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Simultaneous presentation and differential reinforcement to increase consumption

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Abstract

Many autistic children display feeding difficulties and consume a limited food variety. These feeding difficulties could be conceptualized as change-resistant behavior because children often exhibit rigid mealtime routines, avoid novel foods, and only consume foods according to specific types, textures, or under specific mealtime conditions. Currently, behavior-analytic treatments for pediatric feeding disorders have the most empirical support and many studies have demonstrated the effectiveness of extinction-based treatments. However, there is less research on alternative treatments for increasing consumption of novel or non-preferred foods among children with autism spectrum disorder (ASD). In the current study, we evaluated simultaneous presentation and differential reinforcement to increase consumption of novel, target foods for two participants with ASD and change-resistant feeding behavior.

KEYWORDS
autism spectrum disorder, avoidant restrictive food intake disorder, differential reinforcement, simultaneous presentation, stimulus fading

1 | INTRODUCTION

Avoidant/Restrictive Food Intake Disorder (ARFID) is diagnosed when a child consumes insufficient calories, hydration, or variety of foods and liquids to maintain appropriate health and growth (American Psychiatric Association, 2013; Diagnostic and statistical manual of mental disorders [5th ed.]). These challenges can lead to nutritional deficiencies and marked interference with psychosocial functioning (Goday et al., 2019). Many children who initially present with ARFID also display oral-motor skill deficits or experience concerning medical events; therefore, there may be significant overlap in the presenting features of the diagnosis with a traditional pediatric feeding disorder diagnosis (Rommel et al., 2003; Sharp et al., 2022).

Research has shown that up to 89% of children with autism spectrum disorder (ASD) display feeding difficulties (Silverman, 2015). Although common, the topography and severity of feeding concerns varies significantly across children. Children with feeding difficulties often display rigidity in terms of the type, texture, or other stimulus properties (e.g., color, temperature) of the foods they select (Bandini et al., 2010; Crowley et al., 2020). These feeding difficulties could be conceptualized as one form of resistance to change or insistence upon sameness, which is a core feature of ASD (Turner, 1999). Children with change-resistant feeding behavior often consume a limited variety of unhealthy foods and refuse to try novel alternatives or eat their preferred foods if the foods are presented in a novel manner (Peterson et al., 2016). According to one study by Bandini et al. (2010), autistic children were more likely to have limited diets, demonstrate a high frequency of single-food intake, and display more nutrient deficiencies than same-aged, typically developing children.

Although children with limited diet variety may appear healthy, there could be underlying or masked health concerns. For example, prolonged exposure to insufficient nutrition could place the child at risk for developing learning and behavior challenges, dental health concerns, or other severe health-related illnesses, such as gastrointestinal problems, obesity, or metabolic dysfunction (Broder-Fingert et al., 2014; Schreck et al., 2004). These types of pervasive feeding difficulties can arise or worsen at any point during childhood, and often warrant intervention.

Many studies have shown that children who engage in food refusal or change-resistant feeding behavior have inapprorpriate mealtime behavior that is maintained by negative reinforcement (Saini et al., 2019). As such, there is a wealth of empirical support for escape extinction as an effective treatment (Volkert & Piazza, 2012). Although highly effective, escape extinction may not be tenable in some conditions. For example, clinicians who are not properly trained to use it safely and who do not have access to ongoing supervision and guidance from a trained professional should avoid use of escape extinction. In addition, clinicians who are not working in close collaboration with an interdiscplinary team of experts (i.e., professional with expertise in pediatric swallow safety, relevant medical providers, dietician) or in settings with the appropriate resources (e.g., safe seating) should consider alternatives to escape extinction.

In a review of behavior-analytic interventions for feeding difficulties, Bachmeyer (2009) identified several strategies without escape extinction with growing support, including differential reinforcement of alternative behavior (e.g., Brown et al., 2002; Chen et al., 2022; Crowley et al., 2020), demand and stimulus fading (e.g., Luiselli et al., 2005; Riordan et al., 1980; Wilkins et al., 2014), and simultaneous presentation (e.g., Ahearn, 2003; Buckley & Newchok, 2005; Piazza et al., 2002). In previous studies, differential reinforcement interventions have involved providing access to social positive (e.g., tangibles, attention; Budhan et al., 2019; Patel et al., 2002) or negative (e.g., brief breaks, meal termination; LaRue et al., 2011) reinforcers following alternative responses to inappropriate mealtime behavior (e.g., bite acceptance, consumption; Peterson et al., 2015). Even though differential reinforcement alone is generally insufficient to increase acceptance for many children with feeding disorders, it can be a useful treatment component to improve the mealtime experience for the child, reduce other challenging or concerning behavior (e.g., negative vocalizations), or maintain treatment effects after removal of escape extinction (Crowley et al.). For example, Patel et al. (2002) demonstrated that even though escape extinction was necessary, adding differential reinforcement resulted in generally lower levels of negative vocalizations.

Stimulus- or demand-fading interventions for feeding involve a systematic alteration of the stimulus properties of the foods or feeding context (e.g., utensils) to increase appropriate feeding responses and reduce inappropriate mealtime behavior. For example, researchers have gradually altered the stimuli associated with the bite or drink presentation (e.g., utensil fading, such as spoon-to-cup or syringe-to-cup; Groff et al., 2011; Groff et al., 2014) or the proximity of bites to the lips (e.g., Rivas et al., 2010). Fading interventions may be helpful because they often involve reinforcing behavior the child is already emitting and then gradually changing the response requirement or stimulus conditions associated with subsequent steps or targets. For example, within a feeding treatment context, feeders could initially reinforce responding toward less complex responses by altering the aversive properties of the food (e.g., pairing the food with more appetitive stimuli) and/or reducing the response effort associated with consumption (e.g., use of a food texture or bite size that requires less response effort). Once the child is consistently consuming the target food in the altered format, the feeder can gradually change stimulus properties, one by one, to increase the likelihood the child will complete the desired target response (e.g., consumption of the target food). Researchers hypothesize that fading or other antecedent manipulations may be effective because they reduce the value of escape as a reinforcer (Bachmeyer, 2009).

Stimulus or demand fading that involve manipulations to the food may not be appropriate for children who consume nothing by mouth or who have severely limited oral-motor skills. However, fading may be an appropriate treatment for children with ASD who consume at least some foods or liquids by mouth (e.g., limited diet consisting of unhealthy foods; Schreck et al., 2004) and possess the oral-motor skills to manage different textures or bolus sizes safely. In these cases, an appropriate starting point for a fading intervention could be to begin with a feeding behavior or food that the child already emits or consumes, respectively.

Researchers have been successful with various stimulus and demand fading interventions to improve feeding behavior. For example, some researchers have gradually altered the concentration of preferred to non-preferred foods or liquids (e.g., Luiselli et al., 2005; Tiger & Hanley, 2006) and the visual properties and flavor of the foods through use of food/liquid blending (e.g., Patel et al., 2001). Patel et al. (2001) gradually increased one participant's consumption of a target beverage by blending the target beverage (Carnation Breakfast Essentials with whole milk) with a highly preferred or accepted liquid (water) and using stimulus fading to eventually remove water. As the child demonstrated mastery of different water/milk blends (e.g., 90% water/10% milk; 80% water/20% milk), researchers faded the amount of water from all drink presentations until the child was consistently consuming only the Carnation Breakfast Essentials and whole-milk drink.

Using a similar approach, Piazza et al. (2002) and Ahearn (2003) presented reportedly preferred foods in the same bite presentation with nonpreferred foods. For example, in Piazza et al., feeders placed one piece of the child's nonpreferred food (e.g., broccoli) on top of one piece of the child's preferred food (e.g., potato chip); in Ahearn, feeders placed one piece of the child's nonpreferred food (e.g., carrot) on a spoon with a dollop of the child's preferred condiment on top (e.g., ketchup). Researchers across both studies demonstrated that presenting simultaneous bites increased participants' consumption of nonpreferred foods.

Although Piazza et al. (2002) and Ahearn (2003) demonstrated robust outcomes with the simultaneous-presentation interventions, they were not able to demonstrate that participants would continue to consume the nonpreferred foods in the absence of the preferred foods. That is, the simultaneous-presentation intervention did not include a stimulus-fading component to remove the preferred foods from bite presentations. In addition, escape extinction was used in both studies. Practitioners should consider removal of the preferred-food component to eventually present bites in a more typical or socially acceptable manner (i.e., present the child with a bite of broccoli without also simultaneously presenting a bite of potato chip). Fading the simultaneous bite could also make things easier on caregivers in terms of meal preparation, and lead to more robust improvements in the child's nutrition.

The purpose of the current study was to determine whether a treatment package involving simultaneous presentation and differential reinforcement with fading would increase consumption of target foods for two children with ASD and change-resistant feeding behavior. First, feeders conducted a demand assessment to determine which steps of a feeding response chain the children would complete without intervention (e.g., lifting a spoon with a bite of food to touch the lips, accepting a bite of hot dog when it was presented simultaneously with a bite of Fruit Roll-Up). Once we determined starting points, feeders used demand fading (Alex), simultaneous presentation with stimulus fading (Alex and Wade), and differential reinforcement (Alex and Wade) to increase the participants' consumption of three target foods. We used the same strategies to introduce two additional target foods for Alex after the study. There were challenges when we attempted to begin treatment with only one antecedent strategy (demand fading) implemented in isolation or with differential reinforcement. After further analysis and assessments (preference and demand assessments), we identified packages that led to an increase in consumption of novel, target foods for both participants.

2 | METHOD

2.1 | Participants

Inclusion criteria for the study were that the children were (a) deemed medically appropriate for feeding intervention and safe to consume table-textured foods orally per physician and speech language pathologist evaluations; (b) diagnoses of ASD and ARFID by qualified healthcare providers; (c) between the ages of 3 and 8 years; (d) consuming less than 20 but more than three foods by mouth, per caregiver report; (e) consuming at least 90% of their estimated energy needs by mouth and were not dependent on supplemental nutrition, like a gastrostomy tube; and (f) not experiencing growth failure, which would have required more immediate intensive intervention. Alex and Wade met all of these inclusion criteria, and both of their caregivers had goals for their children to be willing to try new foods. Alex and Wade were Caucasian males and at the start of the study, were 5 and 4 years old, respectively.

After each child was enrolled in the study, a behavior analyst interviewed caregivers about the children's current and past feeding behavior and medical history, measured and recorded the child's height and weight, and conducted direct observations of the child's chewing skills with table-textured foods. To determine whether children displayed unsafe, inappropriate, or risky chewing behavior, the first author observed the child eat foods they regularly ate at home (e.g., spaghetti and chicken nuggets for Alex; grilled cheese sandwich and crackers for Wade). The authors defined unsafe chewing as any instances of swallowing food without sufficient chews to break the food down (i.e., mastication, as defined in Volkert et al., 2014); coughing or gagging after food entered the mouth that was accompanied by a red face, watery eyes, or both; and/or swallowing food while protracting the neck and either reaching for the neck or the corners of the mouth moving posteriorly (i.e., hard swallows or possible choking). We generated these criteria based on recommendations from our program's speech language pathologist. Observers collected data on coughs, gags, and unsafe chewing (e.g., swallowing food without sufficient chews) throughout the study. If there was unsafe chewing during the initial observations or throughout the study, we would have immediately withdrawn the participant, but this did not occur.

Both participants were diagnosed with ARFID. At the start of the study, Alex regularly consumed a few different proteins (e.g., chicken nuggets, eggs) and complex carbohydrates (e.g., spaghetti, Cinnamon Toast Crunch cereal), for a total of 11 foods and did not eat fruits or vegetables. Throughout the study, Alex received early intensive behavioral intervention services in a university-based applied behavior analysis (ABA) clinic that focused on increasing communication and social skills but not feeding. Wade ate a few fruits (e.g., bananas), proteins (e.g., grilled cheese sandwich), and complex carbohydrates (e.g., crackers), for a total of 13 foods. Throughout the study, Wade attended daycare and received speech services that focused on increasing his communication skills. According to caregiver reports, both participants refused to eat even preferred foods if the preferred foods were presented in a novel or non-preferred manner. For example, Wade refused to eat grilled cheese sandwiches if they were above or below a specific temperature, if they had crust, or if they were not cut diagonally. Both participants consumed unhealthy snack foods (e.g., candy, cookies), engaged in challenging behavior when caregivers attempted to present novel or non-preferred foods (e.g., aggression, property destruction, elopement), and participated in previous feeding therapy that did not use a behavior-analytic approach (e.g., speech therapy, sequential-oral-sensory approach) but had not made progress. Both participants were self-feeders and used their fingers or utensils (e.g., spoon) to consume bites of food, which feeders observed during initial meal observations. Both children demonstrated vocal verbal behavior and communicated with multiple-word sentences. Both children displayed a large repertoire of gross- and fine-motor skills, imitation skills, and could readily follow 3-4-step instructions (based on our initial observations and caregiver reports).

2.2 | Setting and materials

Feeders conducted meals in rooms in a pediatric feeding disorders clinic in a university-based medical center. Materials included digital-food scales, iPads, laptop computers, Maroon spoons, plastic bowls, video cameras, video-recording computer software, a table and chairs, and timers. Participants sat in an adaptive seat that promoted safety and upright position, called the Special Tomato Chair. The Special Tomato Chair is made from a soft, heavy-duty foam that allows the child to sit comfortably and maintain an upright posture, with back and head support.

Before the study, caregivers selected three target foods for Alex and Wade that neither participant were eating, but the caregivers wanted them to eat. The authors asked caregivers to select a small number of target foods to begin, but taught them how to use this protocol to continue expanding the children's diets after the study ended. Both sets of caregivers reported that beginning with target foods that the family regularly consumed and that were affordable for them, would be most meaningful beginning goals. Thus, the target foods for the study were pea, carrot, and apple for Alex, and hot dog, corn, and macaroni and cheese for Wade. Alex's caregiver also selected garbanzo bean and orange, which we targeted with the final treatment package (described below; data available in Appendix A). Feeders conducted a paired-stimulus preference assessment (Fisher et al., 1992) to identify the participants' preferred foods, which were Oreo cookie for Alex, and Laffy Taffy and Fruit Roll-Up for Wade, for use during simultaneous presentation and stimulus fading. Feeders also conducted a separate preference assessment to identify preferred non-food tangible items to be used during differential reinforcement. The top preferred item for both children was an iPad that was loaded with kid-friendly YouTube videos.

Throughout the study, each *presentation* was one bite. One bite of target food was a 0.6-cm by 0.6-cm by 0.6-cm piece of the food. One bite of simultaneous food for Alex was a 0.6-cm by 0.6-cm by 0.6-cm bite of target food inside approximately 1.8-cm by 1.8-cm by 1.8-cm piece of Oreo cookie. Feeders separated the outside cookie piece from the cream filling, pressed a pea into the filling, and replaced the cookie piece on top of the filling. The target food was always visible in the simultaneous bite for Alex. One bite of simultaneous food for Wade was a 0.6-cm by 0.6-cm by 0.6-cm bite of target food wrapped in approximately 2.5-cm by 4.5-cm piece of Laffy Taffy or Fruit Roll-Up. Feeders placed one bite of hot dog on top of a flattened piece of Fruit Roll-Up and folded the sides of the Fruit Roll-Up to completely cover the bite of hot dog. The target food was initially not visible for Wade. During stimulus fading, feeders presented a simultaneous food and gradually decreased the size of the preferred food across steps, while the target food remained the same size (described below). Appendix B contains example images of the simultaneous bites for two of Alex's foods and one of Wade's foods Figures B1–B3.

2.3 | Feeders and observers

Feeders and observers (i.e., data collectors) were ABA doctoral-training students who were completing practicum internships in the feeding clinic, or were staff members in the feeding clinic who had Bachelor's, Master's, or Doctoral degrees in psychology, ABA, or a related field. The authors used behavioral skills training to teach feeders and observers to implement the baseline, assessments (demand, preference), and feeding interventions and to collect data. The students and staff who conducted this study implemented these protocols routinely and were required to pass integrity checks as part of their clinical roles. However, before students or staff served as feeders for the current study, their procedural integrity had to be 80% or greater for at least three consecutive sessions for the interventions that were evaluated. Observers could be data collectors after they had 80% or greater agreement with at least one other trained data collector for a minimum of three sessions, across primary dependent variables.

2.4 | Response measurement

The primary dependent variables were step completion and consumption. Observers collected data on these variables with laptop computers using DataPal 1.0 (a Beta version of BDataPro; Bullock et al., 2017). A presentation occurred when the feeder placed one bite on a spoon in a bowl in arm's reach of the participant. In demand fading, observers scored *step completion* when the participant engaged in the response that was appropriate based on the feeder's instruction (e.g., ‘Pick up the spoon’) within 8 s of the presentation and instruction. DataPal 1.0 converted occurrences of step completion to a percentage after dividing the frequency of step completion by the number of instructions presented.

Observers scored *acceptance* when the participant placed the entire bite inside his mouth within 8 s of presentation. Observers scored *mouth clean* when no food was in the participant's mouth 30 s after the bite entered the mouth, not including bites that were expelled (i.e., spit or allowed food greater than the size of a pea to fall out of the mouth). *Consumption*, or the terminal step, occurred when the participant both accepted and had a mouth clean for a bite. The first author calculated percentage consumption by identifying and summing the number of bites for which acceptance and mouth clean occurred, dividing by the number of bites presented, and converting the ratio to a percentage. Throughout the manuscript, the term *no food in the mouth* means that no food the size of a grain of rice or larger was in the participant's mouth. The term *food in the mouth* means the food that was remaining in the mouth was rice size or larger.

2.5 | Procedural integrity

At least one observer scored treatment integrity for 100% of sessions. Observers scored *correct spoon placement* by activating a duration key when the feeder met criteria for correct spoon placement and deactivating the key if the feeder did not meet criteria for correct spoon placement. Observers scored correct spoon placement during baseline and treatment when the feeder (a) presented the spoon with a bite in a bowl in arm's reach of the participant, (b) removed the spoon and bowl if the bite entered the participant's mouth, (c) removed the spoon and bowl after 30 s if the bite did not enter the participant's mouth, and (d) presented the next bite 30 s after the previous bite entered the participant's mouth or immediately after removing the spoon and bowl when the bite did not enter the mouth. DataPal 1.0 converted correct spoon placement to a percentage after dividing the duration of correct spoon placement by the session time. Mean correct spoon placement was 92% (range, 84%–98%) across participants.

Observers scored *incorrect praise* if the feeder did not provide behavior-specific praise (e.g., ‘Good job taking your bite’ or ‘Good job swallowing your bite’) within 5 s of acceptance and mouth clean or provided praise when bites entered the mouth after 8 s or when packing (i.e., food in the mouth at the mouth check) occurred. DataPal 1.0 converted incorrect praise to a percentage after dividing the instances of incorrect praise by the total opportunities to provide praise, which was the sum of acceptance and mouth clean. Feeders provided incorrect praise during 4% (range, 0%–6%) of opportunities within a session across participants.

2.6 | Interobserver agreement

Two observers independently and simultaneously collected data on step completion and consumption during a mean of 34% (range, 32%–36%) of sessions across participants. DataPal 1.0 calculated interobserver agreement (IOA) for step completion and consumption by dividing the number of agreements by the total number of agreements plus disagreements and converting the ratio to a percentage. We defined an agreement as both observers scoring the occurrence of the behavior or not scoring the occurrence of the behavior in the same 10-s interval and a disagreement as one observer scoring and one observer not scoring the occurrence of the behavior in a 10-s interval. Mean IOA across participants was 96% (range, 86%–97%) for both step completion and consumption.

Two independent observers simultaneously and independently collected data on correct spoon placement and incorrect praise during a mean of 34% (range, 32%–36%) of sessions across participants. DataPal 1.0 calculated IOA for treatment integrity by dividing the number of agreements by the number of agreements plus disagreements and converting the ratio to a percentage. Mean IOA was 93% (range, 81%–99%) for correct spoon placement and 95% (range, 92%–100%) for incorrect praise across participants.

2.7 | Experimental design

To evaluate step completion and consumption, we used a concurrent multiple-baseline-across-foods design with brief reversals. We used the multiple-baseline-across-foods design as a control to demonstrate that consumption of target foods did not increase until the feeder exposed the food to at least one of the interventions. We randomly selected the order of foods to target during treatment (e.g., first pea, then carrot, then apple for Alex).

The brief reversals during demand fading for Alex, in which feeders probed the terminal step (i.e., consumption) with and without reinforcement, tested whether demand fading was necessary or whether Alex would complete the terminal step without further fading. The brief reversals for Alex and Wade during simultaneous presentation and stimulus fading, in which feeders presented a bite with and without reinforcement, tested whether stimulus fading was necessary or whether the participant would consume the bite without additional fading. Feeders continued with fading if consumption of the bite during the reversal was below 80% or continued presenting the bite at the terminal step if consumption during the reversal was 80% or above.

2.8 | General procedure

Feeders conducted 60-90-min meals three times per week with each participant. Meals consisted of multiple sessions with brief breaks between sessions. The mean number of sessions per meal were eight and nine for Alex and Wade, respectively. Feeders briefly stated the current contingencies before each meal (e.g., 'If you take the bite, you can have the iPad') or during the meal if the contingencies changed.

2.8.1 | Baseline

Sessions included five presentations. Feeders presented one bite on a spoon in a bowl in arm's reach of the participant with the vocal instruction, "Take a bite," approximately every 30 s. Feeders removed the bowl after the participant placed the bite in his mouth or 30 s elapsed from presentation. Feeders provided praise (e.g., 'Good job taking a bite's) for acceptance. Feeders started a timer for 30 s if the participant placed the bite in his mouth and conducted a mouth check when 30 s elapsed by saying, "Show me." Feeders also touched a baby spoon to the participant's lips if he did not open his mouth within 3 s so they could check to see if any food was in the mouth.

Feeders presented the next bite after providing praise for mouth clean or saying, "Swallow your bite," if the participant was packing (i.e., food pea-sized or greater in the participant's mouth 30 s after the bite entered the mouth). Mouth checks always occurred 30 s after a bite entered the mouth. If the participant had food in the mouth at the mouth check that followed the fifth bite presentation, feeders conducted mouth checks every 30 s until no food was in the mouth or 10 min elapsed from session initiation. If food was in the participant's mouth when 10 min elapsed, feeders gently wiped out the participant's mouth with an unflavored toothette oral swab.

Feeders did not provide differential consequences for coughing, gagging, inappropriate mealtime behavior, negative vocalizations, or vomiting. If vomiting occurred, feeders would wipe away the emesis, quickly sanitize and disinfect the area, and present fresh bites for subsequent presentations, but that did not occur for either participant during the study. If inappropriate mealtime behavior occurred, such as the child throwing the utensil, bowl, or food, the feeder did not replace the items and did not provide additional attention. Observers collected continuous data on coughs, gags, inappropriate mealtime behavior, negative vocalizations, and vomiting throughout the entire duration of the study. As part of our general clinical practice, we monitor these behaviors for safety and to ensure that treatment leads to low levels. These behaviors occurred at consistently low or zero levels for these participants during the study (data available upon request from the first author). For Wade, we also conducted one baseline session for each target food with differential reinforcement, meaning feeders gave Wade an iPad and high-quality attention for 30 s following consumption.

2.8.2 | Demand assessment

Before demand fading, feeders conducted an assessment to identify the demand closest to the terminal response (i.e., consumption) for which step completion was at or above 80%. Each session included five presentations at one demand step. Feeders then followed the baseline procedure with the exception that for demand steps before the terminal step, feeders did not conduct mouth checks. The steps were not conducted in a sequential order that follows a typical chain for eating (i.e., pick up spoon, lift to lips, place bite in mouth, chew, swallow) and instead were randomized across participants. We presented the steps out of order to avoid conducting an actual fading progression/sequence of steps during our initial assessment phase. The randomized steps for Alex were: place bite in mouth and remove it; place bite in mouth, chew 7 times, and remove it; pick up spoon with bite, lift to lips, then place spoon back in the bowl; place bite in mouth, chew once, and remove it; pick up spoon, lift it halfway to lips, and place spoon back in the bowl; place bite in mouth, chew 10 times, and swallow; place bite in mouth, chew 6 times, and remove it; place bite in mouth, chew 1 time, and remove it. The randomized steps for Wade were: place bite in mouth, chew 8 times, hold in mouth 20 s, and remove it; pick up spoon, lift it halfway to lips, and place spoon back in the bowl; place bite in mouth, chew 8 times, and swallow; place bite in mouth and remove it; grasp spoon and release; place bite in mouth and hold in mouth for 5 s, remove it; place bite in mouth, chew 8 times, hold in mouth for 5 s, remove it; lift spoon, touch to lips, and place spoon back in bowl; place bite in mouth, chew 1 time, and remove it.

For Wade, feeders conducted two additional steps with Laffy Taffy based on Alex's treatment results, which were: place bite of Laffy Taffy in mouth, chew, and then swallow; and place simultaneous bite of food (i.e., Laffy Taffy and hot dog) in mouth, chew, and swallow. The identified starting point for Alex was: chew target bite once, then remove it; the identified starting point for Wade was place simultaneous bite in mouth, chew, and swallow.

We selected most of the steps to approximate typical behaviors included in the chain for eating a bite of food. However, we attempted to avoid steps that could be problematic. For example, feeders instructed participants to hold the bite in the mouth for up to 25 s, but not for longer durations to avoid packing. Feeders randomly selected the number of chews to determine whether participants would engage in appropriate chews (not necessarily to identify the point of mastication). Given that bites were small (i.e., 0.6 by 0.6 by 0.6 cm bites) and both participants demonstrated consistent chewing during initial meal observations, fewer chews were necessary to break the bite down completely. We arbitrarily selected the numbers of chews for the purpose of the assessment, but this should be a consideration for future research. Practitioners should rely on guidance from trained professionals regarding the appropriate number of chews to target.

2.8.3 | Demand fading with differential reinforcement (Alex only)

The procedure was like the demand assessment with the following modifications. The procedure included demand fading in which Alex's level of completion with the current step determined whether upcoming sessions remained at that step or changed to the next step. Alex progressed to the next step when step completion was at or above 80% for three consecutive sessions. Alex returned to a previous step when step completion was below 80% for three consecutive sessions. The progression of steps during fading were (step A) chew once, remove the bite (starting point); (step B) chew twice, remove the bite; (step C) chew three times, remove the bite; (step D) chew four times, remove the bite; (step E) chew seven times, remove the bite; (step F) chew 10 times, remove the bite; (step G) chew 10 times, hold in mouth 5 s, remove the bite; (step H) chew 10 times, hold in mouth 15 s, remove the bite; and (step I) chew 10 times, hold in mouth 25 s, remove the bite (See Table 1 for each target steps and the associated letters in Figure 1). Feeders gave Alex an iPad and high-quality attention for 30 s following each occurrence of step completion.

Demand Fading Brief Reversals. Feeders conducted brief reversals with pea to baseline with and without reinforcement, and with pea at the current demand-fading step without reinforcement to determine whether additional demand fading or differential reinforcement were necessary. Due to time constraints, baseline and current demand-fading step probes without reinforcement were not conducted between sessions 80 and 110, although baseline with reinforcement continued. Baseline without reinforcement sessions were resumed around session 120, as the current demand-fading step moved closer to the final step. In brief reversals to baseline *without* reinforcement, feeders followed baseline procedures. In brief reversals to baseline *with* reinforcement, feeders followed baseline procedures but gave Alex an iPad and high-quality attention for 30 s following consumption. In brief reversals to the demand-fading step *without* reinforcement, feeders followed the demand-fading-with-reinforcement procedure, but only provided praise for step completion.

2.8.4 | Simultaneous presentation, differential reinforcement, and stimulus fading

Alex never met criteria for step completion with the terminal step for pea in demand fading with differential reinforcement; thus, feeders implemented simultaneous presentation and stimulus fading with pea. Wade participated in the study after Alex. Based on Alex's progress and Wade's responding during the demand assessment, feeders used simultaneous presentation, stimulus fading, and differential reinforcement for Wade and did not conduct demand fading.

The procedure was like baseline with the following modifications. The presented bites were simultaneous foods for both Alex and Wade. Feeders gave Alex and Wade an iPad and high-quality attention for 30 s for consumption of the simultaneous bite.

Although feeders identified Laffy Taffy as a highly preferred food that Wade would chew and swallow during the previous preference and demand assessments, he did not maintain consumption when it was used in simultaneous presentation (sessions 33–36 in Figure 2). Feeders hypothesized that chewing Laffy Taffy for multiple consecutive trials may have required too high response effort, due to the amount of chewing necessary to break down the thicker, sticky taffy texture. Feeders then conducted a brief assessment using baseline procedures to determine whether Wade would consume a simultaneous bite with alternative highly preferred foods that were identified in the preference assessment (i.e., fruit snack, Fruit Roll-Up, cookie). Wade consumed the most simultaneous bites with Fruit Roll-Up but also inspected the pieces closely and occasionally unfolded the simultaneous bites. Because Wade

TABLE 1 Progression of demand and stimulus fading steps for Alex.

Treatment	Step	Target
Demand fading with pea	A	Chew one time, remove bite
	B	Chew two times, remove bite
	C	Chew three times, remove bite
	D	Chew four times, remove bite
	E	Chew seven times, remove bite
	F	Chew 10 times, remove bite
	G	Chew 10 times, hold in mouth 5 s, remove bite
	H	Chew 10 times, hold in mouth 15 s, remove bite
	I	Chew 10 times, hold in mouth 25 s, remove bite
Simultaneous presentation, differential reinforcement, and stimulus fading with pea and carrot	A2	Size of preferred food component was 1.8 cm by 1.8 cm by 1.8 cm
	B2	Size of preferred food component was 1.8 cm by 1.8 cm by 0.6 cm
	C2	Size of preferred food component was 0.6 cm by 0.6 cm by 0.6 cm
	D2	Size of preferred food component was 0.24 cm by 0.24 cm by 0.24 cm
	E2	Dusting of Oreo cookie that covered entire surface

occasionally pulled the bites apart, feeders first implemented 10-bite sessions in which they randomly rotated between bites of Fruit Roll-Up alone and simultaneous bites with hot dog (i.e., 5 bites Fruit Roll-Up alone and 5 simultaneous bites; sessions 40–52 in Figure 2) using the simultaneous presentation and differential reinforcement procedure. Observers only scored consumption of the simultaneous bites (i.e., 0.6-cm by 0.6-cm by 0.6-cm bite of hot dog wrapped in approximately 2.5-cm by 4.5-cm piece of Fruit Roll-Up) during the 10-bite sessions.

The simultaneous presentation procedure included stimulus fading in which participants' level of consumption in the current session determined whether the size of the preferred-food component of the simultaneous bite stayed the same or changed. The size of the preferred-food component of the simultaneous bite decreased when consumption of the simultaneous bite was 80% or greater for at least three consecutive sessions. The size of the preferred-food component of the simultaneous bite increased when consumption of the simultaneous bite was 20% or lower for at least three consecutive sessions. Sizes of the preferred-food component (i.e., Oreo cookie) of the simultaneous bite for Alex during stimulus fading were approximately 1.8 cm by 1.8 cm by 1.8 cm (Step A2), 1.8 cm by 1.8 cm by 0.6 cm (Step B2), 0.6 cm by 0.6 cm by 0.6 cm (Step C2), 0.24 cm by 0.24 cm by 0.24 cm (Step D2), dusting of Oreo cookie that covered the entire surface of the target bite (Step E2), and no Oreo cookie. Successive sizes of the preferred-food component (i.e., Fruit Roll-up) of the simultaneous bite for Wade during stimulus fading were approximately 2.5 cm by 4.5 cm (Step A2), 1.9 cm by 2.5 cm (Step B2), 1.3 cm by 2.5 cm (Step C2), 1.3 cm by 1.9 cm (Step D2), 1.3 cm by 1.0 cm (Step E2), 1.0 cm by 0.5 cm (Step F2), and no Fruit Roll-Up (See Tables 1 and 2 for each target step and the associated letter-number in Figures 1 and 2).

Feeders implemented treatment with two additional foods for Alex (i.e., garbanzo bean, orange) to determine whether Alex would consume new foods in the absence of the entire demand-fading sequence. The procedure was the same as the simultaneous presentation, differential reinforcement, and stimulus fading condition (Figure in Appendix A Figures A1 and A2).

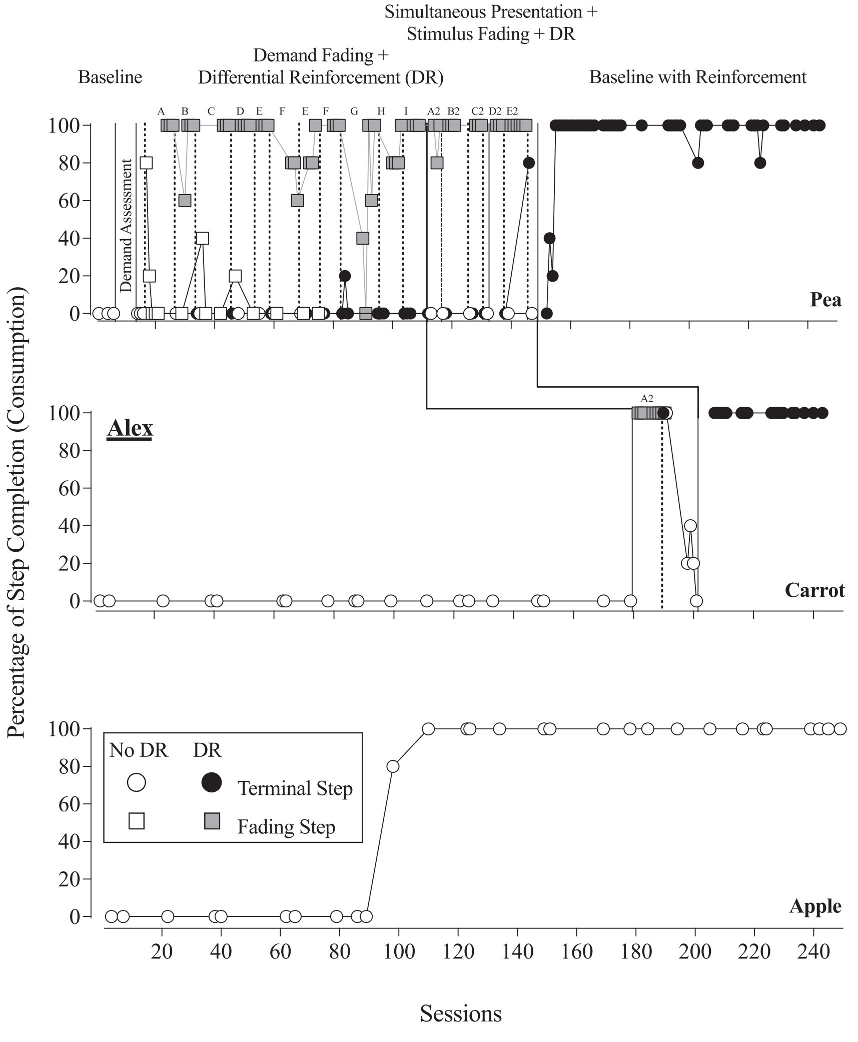

FIGURE 1 Percentage of step completion (including consumption) during Alex's treatment for pea (top), carrot (middle), and apple (bottom).

Within-Session Fading. Feeders implemented within-session fading with macaroni and cheese with Wade because consumption decreased to 20% or lower levels after repeated attempts to fade across steps. More specific, decreases in consumption occurred when observers (and presumably Wade) could see various stimulus properties of the target bite (e.g., the yellow color, the liquid cheese and noodle). The bite presentations during within-session fading were: the Fruit Roll-Up *completely covered* the bite of macaroni and cheese such that no properties of the macaroni and cheese were visible to the observers (1.7 cm by 2.5 cm), the Fruit Roll-Up *partially covered* the bite of macaroni and cheese (1.3 cm by 2.5 cm) such that properties of the macaroni and cheese were partially visible to the observers, and the Fruit Roll-Up was absent (only target bite present). The within-session fading sequence refers to the five bite presentations in order and was as follows: the number of completely covered to partially covered bites per session was four to one (step 1: Sessions 236–242), then three to two (step 2: Sessions 243–246), then two to three (step 3: Sessions 247–253), and then one to four (step 4: Sessions 254–269). Feeders then presented five partially covered bites (step 5: during Sessions 270–278). Finally, the number of partially covered to only target bites was four to one (step 6: Sessions 279–285) and then two to three (step 7: Sessions 286–293).

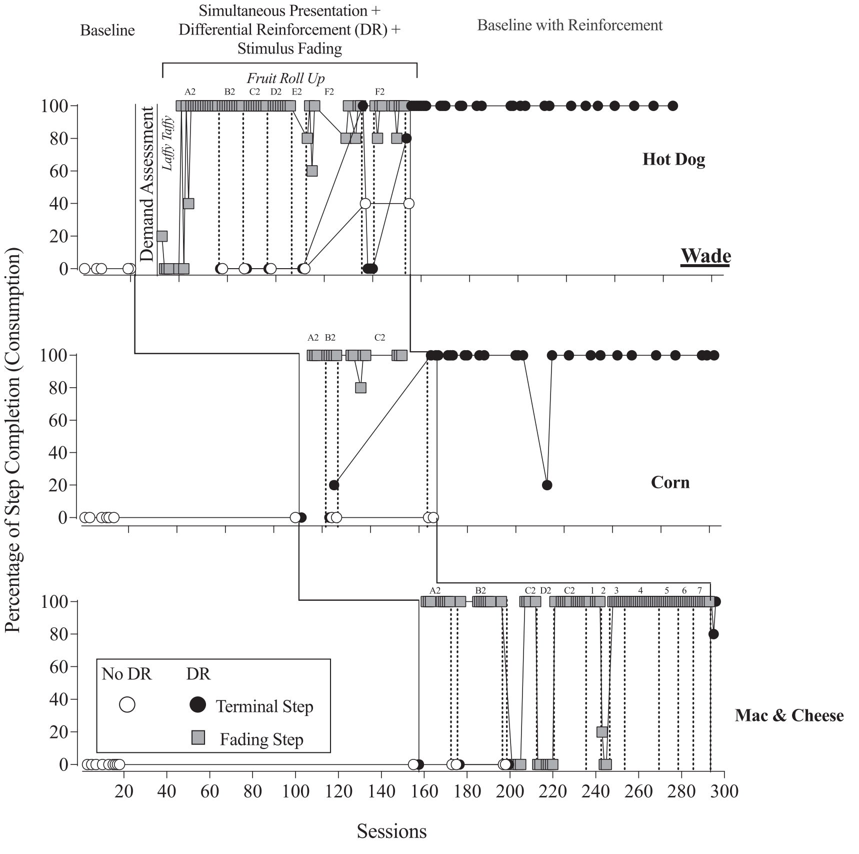

FIGURE 2 Percentage of step completion (including consumption) during Wade's treatment for hot dog (top), corn (middle), and macaroni and cheese (bottom). Within-session fading for macaroni and cheese occurred in sessions 236–293.

Beginning with Session 294, feeders presented all sessions with five target bites and no preferred-food component. The criteria for changing the visibility of the macaroni and cheese and visibility ratios across sessions (e.g., changing from one completely covered to four partially covered bite presentations) were the same as stimulus fading (See Appendix B for example images of within-session fading visibility ratios; See Table 2 for each target step and the associated numbers in Figure 2). Feeders did not conduct baseline sessions with and without reinforcement between within-session fading steps because we thought they were too disruptive and would result in carryover.

Stimulus Fading Brief Reversals. Feeders periodically conducted brief reversals in which the feeder presented a bite of target food with and without differential reinforcement to determine whether additional stimulus fading was necessary. In brief reversals to baseline *with* and *without* reinforcement, feeders followed the demand-fading brief-reversal procedure. Feeders did not follow specific criteria to decide when to conduct brief reversals, but randomly selected the beginning or end of the child's appointments to conduct these sessions.

3 | RESULTS

Figure 1 displays the percentage of step completion and consumption for Alex's target foods that were pea (top), carrot (middle), and apple (bottom). During the initial baseline with pea, Alex did not consume any bites. Alex initially had higher levels but did not maintain step completion during demand fading with pea (i.e., Sessions 17–22;

TABLE 2 Progression of demand and stimulus fading steps for Wade.

Treatment	Step	Target
Simultaneous presentation, differential reinforcement, and stimulus fading with hot dog, corn, and macaroni and cheese	A2	Size of preferred food component was 2.5 cm by 4.5 cm
	B2	Size of preferred food component was 1.9 cm by 2.5 cm
	C2	Size of preferred food component was 1.3 cm by 2.5 cm
	D2	Size of preferred food component was 1.3 cm by 1.9 cm
	E2	Size of preferred food component was 1.3 cm by 1.0 cm
	F2	Size of preferred food component was 1.0 cm by 0.5 cm
Simultaneous presentation, differential reinforcement, stimulus fading, and within session fading for macaroni and cheese	1	Completely covered to partially covered bites was four to one
	2	Completely covered to partially covered bites was three to two
	3	Completely covered to partially covered bites was two to three
	4	Completely covered to partially covered bites was one to four
	5	Five partially covered bites
	6	Partially covered to target bites was four to one
	7	Partially covered to target bites was two to three

M = 20%; range, 0%–80%) until feeders added differential reinforcement (beginning with Session 24). Step completion was relatively high and stable through demand fading including when the instruction was to chew the bite 10 times, hold it in the mouth for 25 s, and then remove it from his mouth (M = 95%; range, 40%–100%). However, Alex's step completion during brief reversals remained low (baseline reversals with reinforcement M = 1%; range, 0%–20%; baseline reversals without reinforcement M = 0%). When feeders initiated simultaneous presentation (Session 135), percentage of consumption increased to 100%. Percentage of consumption was 0% during brief reversals to baseline with and without reinforcement; therefore, feeders returned to simultaneous presentation and began stimulus fading (i.e., decreased the size of the preferred-food component to 0.6 cm by 0.6 cm by 0.6 cm; Session 141), during which, consumption maintained at high levels (100%). The percentage of consumption was at 80% and 0% during brief reversals to baseline with and without reinforcement, respectively. Due to Alex's high level of consumption in the brief reversal to baseline with reinforcement, feeders continued these sessions and consumption maintained (M = 94%; range, 0%–100%).

Next, feeders exposed carrot (middle tier) to simultaneous presentation (Session 180) and observed an increase in percentage of consumption to high, stable levels (M = 100%) that persisted during brief reversals to baseline with and without reinforcement. However, consumption did not maintain without reinforcement (Sessions 198–201); therefore, feeders implemented baseline with reinforcement and observed high, stable percentage of consumption with carrot (100%). Alex's third food, apple (bottom), increased to high, stable levels of consumption during baseline without reinforcement, beginning at Session 98 (*M* = 65%; range, 0%–100%), an outcome we attributed to generalization.

Figure 2 displays percentage of consumption for Wade for hot dog (top), corn (middle), and macaroni and cheese (bottom). During initial baseline with hot dog (top), Wade engaged in zero percentage of consumption. Wade did not maintain consumption when Laffy Taffy was used for simultaneous presentation (Sessions 34–37). However, Wade continued to consume simultaneous bites of hot dog when presented with Fruit Roll-Up in 10-bite sessions (alternating with Fruit Roll-Up-only bites; Sessions 41–53). After Wade's consumption maintained across multiple sessions, feeders returned to 5-bite sessions that included all simultaneous bites (beginning with Session 54). Percentage of consumption maintained at high, stable levels (*M* = 100%) as feeders faded the preferred-food component (i.e., from 2.5 cm by 4.5 cm, to 1.9 cm by 2.5 cm, to 1.3 cm by 2.5 cm pieces) from the simultaneous bite. Step completion was 0% during brief reversals to baseline with and without reinforcement. Wade had more variable responding when the size of the preferred-food component was faded to 1.3 cm by 1.9 cm (Sessions 100–118, *M* = 89%; range, 60%–100%), and consumed bites in one of the brief reversal sessions to baseline with reinforcement (Session 127 = 100%), but responding did not maintain. Feeders then conducted one additional fading step (i.e., preferred-food component was 1.3 cm by 1.0 cm) during which, percentage of consumption returned to high levels (*M* = 96%; range, 80%–100%). Wade began consuming all bites in the next brief reversal to baseline with reinforcement sessions (*M* = 99%; range, 80%–100%). Wade continued consuming bites of hot dog in baseline with reinforcement for the remainder of the evaluation.

Next, feeders exposed corn (middle tier) to simultaneous presentation and observed an immediate increase in percentage of consumption to high, stable levels (*M* = 100%). The percentage of consumption was low and variable during brief reversals to baseline with and without reinforcement; therefore, feeders faded the size of the preferred-food component from bites and observed that consumption maintained at high levels (i.e., to 1.9 cm by 2.5 cm; *M* = 98%; range, 80%–100%). During the next brief reversal to baseline, Wade consumed all bites with reinforcement and had zero consumption without reinforcement. Feeders continued the baseline-with-reinforcement condition (*M* = 100%) and consumption maintained at high levels.

Finally, feeders exposed Wade's third food, macaroni and cheese (bottom tier) to simultaneous presentation and differential reinforcement with stimulus fading. The percentage of consumption initially increased from baseline and maintained at high, stable levels during stimulus fading (Sessions 173–208; *M* = 100%). However, percentage of consumption was variable after the preferred-food component was faded to a degree that presumably enabled Wade to see the stimulus features of macaroni and cheese (i.e., Fruit Roll-Up piece was 1.9 cm by 2.5 cm and Wade could likely see the yellow cheese sauce and noodle on either side of the Fruit Roll-Up). Feeders attempted to return to a previous fading step and then progress, but were not successful. Next, feeders implemented within-session fading to reduce the amount of the preferred-food component more gradually (Sessions 236–293; Mean = 89%; range, 0%–100%). Eventually, consumption maintained at high, stable levels during the reversal to baseline with differential reinforcement (beginning at Session 294; *M* = 100%) and maintained.

Appendix A displays the percentage of consumption for garbanzo bean and orange (additional target foods) for Alex. Feeders introduced these two foods after the evaluation with pea, carrot, and apple.

4 | DISCUSSION

Feeding difficulties can be dangerous if left untreated, can cause stress if caregivers must prepare the same foods daily and separately from what the rest of the family eats, or if they must manage frequent challenging mealtime behavior. In many cases, caregivers may feel discouraged from trying to present new foods or from working to improve and change their child's diet (Volkert et al., 2016). Caregivers might alter their own meal routines or only present foods they know their child will consume, even though the child's feeding difficulties may lead to poor health. Although these actions might temporarily mitigate or reduce challenging behavior in the moment, caregivers may unintentionally reinforce challenging mealtime behavior. If left unaddressed, it is likely that feeding difficulties will remain the same or intensify over time (Joseph et al., 2013). As such, caregivers have reported feelings of anger, anxiety, and depression (Auslander et al., 2003). This study demonstrates that antecedent- and reinforcement-based interventions can be used to introduce new foods in gradual and systematic ways.

In the current study, Alex and Wade began consuming novel target foods with a treatment that included simultaneous presentation and differential reinforcement. Feeders faded the preferred foods from simultaneous bites and both children maintained target-bite consumption with differential reinforcement only. Using the same treatment, Alex began consuming an additional two foods after the study evaluation. Alex participated in the study first. His initial treatment included a demand-fading progression during which, he began consistently accepting, chewing, and holding the target bite in his mouth. However, Alex did not complete the terminal step (swallowing the bite) until feeders included simultaneously presented bites with Oreo cookie. Based on Alex's results and the results of Wade's initial demand assessment, we began Wade's treatment with simultaneous presentation.

Other studies have included demand- or stimulus-fading progressions (e.g., Bachmeyer et al., 2013; Groff et al., 2014; Kerwin et al., 1995; Luiselli, 2000) and pre-assessments to inform starting points (e.g., Andersen et al., 2022; Nadjowski et al., 2012; Rivas et al., 2010). Children with feeding disorders present with different types of feeding difficulties. Some children do not consume any food or liquid by mouth. However, children with change-resistant feeding behavior often engage in some type of oral feeding behavior, even if it is with a limited variety of food (Bandini et al., 2010; Schreck et al., 2004). Alex and Wade were consuming 11 and 13 foods, respectively, and a variety of unhealthy foods (e.g., candy, cookies) before the study. During initial meal observations, the authors observed both participants pick up bites of food of varying textures, place the bites inside their mouths, chew until the bites were masticated, and swallow. The authors used this information to assess which feeding instructions the participants were most likely to cooperate with before treatment. Future researchers should continue to evaluate these types of pre-assessments to empirically identify starting points for demand- or stimulus-fading progressions. Practitioners should consider the time and resources needed for pre-assessments and whether inclusion of lengthy fading progressions are appropriate on an individual basis.

In addition, future researchers should continue to explore child choice in the selection of target foods or starting points, to determine what role choice plays in the treatment process. Including child choice may enhance social validity, but also may be more feasible when participants have language skills like Alex and Wade. Empirical investigations of choice could provide helpful information regarding its effects as an independent variable.

Initially, feeders presented different instructions to the participants (e.g., grasp the spoon, bring it to your lips, place the bite in your mouth) to identify the instruction closest to the terminal response (i.e., consumption) for which step completion was at or above 80%. The demand-fading intervention was successful for Alex until step requirements included consumption. A limitation of these preconsumption steps is that it requires the practitioner to reinforce potentially inappropriate behaviors (e.g., expulsion, packing). In addition, we selected an arbitrary number of chews during demand-fading steps. As such, the authors recommend that experienced practitioners develop these assessments and interventions on a case-by-case basis to avoid causing the development of new inappropriate behaviors or safety risks. Feeders only presented the instructions with one target food (pea), so Alex may have responded differently to others. In addition, feeders randomly presented certain feeding instructions to limit the overall time allocated to the demand assessment given it could result in a lengthy treatment evaluation. We did not initially evaluate Alex's responding with Oreo cookie in the demand assessment but observed him consume Oreo cookie during initial observations. Therefore, the authors decided to include Oreo cookie in the next fading steps. Based on what we learned from Alex's responding, we modified the demand assessment for Wade to include simultaneous bites (e.g., 'Place the bite [Fruit Roll-Up or Laffy Taffy and hot dog] in your mouth, chew, and swallow') and started his treatment with simultaneous bites. Future researchers should continue to include assessments that help to identify fading progressions involving simultaneously presented foods, and identify ways to systematically alter those progressions based on child responding.

