each appropriate response and then give a toy after the completion of multiple appropriate responses:

Always Often Fairly Often Occasionally Rarely

9. I find it easiest to give a toy after the completion of multiple appropriate responses:

Always Often Fairly Often Occasionally Rarely

10. At home, I will give a toy immediately after each appropriate response:

Always Often Fairly Often Occasionally Rarely

11. At home, I will give a token immediately after each appropriate response and then a toy after the completion of multiple appropriate responses:

Always Often Fairly Often Occasionally Rarely

12. At home, I will give a toy after the completion of multiple appropriate responses:

Always Often Fairly Often Occasionally Rarely

Comments:
