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Practical functional assessment and treatment of pediatric food selectivity

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Abstract

Food selectivity affects up to 45% and 80% of individuals with and without disabilities, respectively. Behavior analytic interventions have consisted primarily of differential reinforcement and escape extinction. Escape extinction, while efficacious, may also result in increased aggression, gagging, or vomiting, and therefore may not be feasible or desirable under some conditions. We describe a model for assessing and treating food selectivity and refusal without escape extinction for young children with and without developmental disabilities. The model involved: (a) indirectly and directly measuring food preferences to identify foods that established mealtime problem behavior and other foods that could be used as reinforcers, (b) evaluating the sensitivity of mealtime problem behavior to environmental variables through an interview-informed synthesized contingency analysis (IISCA), and (c) incorporating the assessment results into a progressive treatment process consisting of choice making opportunities and differential and synthesized reinforcement of successive approximations to eating.

Keywords: assessment, food refusal, food selectivity, functional analysis, shaping, treatment

Practical Functional Assessment and Treatment of Pediatric Food Selectivity

Problems related to eating are common among children, affecting up to 45% and 80% of individuals with and without disabilities, respectively (Fernand, Penrod, Fu, Whelan, & Medved, 2016), and exist along a continuum of severity from food refusal to food selectivity (Williams, Field, & Seiverling, 2010). When a child does not voluntarily eat all or most foods and the result is inadequate caloric intake, malnutrition, or the necessity of supplemental feeding devices, it is characterized as food refusal. Food selectivity, by contrast, is associated with eating a limited number of foods. The child meets his developmental caloric needs, but the diets of food selective individuals are often low in nutritional value and high in fats and sodium (Peterson, Piazza, & Volkert, 2016), which can adversely affect the health of the individual. In addition, food selectivity can lead to high levels of family stress (Cooper et al., 1995) as caregivers work around their child's selective eating behaviors (e.g., only preparing certain brands of foods). Often these issues are exacerbated by the co-occurrence of mealtime problem behavior.

Treatments for problem behavior in general are more likely to be effective and less likely to be reliant on punishment when preceded by functional assessments (Campbell, 2003). Textbooks and handbooks recognize a generally recommended process to assess the variables influencing severe problem behavior (e.g., Cooper, Heron, & Heward, 2007; Madden, Dube, Hackenberg, Hanley, & Lattal, 2013; Martin & Pear, 2015). The assessment process for identifying the variables influencing mealtime problem behavior is less canonized, however. In a review of thirty food selectivity treatment studies with children with autism, Silbaugh et al. (2016) reported that all included some sort of pretreatment assessment, but the processes were not described in detail and assessment type was inconsistent across studies. For example, Allison et al. (2012) conducted a functional analysis of mealtime problem behavior but did not describe how the conditions or foods were selected for inclusion. Therefore, it would be difficult to replicate these assessments, although it should be noted that the difficulty with providing a sufficiently technological description is not unique to these authors or the feeding literature but is an issue for much of applied science. Of the reviewed studies in Silbaugh et al. (2016), assessments took the form of indirect assessments (e.g., interviews, questionnaires, surveys), observations, preference analyses, and functional analyses. All studies employed indirect assessments, and most authors relied solely on indirect assessments. Ten studies used analyses—direct observation of behavior while factors are systematically manipulated—with the majority analyzing food preferences (i.e., food preference analyses) and did not evaluate the variables influencing mealtime problem behavior (i.e., they did not conduct functional analyses of mealtime problem behavior).

Multiple examples of functional analysis of mealtime problem behavior do exist, however. Saini, Kadey, Paszek, and Roane (2019) conducted a review of functional analyses of mealtime problem behavior published between 2000 and 2016. They identified 86 analyses across 23 studies. This review too revealed inconsistencies across pretreatment assessment methods. Of the 86 analyses, 13 (15%) were reported to be proceeded by both an indirect and descriptive assessment, and 10 (12%) were proceeded by only a descriptive assessment. For 55 (64%) analyses, no indirect or descriptive assessments were reported. It's possible that brief or informal assessments took place prior to these functional analyses, or that analyses were not informed by any indirect or descriptive assessment and the conditions and materials were preselected by the experimenters. As Silbaugh et al. (2016) and Saini et al. (2019) have noted, observation and analysis of behavior prior to treatment for mealtime problem behavior and food selectivity/refusal is limited in the literature, and when researchers are conducting analyses, indirect or descriptive assessments that typically precede analyses are not well described or not reported.

A model for integrating information from indirect and descriptive assessments into the functional analysis was recently described by Hanley, Jin, Vanselow, and Hanratty (2014). This type of analysis has since been labelled an interview-informed synthesized contingency analysis (IISCA; Jessel, Hanley, & Ghaemmaghami, 2016) and the entire process, a practical functional assessment (PFA), which includes an open-ended interview, with or without brief observation. It has been replicated across multiple research groups (e.g., Beaulieu, Van Nostrand, Williams, & Herscovitch, 2018; Ferguson et al., in press; Fisher, Greer, Romani, Zangrillo, & Owen, 2016; Ghaemmaghami, Hanley, Jin, & Vanselow, 2015; Herman, Healy, & Lydon, 2018; Jessel, Hanley, & Ghaemmaghami, 2016; Jessel, Hanley, Ghaemmaghami, & Metras, 2019; Jessel, Ingvarsson, Metras, Kirk, & Whipple, 2018; Jessel et al., 2018; Lambert et al., 2017; Rose & Beaulieu, 2018; Strand & Eldevik, 2018; Santiago, Hanley, Moore, & Jin, 2016; Strohmeier, Murphy, & O'Connor, 2016; Taylor, Phillips, & Gertzog, 2018), and shown to yield effective treatment outcomes.

There is considerable research evaluating treatments for food selectivity, and Silbaugh et al. (2016) found that differential reinforcement and escape extinction were the most common. Escape extinction procedures include nonremoval of the spoon (Hoch et al., 1994; Peterson, Piazza, & Volkert, 2016) and physical guidance (Borrero, Joseph Schlereth, Rubio, & Taylor, 2013; Ives, Harris, & Wolchick, 1978). Nonremoval of the spoon is a procedure in which the spoon is held near the child’s mouth until the child takes the bite or opens his or her mouth wide enough for the feeder to deposit the bite. Physical guidance involves the feeder applying gentle pressure to the child’s jaw or lips and depositing food into the mouth. These two procedures may require the child to be restrained in a seat and are often combined with re-presentation of expelled bites (Bachmeyer et al., 2009; Coe et al., 1997). Re-presentation of expelled bites serves to extinguish or punish expulsion. Ahearn et al. (1996) compared the efficacy of nonremoval of the spoon and physical guidance (both combined with re-presentation of expelled bites) with three young children who exhibited food refusal. The authors found that both procedures were efficacious in increasing acceptance of foods, but that physical guidance was associated with lower levels of problem behavior.

Several studies have shown that escape extinction may be necessary to increase consumption of nonpreferred foods (Patel, Piazza, Martinez, Volkert, & Santana, 2002; Piazza, Patel, Gulotta, Sevin, & Layer, 2003; Reed et al., 2004). For example, Piazza et al. (2003) evaluated the effects of contingent positive reinforcement, extinction, and a combination in the treatment of food and liquid refusal with four young children with autism. In all cases, the use of positive reinforcement (i.e., access to tangibles and praise) as a sole intervention was ineffective in increasing consumption. Escape extinction, isolated or combined with positive reinforcement, was efficacious. On the other hand, for some participants, escape extinction has been shown to be insufficient to increase consumption. Mueller et al. (2004) and Patel et al. (2001), for example, reported that prior to the treatments evaluated in the studies, physical prompting and nonremoval of the spoon, respectively, were unsuccessful. Thus, in some cases, alternative procedures are needed for successful treatment outcomes. In addition, in many applied settings, escape extinction may be difficult to implement, unacceptable to stakeholders, or both. Extinction may be associated with an increase in the frequency and/or intensity of problem behavior, emotional responding, and induced aggression (Lerman, Iwata, & Wallace, 1999). These behaviors may be difficult for caregivers to manage and mealtimes may become aversive for both children and caregivers (Bachmeyer, 2009). Further, it may be difficult for practitioners and caregivers to implement these procedures with fidelity in applied settings, which may reduce the efficacy of the procedure.

Therefore, some authors have developed procedures that circumvent the necessity of escape extinction, such as manipulating different parameters of reinforcement (Athens &Vollmer, 2010) in a differential reinforcement arrangement, and shaping or demand fading (Hagopian and Thompson, 1999), and several studies addressing food selectivity have combined these methods successfully. Penrod, Gardella, and Fernand (2012) evaluated a combination of a food related high-probability demands with low-probability demand fading to increase food consumption with two boys with autism. Koegel et al. (2012) also used shaping across response topographies to increase the consumption of nonpreferred foods with three young boys with autism. Results of both studies showed an increase in consumption of nonpreferred foods without the use of escape extinction.

Although these studies highlight the potential utility of shaping and differential reinforcement to treat food selectivity, there are some limitations. The authors did not report how the 48 targeted foods in the Koegel et al. (2012) study were selected and how sessions were conducted to include all the foods. Both studies reported that the participants engaged in disruptive mealtime behavior; however, neither included a functional analysis, making it unclear whether reinforcement contingencies mimicked the qualitatively rich reinforcement contingencies maintaining disruptive behavior in the natural environment. Neither study reported measures of disruptive behavior during treatment, and it is unknown to what extent these treatments minimized or eliminated mealtime disruptive behavior. In addition, both sets of authors either aggregated data across all foods per session or collected probe data. As a result, readers are unable to see the ongoing results of shaping. The shaping process may be better understood if authors show trial by trial data. Finally, the participants in these studies were all children on the autism spectrum; therefore, additional research is needed to evaluate the generality of these interventions with those without developmental disabilities.

The purpose of the current study is to extend the PFA process to mealtime problem behavior (Study 1) and evaluate a technology for identifying preferred and nonpreferred foods. A second purpose is to evaluate a treatment package to increase consumption of targeted foods without the use of escape extinction (Study 2), while tracking IMB and SPB throughout the treatment.

Study I: Assessment

Method

Assessment overview. Figure 1 illustrates the assessment process**.** First, caregivers were referred to our program by their child's pediatrician and filled out a selective eating screening tool (see Supporting Information 1) to determine inclusion eligibility. Once approved for the study, caregivers were sent a *food preference survey* (see Supporting Information 2) to specify which foods their child and family reliably ate. Caregivers then met with a behavior analyst for an open-ended interview (see Supporting Information 3) in which the experimenters learned about potential variables influencing mealtime problem behavior. On subsequent visits, we analyzed the child's preference for foods in a modified single-stimulus preference analysis and observed the caregivers delivering a meal to their child in a *mealtime observation*. A functional analysis, specifically an IISCA, of mealtime problem behavior was then conducted.

Participants and setting. The study included seven children who were reported to either be selective eaters or to engage in food refusal (see Table 1). All were referred to our clinic for eating problems and mealtime problem behavior. No child was referred but disqualified from the study. Three siblings were referred but were assigned to a small-group protocol. The study was approved by a university institutional review board and the participants were not expected to be exposed to more than minimal risk.

Gabby was a four-year-old girl with autism. She was primarily reported to eat macaroni and cheese, SpaghettiOs, kielbasa, Lunchables pizza, candy, and chips. When instructed to try new or nonpreferred foods, Gabby would engage in verbal protests and gagging. Her mother reported that if she persisted, Gabby would have panic attacks (emotional responding, heavy breathing). Due to Gabby's selective eating and problem behavior, the family avoided eating meals together in the home or community.

Liam was a six-year-old boy without any diagnosis. Liam primarily ate peanut butter sandwiches, grilled cheese, and pizza, but would only eat these foods if they were prepared in a specific way. When instructed to try new foods, Liam typically pushed the food away or threw the food in the trash. If parents persisted, Liam would flop to the ground, cry, or vomit. As a result, Liam's mother refrained from cooking typical meals at home, even for herself.

Ali was a four-year-old girl diagnosed with autism. Her mother reported that Ali was a healthy eater until 18 months of age when the mother observed regression in social skills and in the variety of foods Ali ate. Ali ate chicken nuggets, pizza, strawberries, bananas, peanuts, and common junk foods (e.g., candy and chips). When Ali was instructed to try novel or nonpreferred foods, she would engage in tantrums, which included aggression and throwing herself on the floor.

Luke was a six-year-old boy diagnosed with autism and attention-deficit/hyperactivity disorder. Luke ate a variety of foods; however, when instructed to eat or to be in the presence of foods that contained sauces or pasta (e.g., spaghetti, chicken noodle soup), he engaged in severe problem behavior such as throwing food and aggression. As a result, he was often removed from the school cafeteria during lunch due to problem behavior, and his family avoided preparing these foods at home.

Justin was a four-year-old-boy without any diagnosis. Justin was reported to eat only five to 10 bites of food per day of peanuts, peanut butter crackers, or Pop Tarts. His meals were supplemented with a chocolate protein drink. Justin would eat two items from specific fast food restaurants, but his mother restricted access to these items to once or twice per week. When instructed to eat novel or nonpreferred food items, Justin's mother reported that he would verbally protest and request to do something else (e.g., play on the tablet). If his mother persisted, he was reported to scream, cry, and attempt to escape by pushing the food away, leaving the table, or falling to the floor.

Derek was a four-year-old boy with autism and short-bowel syndrome. Derek relied on a gastrointestinal tube (G-tube) for all his caloric intake. Derek was in a medical foster care and had been living with his current foster care family for one year. Prior, he lived with different foster care families and spent one year living in a hospital, from age 1.5 to 2.5. During this time, he was reported to eat apple sauce and yogurt, but subsequent foster care families could not confirm this. His current family reported that they would offer Derek foods and model eating the food. Derek was reported to verbally protest and push food away. Because Derek engaged in severe problem behavior (self-injury, aggression, pulling out G-tube), his caregivers never persisted with their attempts.

Aiden was a four-year-old boy with autism. Aiden was reported to be disinterested in eating and inconsistently ate bread, certain cereals, candy, peanut butter and jelly sandwiches, and corndogs. Aiden's parents reported that, when offered other foods, he would push the food away or push whoever was offering the foods. His mother would sit with Aiden and hand feed him the foods he sometimes ate. The family reported that Aiden's food selectivity was time-consuming and stressful for the family.

We conducted sessions in therapy rooms located in the psychology department of a university for all children except Derek, whose sessions occurred in a room in his foster home. Therapy rooms contained tables, chairs, and materials related to observations. Sessions took place two to five days per week and lasted approximately 1 h each.

Measurement and interobserver agreement. Trained observers took data using software on laptops and paper data sheets in-vivo or via video recordings. Data were collected on problem behavior, preconsumption, consumption, and consequences delivered by caregivers. Problem behavior was categorized into inappropriate mealtime behavior (IMB) and severe problem behavior (SPB). IMB was defined as verbal protests, covering mouth, whining, spitting out food, moving plate or bite of food away, or turning head (if presented with a bite). SPB was defined as aggression, self-injury, property destruction, and yelling or screaming. Operational definitions are available from the first author. The designation of IMB of has precedence in the feeding literature (Piazza et al., 2003), and we additionally measured SPB in addition to IMB.

Preconsumption was defined as physically contacting the food, such as licking the food or moving very small bites of the food past the plane of the lips. Consumption was defined as ingesting the entire bite of food (chewing and swallowing). If the participant took and swallowed a grain sized bite, for example, this was considered preconsumption. Consequences delivered by caregivers included attention, defined as verbal or physical interaction; escape, defined as the termination of the demand in place (i.e., removing the spoon or changing the demand); and tangible delivery, defined as the presentation of preferred edibles or toys.

Interobserver agreement (IOA) was scored by having a second independent observer collect data on all dependent variables for a minimum of 20% of sessions. Data were compared on an item-by-item agreement per trial for the preference analysis and the number of agreements were divided by the total number of agreements and disagreements and multiplied by 100. An agreement was scored if both observers recorded the same dependent variable on a given trial. Mean IOA across participants for the preference analysis was 98% (range, 93-100%). Data were compared on a 10-s interval-by-interval basis for the mealtime observation and functional analysis. Agreement was calculated by dividing the smaller number of responses by the larger number and multiplying the quotient by 100. An agreement was scored if both observers recorded the same dependent variable within the 10-s interval. Mean IOA across participants for the mealtime observations was 87% (range, 80-93%). Mean IOA across participants for the functional analyses was 94% (range 80 -100%).

Procedures

Screening tool. Once a family was referred to our services, a conversation took place between caregivers and the clinical director or first author. General questions were asked regarding their child's characteristics and food selectivity. Using the screening tool, caregivers were to then briefly describe their child's food selectivity or refusal, if their child engaged in problem behavior during mealtimes, whether their child consumed all calories by mouth, if there were any known medical explanations for their child's selective eating or refusal, and their history with medical professionals related to their child's eating problems. In addition, caregivers were asked if their child had ever received an oral-motor or nutrition evaluation and if their child had any medical diagnoses or allergies. The child cleared the screening process when it was confirmed that they were a safe oral feeder via the information provided.

Food preference assessment. A two-step process for identifying preferred and nonpreferred foods was initiated once the child cleared the screening process. The goal of the process was to identify foods the child reliably refused and foods that the child reliably ate. That is, foods were to be identified that may have historically served as establishing operations or reinforcers for mealtime problem behavior. These foods would then populate the mealtime observation, functional analyses, and subsequent treatment. The first step was to indirectly assess preference for foods in a survey. Caregivers filled out a food preference survey, which contained a list of 10-20 foods per nutritional category (e.g., dairy, vegetables, grains). Caregivers were asked to record if their child never, sometimes, or always ate that food and to indicate if their family ate that food. There was also an option to indicate if they were unsure or if there were no opportunities. Caregivers were then to nominate three foods from each category they wished their child would eat. A space was provided for caregivers to indicate their preference for specific brands or ways of preparing the food and to note any relevant foods that were not listed.

The second step was to analyze child preference for foods in a modified single-stimulus preference analysis[1]. The foods selected for the preference analysis were informed by the food preference survey and conversations with caregivers during the open-ended interview. Conversations included discussions of what the family typically ate home and what foods would most benefit the child. The selection of the foods was largely caregiver-led, and they selected up to six reported preferred and nine reported nonpreferred foods. These foods were (a) reported by the caregivers as always or never eaten by the child, respectively, (b) foods the family would eat,

[1] Regarding the term *preference analysis*, it is not our intention to indicate that we are doing something functionally distinct from others terming their activities *preference assessments*; rather, we use the term analysis in the same way that a functional analysis is often part of a functional behavior assessment. An analysis reveals the controlling variables of which behavior is a function through direct observation, manipulation of relevant variables, and replication. Therefore, a survey is part of a preference assessment, but directly observing a child's behavior when foods are systematically and repeatedly presented may be more accurately referred to as a preference analysis.

and (c) easy to prepare and store in our clinic. Foods were not selected if the caregivers reported that the child sometimes ate the food or if the family reported they also never ate that food.

Prior to the start of the analysis, the analyst told the child that she would be presenting different types of food, and the child could eat the foods or not. The reported preferred and nonpreferred foods were each presented to the child twice, and the presentation was randomized using a web-based list randomizer. The food was prepared according to its package directions and cut into small pieces (approx. 2 cm x 2 cm). Food that was intended to be hot was cooked and reheated for each presentation. A small bite of the food was placed on a plate with a spoon, and consumption was child-directed; that is a bite was never held to the child's mouth.

Following each presentation, the bite was removed if the child engaged in IMB, SPB, or indicated in any way that he or she did not want to consume the bite (e.g., "I don't eat that kind of food"). If the child did not engage in IMB or SPB or did not approach the food within 30 s, the food was removed, and the next bite was presented. If the child consumed the food, the analyst remained neutral and the next food was presented after the child was finished. A food was presented more than twice if consumption was inconsistent across the two presentations. Following the analysis, caregivers selected up to six nonpreferred foods to target for consumption during treatment, and these populated subsequent assessments.

Practical functional assessment of mealtime problem behavior. A three-step process for identifying the environmental variables influencing mealtime problem behavior was conducted for each child. The goals of the functional assessment were to (a) safely demonstrate strong control over mealtime problem behavior, (b) develop a baseline of tolerable problem behavior in the presence of food-related establishing operations, and (c) identify a motivating context in which to subsequently increase consumption during treatment.

First, an open-ended functional assessment interview (modified from Hanley, 2012) was conducted with caregivers (see Supporting Information 3). Caregivers were asked to describe problem behavior associated with mealtimes and to note any associated non-dangerous topographies that may precede more dangerous forms. Questions were asked about the possible reinforcement contingencies maintaining problem behavior during mealtimes, what tactics caregivers used to get their children to eat, and what occurred when they were unsuccessful. From these questions, we gained information about a possible class of mealtime problem behavior to reinforce during the analysis, possible establishing operations that were likely to evoke problem behavior, and potentially reinforcing consequent events.

Second, a descriptive assessment, in the form of a mealtime observation, was conducted with caregivers and their children. The purpose of the mealtime observation was to evaluate the extent to which caregivers delivered consequences following IMB, SPB, preconsumption, and consumption. An additional goal was to obtain a baseline of consumption and problem behavior from which to evaluate the treatment transfer to caregivers following treatment with an analyst. The nonpreferred foods selected by the caregivers from the preference analysis were arranged into a 15-18 bite meal, depending on how many foods were selected. The food was prepared in the same manner as in the preference analysis. Caregivers were asked to engage in behavior they typically would when presenting novel or nonpreferred foods to their child, and they were informed that they could terminate the session at any time, for any reason. Preferred foods identified in the preference analysis and toys selected by the child were available to the caregivers and they could use them, or not, in any manner they wanted. Sessions lasted 10 min unless the caregiver terminated the session early.

Next, a functional analysis was conducted. Information from the interview and the mealtime observation informed the design of individualized test and control conditions for each child. All events reported in the open-ended interview and/or observed during the mealtime observation as potentially relevant to the maintenance of mealtime problem behavior were freely available in the control condition and delivered contingent on IMB or SPB in the test condition. Each child's analysis is described below; however, in general, during the test condition the child's preferred materials and attention were removed, a single bite of a nonpreferred food was presented, and the child was instructed to take a bite. Contingent on any problem behavior, the bite was removed, and the positive reinforcers were made available.

Results and Discussion

Food preference assessment. The results from the preference analyses are shown in Figure 2 and 3. Gabby consumed all her reported preferred foods (first panel) and never consumed five out of the six reported nonpreferred foods. Her preferred foods were then scheduled as part of the synthesized reinforcement contingency in the analysis and the five foods she never consumed were integrated into the analysis as part of the establishing operation. Gabby engaged in IMB, such as gently pushing away the plate or verbally refusing the food, on 83% of trials that she did not consume the food. These behaviors never escalated to any forms of SPB, presumably because milder forms of refusal were immediately reinforced. Her caregivers selected the five nonpreferred foods she did not consume to target for consumption in the subsequent treatment.

Liam consumed all his reported preferred foods (second panel) and did not consume any of his reported nonpreferred foods. Liam engaged in IMB, such as verbal protests (e.g., "yucky") on 100% of the trials he did not consume the food. SPB was never observed. His caregivers selected six nonpreferred foods to target for consumption in the subsequent treatment.

Ali consumed all her reported preferred foods (third panel), one reported nonpreferred food, and did not consume seven out of eight of her reported nonpreferred foods. Ali engaged in IMB, such as verbal protests (e.g., “I don’t eat that kind of food”) on 100% of the trials she did not consume the food. SPB was never observed. Her caregiver selected six nonpreferred foods to target for consumption in the subsequent treatment.

Luke (fourth panel) consumed all his reportedly preferred foods and four reportedly nonpreferred foods. He did not consume the remaining reportedly nonpreferred foods and engaged in IMB, such as verbal protests (e.g., “I don’t eat that”) on 100% of these trials. SPB was never observed. His caregivers selected five nonpreferred foods to target for consumption in the subsequent treatment.

Justin consumed five of nine reportedly preferred foods (fifth panel). He did not consume any reportedly nonpreferred foods and engaged in IMB, such as verbal protests (e.g., “I don’t like apple”) on 100% of these trials. SPB was never observed. His caregivers selected six nonpreferred foods to target for consumption in the subsequent treatment.

Derek and Aiden’s preference analysis results are in Figure 3. Derek did not consume any foods (top panel), all of which were reported as nonpreferred. He engaged in IMB on two trials (i.e., pushing the plate away), but on most trials either picked up the foods or did not interact with the food at all. Aiden only consumed one reportedly preferred food (bottom panel), which was retained for his synthesized reinforcement contingency in the subsequent assessments and treatment. Aiden engaged in IMB, such as pushing the plate away, on most all trials in which he did not consume the food. SPB was never observed. Both Derek and Aiden’s caregivers selected six nonpreferred foods to target for consumption in the subsequent treatment. As with the other children, the problem behavior we observed with Derek and Aiden was less severe than reported.

In addition to reinforcing milder forms of refusal, problem behavior may have been milder for all children because a demand was never in place to consume the food during the preference analysis. For those children with functional language, they were told they could eat the food or not; and for those without (Derek and Aiden), the food was placed in front of them without instruction and removed contingent on any refusal or after 30 s. This may have decreased the evocative nature of the food presentations.

Five out of seven children consumed reportedly nonpreferred foods or did not consume reportedly preferred foods during the analysis, highlighting the importance of analyzing preference prior to treatment. The function of the preference analysis, however, was not only to verify the preferred and non-preferred nature of specific foods, but also to insure that we had access to potential establishing operations and reinforcers with which to populate the subsequent mealtime observation, functional analysis, and treatment.

Practical functional assessment of mealtime problem behavior. For six children, the interview with caregivers led to a hypothesis that the child's mealtime problem behavior was sensitive to a combined contingency of escape from nonpreferred foods to preferred foods, attention, and tangibles. For the seventh child, Derek, caregivers did not report that access to food was a potential maintaining variable as he did not orally consume any foods.

Gabby. Gabby's caregivers reported that toys and her tablet were present at the dinner table to encourage Gabby to eat and that following anxious-type behavior (e.g., deep breathing, crying, verbal protests), her parents would rub her back to calm her down and she would be removed from the table. She would then be allowed to access preferred foods she regularly consumed and eat in front of the TV. During the mealtime observations (Figure 4), Gabby engaged in an average of 0.5 instances of IMB per minute across two sessions. Gabby's mother provided attention following 100% of instances of problem behavior and following 91% of instances of preconsumption. She provided escape following 45% of instances of problem behavior and never following preconsumption behavior. Gabby accessed tangibles following 70% of instances of problem behavior and 57% of preconsumption instances. The preconsumption behavior most commonly observed was accepting small bites of banana. Once the bite was accepted, Gabby's mother immediately provided access to a preferred food item some of the time. Gabby then packed the nonpreferred food in one cheek and consumed the preferred food. In the first session, Gabby's mother provided continuous access to her iPad and dolls, mirroring a typical noncontingent reinforcement condition (Cooper et al., 1995). In the second session, she removed the tangibles contingent on problem behavior and prompted Gabby through accepting the nonpreferred foods. Gabby's mother terminated the second session early contingent on IMB and some emotional responding.

In the control condition of her functional analysis, the analyst provided free access to preferred toys, attention, and a preferred food selected by Gabby, and did not present any demands to consume nonpreferred foods. During the test condition, the preferred items and forms of attention were removed, the nonpreferred food was presented, and she was instructed to take a bite. Contingent on IMB or SMB, the analyst removed the bite and offered her choice of a preferred food. She was then allowed access to her preferred tangibles and attention from the analyst. During the functional analysis (Figure 6), problem behavior reliably occurred in the test condition and was absent in the control condition, demonstrating a sensitivity to a combined reinforcement contingency of escape to preferred forms of attention and tangibles. The two topographies of problem behavior observed were spitting out food and verbal protests. Gagging and panic attacks (i.e., heavy breathing, crying), which were reported to occur during meals, were never observed.

Liam. Liam's caregivers reported that following problem behavior during mealtimes, they would negotiate rewards and talk about the food. When Liam continued to refuse, he was allowed access to his preferred foods and toys at the table. During the mealtime observations (Figure 4), Liam engaged in an average of 1.3 and 2.3 instances of IMB per minute across two sessions with his mother and father, respectively. Liam's mother provided attention following 100% of instances of problem behavior and following 94% of instances of preconsumption behavior. She provided escape following 16% of instances of problem behavior and never following preconsumption behavior. Liam accessed tangibles following 100% of instances of problem behavior and of preconsumption behavior. His mother provided continuous access to attention and tangibles across both sessions, and Liam consumed four bites of food (three bites of macaroni and cheese and one bite of rice) across the two sessions. Liam did not consume these bites independently, however, and only accepted them after many prompts and when spoon-fed by his mother. When Liam's mother asked him to take "big" bites, she provided access to reinforcers contingent on Liam taking grain-sized bites. Liam's father did not prompt or reinforce preconsumption behaviors; instead, he asked Liam to consume the nonpreferred foods to receive access to more toys or preferred foods. Liam did not consume any foods with his father, nor did he engage in any preconsumption behavior. Liam's father provided attention following 94% of instances of problem behavior. He never provided escape following problem behavior, and Liam accessed tangibles following 56% of instances of problem behavior. During the second session, Liam's father decreased the amount of prompting and IMB decreased.

The results from Liam's functional analysis are presented in Figure 6. Problem behavior reliably occurred in the test condition and was absent during the control condition demonstrating a sensitivity to the combined contingency of escape to preferred forms of attention and tangibles. The two topographies of problem behavior observed were verbal protests and pushing the plate. Only pushing the place was reinforced (denoted by the asterisk) during the analysis. Flopping and crying, which were reported to occur, were never observed.

Ali. Ali's mother reported that following problem behavior she would instruct her to take deep breaths and ask questions to redirect her. Sometimes she would physically restrain Ali, depending on the severity of problem behavior. Ali's mother often persisted despite problem behavior and had attempted several times to physically deposit food in her mouth. When Ali continued to refuse, she was allowed access to her preferred foods or to leave the table and access her preferred toys.

During the mealtime observations (Figure 5), Ali engaged in an average of three instances of IMB per minute across two sessions. Ali's mother provided attention following 97% of instances of problem behavior and following 97% of instances of preconsumption behavior. She provided escape following 42% of instances of problem behavior and 14% of instances of preconsumption behavior. Ali accessed tangibles following 9% of instances of problem behavior and 7% of instances of preconsumption behavior. Ali attempted to access preferred foods and toys during the mealtime observation several times, but her mother blocked access and said they would be delivered following compliance. Ali's mother asked her to lick the foods and intermittently delivered access to preferred food and toys contingent on compliance. She asked Ali several times to take small bites, but contingent on problem behavior, decreased the requirement to licking the foods. During the second session, she only asked Ali to lick the foods and provided preferred food and toys contingent on compliance. Ali did not consume any of the foods with her mother.

During Ali's functional analysis (Figure 6), problem behavior reliably occurred in the test condition and was absent in the control condition demonstrating a sensitivity to a combined reinforcement contingency of escape to preferred forms of attention and tangibles. The three topographies of problem behavior observed were verbal protests, pushing the plate, and throwing the food away. Only moving the food and pushing the place were reinforced (denoted by the asterisks) during the analysis. Screaming, flopping to the floor, and aggression, which were reported to occur, were never observed.

Luke. Luke's mother reported that following mealtime problem behavior she would offer choices and provide rewards and preferred foods contingent on trying (i.e., licking or taking a small bite of) nonpreferred foods. If problem behavior persisted, the food was removed, and Luke was allowed to access preferred foods or leave the table and access toys.

During the mealtime observations (Figure 4), Luke engaged in an average of 2.8 instances of IMB per minute and engaged in one instance of SPB during the first session. Luke's mother provided attention following 83% of instances of problem behavior and following 100% of instances of preconsumption behavior. She provided escape following 16% of instances of problem behavior and 100% of instances of preconsumption behavior. Luke accessed tangibles following 16% of instances of problem behavior and 100% of instances of preconsumption behavior. Luke independently consumed all three bites of the pizza each session, which was followed by access to attention, escape, and preferred edible items. Because Luke independently consumed the pizza, it was not retained for treatment. His mother also delivered reinforcers contingent on Luke touching the foods to his tongue or taking grain-sized bites.

During Luke's functional analysis (Figure 6), problem behavior reliably occurred in the test condition and was absent in the control condition. The five topographies of problem behavior observed were spitting, yelling, eloping, verbal protests, and covering face. Only eloping, spitting out the food, and yelling were reinforced (denoted by the asterisk) during the analysis. Aggression and throwing, which were reported to occur, were never observed.

Justin. Justin's caregivers reported that following problem behavior they would talk about the importance of eating and allow Justin to leave the table to access preferred tangibles (e.g., watch TV). In addition, they would use candy to motivate Justin to try new foods and would provide access to a nutritional chocolate shake contingent on persistent refusal.

During the mealtime observations (Figure 5), Justin engaged in an average of three instances of problem behavior per minute across two sessions. SPB was never observed. During the second session, he consumed two bites of cereal that his mother fed to him. Justin's mother provided attention following 100% of instances of problem behavior, preconsumption, and consumption. She provided escape following 7% of instances of problem behavior and 50% of instances of preconsumption behavior. Justin accessed tangibles following 25% of instances of problem behavior and never following preconsumption and consumption behavior. Justin's mother primarily attempted to put food into Justin's mouth, and he would turn his head or bat her arm or the spoon.

The results of Justin's functional analysis are in Figure 6. Problem behavior reliably occurred in the test condition and was absent in the control condition. The five topographies of problem behavior observed were moving the bite of food, eloping, verbal protests, moving head (when presented with bite), and batting at the spoon. Aggression and throwing, which were reported to occur, were never observed.

Derek. Derek's caregivers and behavior analyst reported that following refusal, they would encourage him to smell or lick the food. Following persistent refusal or any precursors to more dangerous forms of problem behavior, Derek was allowed to leave the context and access preferred materials. Derek's lead behavior technician, who had been working with him for over a year, conducted the mealtime observation session. Derek engaged in an average of 11.5 instances of IMB per minute across the one session. During the session, the technician provided choices, encouraged Derek to hold or smell the foods, and complied with his mands to move about the room. Derek's behavior technician provided attention following 100% of instances of problem behavior. She provided escape following 84% of instances of problem behavior, and he accessed tangibles following 16% of instances of problem behavior. The technician terminated the session and provided access to preferred materials once Derek began emitting topographies of problem behavior that typically proceeded severe problem behavior.

Problem behavior reliably occurred in the test condition of Derek's functional analysis (Figure 6) and was absent in the control condition. The topographies of problem behavior observed were covering mouth, batting, and verbal protests. Aggression, self-injury, yelling, and pulling out the G-tube, which were reported to occur, were never observed.

Aiden. Aiden's caregivers reported that following problem behavior they would provide Aiden with choices, access to toys and attention, and sometimes would provide access to candy contingent on engagement with nonpreferred foods.

During the mealtime observations (Figure 5), Aiden engaged in an average of 1.3 instances of problem behavior per minute across two sessions. SPB was never observed. Aiden's mother provided attention following 73% of instances of problem behavior. She provided escape following 71% of instances of problem behavior, and Aiden accessed tangibles following 92% of instances of problem behavior. Across the two sessions, Aiden had continuous access to preferred tangible items.

In the functional analysis (Figure 6), problem behavior reliably occurred in the test condition and was absent in the control condition. The two topographies of problem behavior observed were moving the food and batting at the plate or arm of the analyst. All topographies reported to occur at home were observed in the analysis.

As in Piazza et al. (2003), all caregivers reported and were observed to deliver multiple reinforcers following problem behavior, preconsumption, and consumption behaviors. Attention was the most prevalent consequence, and caregivers were also observed to deliver escape and access to tangibles. Despite the difference in the relative probability of observation, all observed consequences were included in the subsequent functional analysis. As Thompson and Iwata (2007) demonstrated, the prevalence of consequences is not correlated with their likelihood to serve as reinforcers. For example, attention could be observed frequently, but may be functionally irrelevant or less relevant, whereas a preferred snack could be delivered infrequently, but still strongly influence problem behavior. There is also the strong likelihood that children's mealtime problem behavior is maintained by an intermittent reinforcement schedule, rendering the relative probabilities of the consequences somewhat unimportant. The purpose of the observation with parents was to evaluate how caregivers responded to problem behavior and to establish a baseline of consumption and problem behavior. Measurement of consequences was primarily included to evaluate the extent to which suspected reinforcers were delivered following mealtime target behaviors and to increase the ecological validity of the subsequent functional analysis of mealtime problem behavior.

The entire assessment process took four visits for all children except Liam, whose process took five visits. Across all children, the preference analysis took an average of 24 minutes (range, 13-37 min), the mealtime observations took an average of 20 minutes (range, 3-

20 min), and the functional analysis took an average of 26 minutes (range, 25-30 min). In total, including the interview, the assessment process took an average of approximately 100-114 minutes across children. Time not accounted for includes food preparation, between-session breaks, and conversations with caregivers prior to and following the assessments. We conducted one assessment per day, but multiple assessments could take place on the same day.

Study II: Treatment of Food Selectivity

Method

Participants and setting. Study 2 included Luke, Liam, and Ali. We conducted treatment sessions in therapy rooms located in the psychology department of a university. Participants visited the clinic two to three times per week and sessions lasted approximately 1 h each.

Measurement, design, and IOA. Data collection was that of study 1, but the list of preconsumption behaviors was task analyzed to shape across during treatment. See Table 2 for the levels of preconsumption for each child.

A changing criteria design was used to evaluate the effects of the intervention on the dependent variables during bite shaping. Functional control was demonstrated when behavior conformed to the reinforcement contingency in place.

IOA was scored by having a second independent observer collect data on all dependent variables for a minimum of 20% of sessions. Data were compared on an item-by-item agreement per trial. IOA across baseline and treatment averaged 99.1 % (range, 93.3-100), 99.4% (range, 67-100), and 100% for Liam, Ali, and Luke respectively.

Treatment procedures. Treatment consisted of the differential delivery of synthesized reinforcers, shaping across and within response topographies without escape extinction, and embedded choice making opportunities. Reinforcers were delivered following specific responses emitted by the child related to preconsumption and consumption, and the criteria for positive reinforcement were gradually increased contingent on meeting the previous criterion. As the reinforcement criteria increased, previously reinforced responses were no longer eligible for positive reinforcement, but escape was available across the entire treatment. Frequent choice-making opportunities were available throughout treatment. During treatment sessions, on each trial, the child had the choice of: which non-preferred food to engage with, how to behave with respect to the non-preferred food in the context of up to 30 preconsumption and consumption behaviors, whether to meet the reinforcement criteria, and preferred food and toys contingent on meeting a certain criterion. In addition, the child always had the choice to participate in the treatment process. There was a designated space, populated with moderately preferred toys, that the child could go to any time he or she wished. Escape was never provided contingent on problem behavior; the analyst simply did not respond to problem behavior. Instead, the child could leave the table anytime.

The goal of this treatment phase was to gradually shape consumption of individual bites of nonpreferred foods across response topographies related to preconsumption and consumption (see Table 2). The topographies were depicted on cards and were presented on a large board (Luke, Liam) or on a handheld board (Ali). Each topography card was associated with a particular color denoting the consequences associated with it. Some responses resulted in the delivery of all reinforcers identified in the IISCA for approximately 60-120 s. Some responses resulted in the delivery of some of the identified reinforcers for approximately 30, and some responses were not eligible for any positive reinforcement. If the child engaged in a behavior associated with no positive reinforcement, the next trial or meal was presented. The different consequences were explained to the child but not experienced prior to the start of treatment. The therapist did however, model and the child emitted some the responses using a preferred food.

A meal (i.e., session) consisted of 4-10 bites of food (i.e., trials), depending on the participant. On each trial the child was presented with the board and instructed to select the card of the behavior he or she wanted to engage in and to the food to engage with. Following the child's response with respect to the food, the corresponding consequence was delivered, and the trial concluded. During bite shaping, the response performed was recorded, regardless of whether it matched the participant's selection. For example, if the child selected the card associated with licking the food but then only picked up the food, holding the food was recorded for response performed.

During baseline, any selection and corresponding behavior resulted in the delivery of the full reinforcement contingency. That is, all the cards during baseline were associated with the color that indicated the delivery of all the positive reinforcers. Treatment began once stable responding was observed during baseline. The initial full reinforcement level was determined by calculating the performance mode during baseline plus one to two levels. All levels at or above this were eligible for the full reinforcement contingency. Two levels below were set to partial reinforcement and all remaining lower levels were set to no access to positive reinforcement. The reinforcement criterion was increased one or two levels following one to three sessions with performance at or above the current criterion for at least 75% of trials.

Foods were considered mastered and removed from the bite shaping phase of treatment following three to five sessions in which the child consumed the entire bite of food. This procedural modification was included because some participants reached the terminal goal of consumption with some foods before others. Bite shaping was concluded once the child had consumed each of the targeted foods across a minimum of three sessions.

Results and discussion. Luke's data are presented in Figure 7. During the functional analysis, Luke engaged in IMB each trial and SPB in one trial. During baseline, Luke primarily engaged in touching the plate of foods. The first full reinforcement criterion was set to holding the food. Throughout the process, Luke met or exceeded the full reinforcement criteria on each trial except for three. He gagged during two trials when the reinforcement criterion was set to touching the food to his tongue for the first time. When the criterion was set to chewing the food 5 times and spitting it out, Luke began consuming the foods (eating two bites of different food per trial). When the criterion was set to swallow, Luke consumed all four bites of the food in one trial. Across five criterion levels, Luke's responding conformed to or exceeded the target criterion. Luke completed bite shaping in eight visits across three weeks. He only left the treatment context for the hang-out area once during his sixth visit for approximately two and a half minutes.

Liam's data for bite shaping are illustrated in Figure 8. During baseline, Liam primarily touched the plate; thus, the first full reinforcement criterion for treatment was set to touching the food. Liam performed at or above the criterion during the first six reinforcement criteria phases with several exceptions. There were several instances of IMB and gagging. Liam performed above the criteria and began consuming macaroni and cheese during the second criterion phase. Liam's performance deteriorated when the reinforcement criterion was increased to swallowing the food. During the first meal at this criterion, he consumed all bites of hamburger and macaroni and cheese with no gagging or problem behavior; however, for the remaining five meals he performed below the criterion apart from macaroni and cheese. We decreased the reinforcement criterion back to chewing the food five times and remained at this level for 12 meals as we continued to observe gagging inconsistently across foods. We again increased the criterion to swallowing the foods. Liam initially performed below the criterion for two meals, but by the fifth meal at this level, Liam consumed all the targeted foods across three meals. Despite having consumed all target foods at this point, his performance continued to be variable. For example, during trials 400-410, Liam consumed all the hamburger, but not the rice, and during trials 421-430, he consumed all the pasta, but not the hamburger. During trials 451-460, he consumed all the lettuce, but not the rice, and during trials 471-480 he consumed all the rice, but not the chicken. Foods were removed from treatment once Liam had consumed the bites across three nonconsecutive meals. Pasta, hamburger, lettuce, and rice were removed after trials 460, 460, 470, and 480, respectively. The last meal, trials 481-490, consisted solely of chicken. Throughout bite shaping, Liam engaged in minimal IMB, but consistently engaged in gagging. In addition, Liam vomited during four trials while chewing or attempting to swallow the lettuce, hamburger, and pasta. Across nine criteria phases, responding conformed to the target criterion in seven out of nine instances. The two criteria phases in which responding did not consistently conform were set to swallowing the foods. Liam eventually swallowed all the foods and completed bite shaping in 28 visits across two months. He left the treatment context during five visits for a range of 30 seconds to 25 minutes.

Ali’s data for bite shaping are in Figure 9. During baseline, she performed the lowest level (look at the food covered across the table) each trial. Thus, the first full reinforcement criterion was set to the second level (look at the food uncovered across the table) and she performed above the criteria by smelling the food on each trial. Her behavior conformed to the criteria in place for the 12 reinforcement phases. Once the criterion was increased to swallow, however, her performance deteriorated. Instead of returning to the previous level as we did with

Liam, we task analyzed the steps further. The bites of food were cut into fourths and three additional levels were added (swallow 25%, 50% and 75% of a bite), but Ali did not meet the new criteria. Thus, three additional criteria were added (chew 25%, 50%, and 75% of the bite 20 times). Ali began swallowing the smaller pieces of macaroni and cheese and noodle when the criteria was set to chewing 25% of the bite 20 times, and she began swallowing the entire bite when the criteria was increased to swallow 25% of the bite. The bites of macaroni and cheese and noodle were temporarily removed from treatment to increase the likelihood that she would swallow the other smaller bites of foods. After several sessions, she began to swallow the carrot, hot dog, and hamburger, although her performance with cucumber was variable, and macaroni and cheese and noodle were added back into treatment. We remained at the criterion of swallow 50% for multiple sessions as she was not consuming the carrot and cucumber. Foods were removed once Ali had consumed the full bite across five sessions. Macaroni and cheese, noodle, hot dog, hamburger, and carrot were removed after trials 221, 233, 241, 242, and 253, respectively. The last meals, trials 254-267, consisted solely of cucumber. After several sessions of no consumption, we decreased the criteria back to swallow 25% and shaped consumption across bite size until the criterion was back at swallowing the full bite. Bite shaping was completed in 33 visits across four months.

Shaping with synthesized reinforcers without the use of escape extinction was efficacious in increasing consumption of the targeted foods for all three participants. Previous studies (Hoch et al., 1994; LaRue et al., 2011; Piazza et al., 2003; Reed et al., 2004) demonstrated that reinforcement alone did not increase consumption and escape extinction was a necessary component. We may have achieved different results for several reasons. First, our process relied on the use of a synthesized reinforcement contingency. The previous studies relied on single reinforcers to be delivered following acceptance. For example, LaRue et al. (2011) evaluated the effects of a 30 s break contingent on mouth clean following functional analyses that suggested that the participants' IMB was maintained in part by escape. For all participants, acceptance was low and inappropriate behavior was high when a 30 s break was provided contingent on mouth clean (most participants never accepted a bite). When escape extinction was implemented, acceptance and mouth clean increased and inappropriate behavior decreased. Thus, escape was identified as relevant to IMB during the functional analyses but was ineffective in decreasing inappropriate behavior or increasing consumption when used alone. This is consistent with Slaton and Hanley's (2018) review findings that 89% of treatments with synthesized reinforcement contingencies achieved a mean baseline reduction of problem behavior of 80% or higher and over half achieved a reduction of 95% or higher, in contrast to 11% and 7% of treatments with isolated reinforcement contingencies, respectively. In other words, it is possible that synthesized reinforcement contingencies increase the probability of treatment efficacy in the absence of escape extinction.