Although some studies have shown that simultaneously presenting two foods together (presumably preferred with non-preferred) can increase consumption of target foods for children with feeding disorders (e.g., Ahearn, 2003; Buckley & Newchok, 2005; Patel et al., 2001; Piazza et al., 2002), less is understood about the underlying mechanisms responsible for behavior change. Presenting novel or less preferred foods together with highly preferred foods may decrease the unpredictable properties of the novel foods and therefore, make mealtimes more familiar (Patel et al., 2001; Piazza et al., 2002). Familiarity may be reinforcing or preferred for some children, especially those with ASD who engage in change-resistant behavior. Alternatively, research has demonstrated that negative reinforcement in the form of escape often maintains inappropriate mealtime behavior for children with feeding disorders (Saini et al., 2019). If including preferred food in the same presentation with less preferred food reduces the aversive properties of the food, escape may become less valuable. Another underlying explanation was that flavor-flavor learning occurred (Capaldi, 1996), in which repeated pairings of the appetitive stimuli with the putative aversive stimuli resulted in a shift in preference (Piazza et al., 2002). More research is needed to arrange appropriate evaluations and better understand these mechanisms.

More generally, it may be difficult to determine which stimulus features of novel or non-preferred foods contribute to feeding challenges. Children may continue to eat the same foods because they prefer the stimulus properties of those foods (e.g., flavor, color), or simply because the foods are familiar and the routine is predictable. Without more information, it could be difficult to identify how to pair or present simultaneous bites.

During the initiation of simultaneous presentation and stimulus fading for Wade, the visual properties of the target foods were completely masked by the preferred foods. That is, the small pieces of hot dog, corn, and macaroni and cheese were each completely covered by the piece of Fruit Roll-Up, such that the feeder (and presumably Wade) could not see any stimulus features of the target foods. As soon as Fruit Roll-Up was faded to a degree that resulted in the macaroni and cheese being visible, consumption decreased to zero. Interestingly, consumption maintained at high levels when bites of hot dog and corn were visible during the fading process. Alex consumed bites of pea and carrot with Oreo cookie even though the visual properties of the target foods were always partially visible. We hypothesized that either the visual properties of macaroni and cheese or the smaller quantity of the preferred-food component lead to decreased consumption for Wade. Within-session fading was necessary to completely remove Fruit Roll-Up from bite presentations with macaroni and cheese, and to introduce Fruit Roll-Up with target bites for Wade initially. The feeders did not specifically inform the participants that the target foods were emedded in the simultaneous bites. If participants would have asked, feeders were instructed to be truthful and to refrain from attempts at "hiding" the target food. During fading, the bites eventually became clearly visible. Future researchers should continue to investigate which properties of the bite presentation (e.g., color, texture, temperature, bite size) are relevant and whether informing children of the pairing is helpful or detrimental to progress. Caregivers of children with feeding difficulties may have attempted strategies to mask aversive or novel properties of foods in the past, which may have led to poor outcomes or the child displaying mistrust. Future researchers should assess this further to determine whether providing more detailed descriptions to the child is helpful and promotes transparency.

When children with feeding difficulties have a narrow diet, reliance on that small variety can be critical for growth and survival. Therefore, practitioners should exercise caution when using interventions that include one or two of the child's limited preferred foods (e.g., differential reinforcement with edible items, blending, simultaneous presentation), because preferences could shift in an opposite manner after repeated pairings with less preferred foods (Bachmeyer, 2009; Kerwin & Eicher, 2004). One solution might be to initially present smaller amounts of the less preferred food in the simultaneous bite. Future researchers should investigate what ratios of preferred to less preferred foods within the simultaneous bites are necessary to increase consumption and reduce the likelihood that preferred foods inadvertently acquire the aversive properties of the less preferred or novel foods. If caregivers rely on a few preferred foods as the only source of calories, it may be safest to use other interventions. Alternatively, many caregivers may wish to completely remove certain unhealthy foods from their child's diet, if the foods are high in sugar or sodium (e.g., for a child with diabetes or certain heart conditions), or select foods that are highly preferred but not always accessible or necessary for calories (e.g., special treat like ice cream). Alex and Wade's caregivers reported that they no longer wanted their children to consume these unhealthy foods so frequently after the study ended because both children were growing well.

Researchers should also continue to investigate which types of preferred foods may be more or less appropriate for simultaneous-presentation interventions. In the current study, we conducted paired-stimulus preference assessments to determine each child's highest preferred foods. Of these, we selected preferred foods that could easily attach to the target foods (e.g., stretchy Fruit Roll-Up that could wrap around the target food) while presented in a simultaneous bite and ones the children were not relying on for calories. For example, we did not select a grilled cheese sandwich for Wade even though it was highly preferred because he was relying on these sandwiches for the majority of his calories. It may be less practical to simultaneously present foods that do not fit together well (e.g., broccoli with a French fry), may require lengthy or effortful chewing (e.g., Laffy Taffy, beef jerky), or that break apart easily (e.g., crumbling cookie). It could be difficult to present foods that easily fall apart if the child is self-feeding given that the child could presumably pull the target food out of the simultaneous bite presentation.

In addition, it is important to consider caregiver preference and approval of these interventions, and to ensure the child is safe to manage higher-textured foods (e.g., demonstrates safe chewing). The original preferred-food component for Wade was Laffy Taffy candy, which is a dense, sticky item that could pose challenges (e.g., increased response effort to chew, could stick to the teeth and result in packing). When we observed Wade stop consuming the simultaneous bite that included Laffy Taffy, we transitioned to a different preferred-food item that was less dense (i.e., Fruit Rollup). The properties of the preferred-food component that ultimatly lead to an effective intervention could vary greatly on an individual basis. Researchers should consider developing other assessment tools that might help to inform what types of preferred foods would or would not be warranted. It is also important for practitioners to use time-based bite intervals with mouth checks that allow sufficient time for the child to chew and swallow each bite safely before moving to the next presentation. This is especially critical when pairing two bites together, which could make the bite size bigger.

It is also important to ensure caregivers agree with temporary use of *unhealthy* food items or other preferred stimuli (e.g., electronics like the iPad) as part of a treatment package. Feeders included pieces of Oreo cookie and Fruit Roll-up in all bite presentations during the early sessions of simultaneous presentation. Both of these items are high in sugar, which could be detrimental to a child's health if the child is exposed to excessive volumes. It is important to note that feeders used small amounts of the preferred foods in the simultaneous bites. In fact, feeders never used more than about three Oreo cookies (Alex) and never more than one full Fruit Roll-up (Wade) per 60-90-min appointment, which equated to roughly one serving size for both items. Both sets of caregivers agreed this was an acceptable volume, especially given that this amount was far less than what both participants consumed at home and that the goal was to remove the high-sugar foods from the simultaneous bites over time. During the intervention and after the study, we advised caregivers to restrict access to these items and to only use them to introduce novel target foods going forward.

In terms of use of electronics (e.g., iPad), the participants earned 30 s of iPad access per bite/instruction if they met the criteria. Feeders conducted eight or nine, five-bite sessions per 60–90-min appointment. If the child met criteria for every instruction, this amounted to approximately 22 min of iPad time, spread across the appointment. Both sets of caregivers agreed to this amount, given that the iPad was not being used as a reinforcer for other skill acquisition targets and was restricted at home during the study. These are important considerations for future research, and should always be discussed with caregivers in the treatment decision process.

We thought it was notable that participants continued to accept and consume bites of target foods with differential reinforcement, even as we faded the preferred foods. Previous literature using differential reinforcement to increase consumption for children with feeding disorders is mixed (Berth et al., 2019). Some research has shown that differential reinforcement is most effective when combined with other treatments (e.g., nonremoval of the spoon; LaRue et al., 2011, Piazza et al., 2003), but there are exceptions in which differential reinforcement alone has lead to meaningful changes in feeding behavior for some children (Crowley et al., 2020). This study adds to the growing body of literature supporting the effectiveness of differential reinforcement to increase consumption when combined with other treatments. Future research should continue to evaluate methods for schedule thinning.

One limitation of the study was the small number of participants and the few number of new target foods, which may not produce immediately meaningful changes to nutritional status. In addition, we did not demonstrate that the treatment produced increases in consumption of highly nutritious foods (e.g., green vegetables, fruits) for Wade. Feeders taught Alex and Wade's caregivers to use this intervention at home so they could continue to introduce novel, healthy foods over time (data on caregiver-fed meals available upon request from the first author). After the study, Wade's caregivers expressed relief knowing they could prepare one meal for all of their children on busy weeknights that included the target foods introduced in treatment, which his siblings consumed often. In addition, the caregivers reported that the family often consumed fast food or quick-fix meals given their busy work schedules. We provided guidance and recommendations for the family to consider adding vegetables, fruits, and healthier proteins over time and to contact a dietician for additional guidance. Alex's mother had been concerned about Alex's dental health given that most of his teeth were capped or filled due to cavities from his reliance on high-sugar foods. Future researchers should add measures that help to quantify nutritional and physiological status changes as a result of treatment (e.g., bloodwork), gather social validity data, and assess long-term follow-up, including generalization to new foods.

Practitioners should consider the time requirement for antecedent-based interventions. Alex and Wade experienced 210 and 296, 5-bite sessions, respectively, before feeders observed an increase in consumption of all three initial target foods to high levels (without Fruit Roll-up or Oreo cookie). Given that we conducted approximately 8-9 sessions per visit and 3 visits per week, total participation time was approximately 8 weeks or 2 months for Alex and 11 weeks or 3 months for Wade. Future researchers should continue to compare antecedent- and reinforcement-based interventions with other treatments that are known to produce more immediate effects (e.g., escape extinction; Peterson et al., 2016) and determine whether efficiency can be improved. Bachmeyer (2009) recommended researchers continue to refine assessment tools that will aid in the identification of antecedent- or reinforcement-based interventions based on a child's (a) relative preference for foods (b) ability for other reinforcers (e.g., tangibles, adult attention), to compete with escape, or (c) feeding skills in the child's repertoire. These are important considerations to identify before implementing a treatment progression that could be lengthy or cumbersome. It is also important to continue identifying alternatives to escape extinction so that there are options for practitioners who may not possess the requisite training or resources.

In addition, it is important for practitioners to monitor behavior that may interfere with timely consumption, such as packing and expulsion, as these behaviors can also impede progress or produce unsafe feeding routines. Feeders observed with Alex that a lengthy demand-fading intervention was ineffective (i.e., increased acceptance but not consumption). Consumption of food is a meaningful goal for children with feeding difficulties and should be the terminal step for all interventions. Although Alex began consuming simultaneous bites, we cannot confirm whether earlier demand-fading steps were necessary.

Intervening on feeding difficulties can be impactful for a child and family's overall wellbeing and quality of life. Though we did not formally assess treatment acceptability, we observed or learned of several significant changes for each participant after the study. First, we observed, and caregivers reported, that when caregivers previously attempted to change meal routines by including novel foods or varying the routine, Alex and Wade engaged in challenging (e.g., aggression, property destruction) and sometimes dangerous (e.g., elopement) behavior. Alex and Wade also both displayed change-resistant behavior across other domains. For example, Wade wore the same Thomas-the-Train T-shirt and black shorts to all feeding appointments. At the end of the study, both children were consuming bites of target foods without engaging in challenging behavior (data on challenging behavior available upon request from the first author). Once exposed to treatment, Alex did not require as many sessions to increase consumption for the additional target foods (e.g., apple did not require intervention; garbanzo bean and orange displayed in Appendix A). In addition, we observed that Wade began wearing new clothing to appointments and there were no occurrences of dangerous or challenging behavior when caregivers began conducting the feeding treatment. Both sets of caregivers reported that they planned to continue these strategies to add nutritious variety to their children's diets. Future researchers should collect data on other change-resistant or challenging behavior to determine whether exposure to feeding treatment improves behavior across multiple domains (e.g., other forms of change-resistance) without directly targeting them.

Behavior-analytic treatments have the most empirical support for pediatric feeding disorders. There is now a wealth of evidence demonstrating that nonremoval of the spoon is effective and generates robust outcomes (Bachmeyer et al., 2019; Peterson et al., 2016), but less evidence to support the use of simultaneous presentation and differential reinforcement, or stimulus and demand fading. This study contributes to the growing body of literature for antecedent- and reinforcement-based interventions as treatment for feeding difficulties in autistic children.

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CONFLICT OF INTEREST STATEMENT

The authors disclose 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.

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APPENDIX A

Alex's Treatment with Additional Target Foods (garbanzo bean, orange).

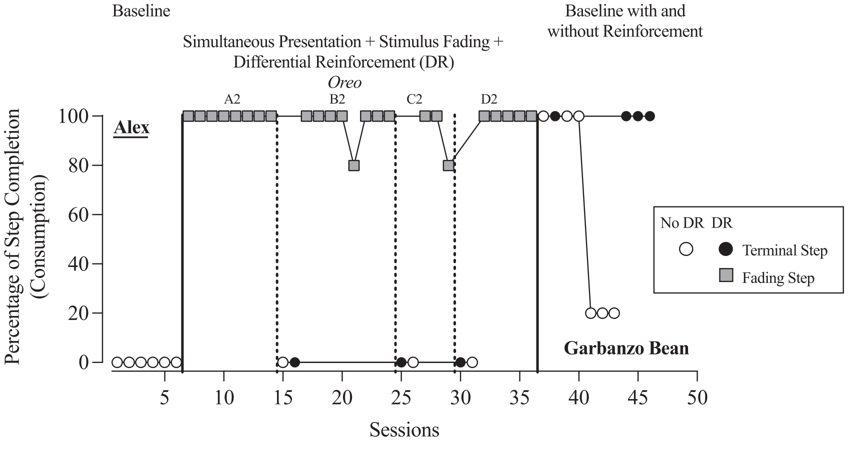

FIGURE A1 Percentage of step completion (including consumption) during Alex's treatment for garbanzo bean.

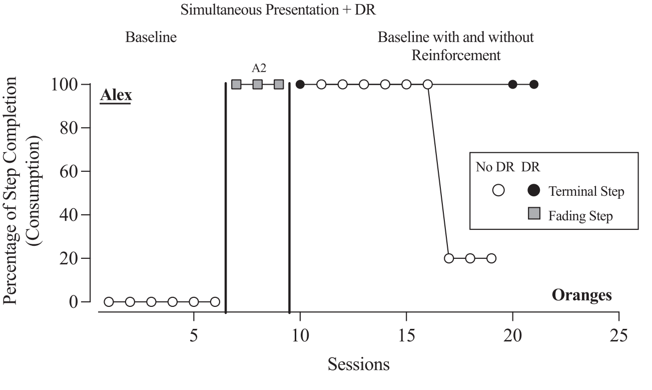

FIGURE A2 Percentage of step completion (including consumption) during Alex's treatment for oranges.

APPENDIX B

Images of stimulus fading steps during the simultaneous presentation intervention. Pea is embedded in each of the bite presentations.

FIGURE B1 Stimulus fading steps with Alex's target food pea and his highly preferred food, Oreo, during simultaneous presentation. Carrot is embedded in each of the bite presentations.

FIGURE B2 Stimulus fading steps with Alex's target food carrot and his highly preferred food, Oreo, during simultaneous presentation.

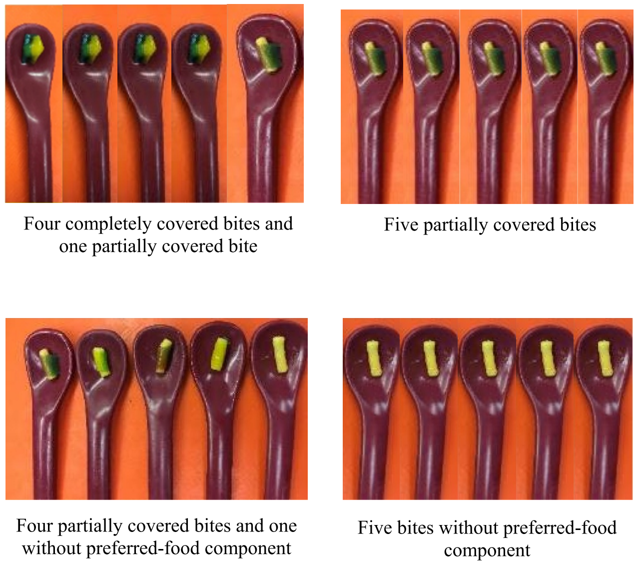

FIGURE B3 Within-session stimulus-fading examples for Wade's target food Macaroni and Cheese with his highly preferred food, Fruit Roll-up.