In addition, we shaped across response topographies towards the terminal goal of consuming food. The leap from non-consumption to consumption may be too challenging and, in the absence of escape extinction, shaping approximations may be necessary. In previous studies, children rarely contacted reinforcement because they never accepted the food. Thus, it is possible that even isolated reinforcers could be efficacious when used in combination with gradual shaping across preconsumption and consumption behaviors.

The value of a treatment can be assessed using many factors, including the extent to which it produces the desired outcomes, the efficiency of the treatment process, and the frequency of problem behavior during the process. Liam, Ali, and Luke consumed all targeted foods by the end of the bite shaping phase of treatment, providing evidence that the present treatment produced at least some of the desired outcomes. Future researchers should evaluate the generality of increased consumption across nontargeted foods, such as by analyzing additional nonpreferred foods during the preference and functional analyses and reintroducing them following the bite shaping phase of treatment.

In terms of treatment efficiency, durations in the present study ranged from several weeks to four months. Liam, Ali, and Luke completed the bite shaping phase of treatment in 28, 33, and 8 1-hr treatment visits, which includes the pretreatment assessment beginning with the initial interview. Some factors that may have affected treatment duration were the number of levels targeted for each participant, time spent at a given level given the participant's performance, and the amount of time spent away from the treatment context. Luke's treatment was relatively more efficient than Liam's and Ali's. Future researchers should evaluate ways to increase efficiency, such as by increasing the number of sessions conducted per day or visits per week. In addition, shaping across all response topographies may not be necessary and probes could be conducted to evaluate whether some levels could be bypassed. Future researchers could also conduct the process with multiple children in a small-group format and evaluate the effects of various group contingencies.

In terms of problem behavior, Liam engaged in IMB in 3.5% (18/506) of trials, Ali engaged in IMB in 12.4% (33/267) of trials, and Luke never engaged in IMB across baseline and treatment sessions. Severe problem behavior was never observed with any of the participants. One reason problem behavior may have remained low across all participants is that escape was not provided contingent on problem behavior as is typical in studies that evaluate methods without escape extinction. That is, there was no programmed contingency for problem behavior;

the analyst responded to problem behavior neutrally, and the participants had the opportunity to leave the treatment space at any time. In addition, the therapist never instructed the child to consume the food (as she did in the functional analysis). The instruction to consume nonpreferred foods may function as an establishing operation for problem behavior given a child's history of mealtime problem behavior. In our study, the child was asked what he or she would like to do on each trial and these choice-making opportunities may have contributed to the low levels of problem behavior throughout treatment.

An additional factor on which to judge the value of a treatment is consumer preference. Hanley, Piazza, Fisher, Contrucci, and Maglieri (1997) demonstrated that differential reinforcement of an alternative behavior, noncontingent reinforcement, and extinction were all equally efficacious in reducing problem behavior maintained by social reinforcement, but participants preferred the differential reinforcement context. Thus, the value of the differential reinforcement was found in the child's preference in addition to the efficacy of the treatment. We did not evaluate this factor, and future researchers should consider evaluating children's relative preference for common treatments for food selectivity using a concurrent-chains procedure. In addition, caregiver's preference could be evaluated as well.

Finally, the severity of the food selectivity may affect a participant's sensitivity to the current treatment. Luke was reported to consume the most foods prior to treatment, and his treatment process took the fewest sessions. In addition, Luke had experienced a previous treatment targeting his tolerance for the presence (but not preconsumption or consumption) of some nonpreferred foods (Ghaemmaghami et al., in press). It is possible that the present treatment would have yielded different outcomes had Luke not experienced this prior intervention.

General Discussion

We evaluated a comprehensive model for addressing food selectivity without escape extinction. We conducted a practical functional assessment of mealtime problem behavior with seven children with and without autism who displayed either food selectivity or food refusal. Problem behavior remained at low rates and of low intensity throughout the entire assessment process. Furthermore, strong control of mealtime problem behavior by ecologically relevant and synthesized reinforcement contingencies was quickly achieved with all children without ever observing severe problem behavior. In addition to affirming hypotheses as to environmental events were influencing mealtime problem behavior, the functional analysis also provided a baseline for each child from which mealtime problem behavior and food selectivity could be addressed. During treatment, the terminal response of consuming multiple nonpreferred foods was gradually shaped using synthesized reinforcers and multiple choice-making opportunities.

Our assessment package advances the literature by combining several components that, together, yield important information to inform treatment. Via survey, interview, and analysis, we identified and confirmed the relevance of specific foods to populate each child's treatment as part of the establishing operation and synthesized reinforcement. We established two baselines, one of mealtime problem behavior and food consumption with the analyst for comparison with treatment, and the other of mealtime problem behavior and food consumption with caregivers. We confirmed that we could present evocative situations reported to evoke SPB and only observe mild forms of mealtime problem behavior that reliably and quickly abated upon reinforcement delivery.

Assessing mealtime problem behavior is associated with unique risks such as gagging, choking, rumination, and vomiting, and these may be difficult to manage in settings without medical personnel. Behavior analytic practitioners may avoid addressing mealtime problem behavior, food selectivity, and food refusal because of these risks. Our study demonstrates that mealtime problem behavior associated with food selectivity and refusal can be analyzed without observing severe problem behavior, and that analysis results can inform an efficacious intervention despite never evoking severe problem behavior and emotional responding.

We minimized risk in several ways. We began the process with a screening tool identify children whose mealtime concerns might be related to medical complications. During the preference analysis, we removed the food contingent on any bid for its removal rather than making the removal contingent on problem behavior or time. We also analyzed reported preferred and nonpreferred foods within the same analysis, which may have reduced the aversiveness of repeated presentations of reportedly nonpreferred foods. During mealtime observations, we gave caregivers the authority to terminate the session at any point for any reason, and three of eight caregivers chose to end the sessions early. During the functional analysis, we provided all suspected reinforcers for mealtime problem behavior immediately following any suspected member of the response class (Warner et al., 2019). By providing reinforcers immediately, we were attempting to prevent the escalation to severe problem behavior that is likely to occur when reinforcers are delayed (Lerman & Iwata, 1996; Warner et al., 2019). By providing all suspected reinforcers, we attempted to remove all possible establishing operations that may have evoked problem behavior.

The current process relied on both indirect and direct assessment methods. Behavior analysts have attempted to determine whether they should use indirect *or* direct assessments (Cote, Thompson, Hanley, & McKerchar, 2007; Green et al., 1988; Iwata, Deleon, & Roscoe, 2013; Thompson & Iwata, 2007). We contend that behavior analysts should ultimately rely on direct manipulation of environmental variables to identify functional relations; however, the results from these analyses may only be useful in so far as the relevant stimuli are analyzed, and this information can be gathered from indirect or observational measures. For example, Fisher, Piazza, Bowman, and Amari (1996) found that when caregivers informed a direct assessment, it resulted in the identification of more potent reinforcers than one populated with a preselected set of stimuli. Parental inclusion in this process may also positively impact subsequent maintenance and generalization of treatment effects.

Our assessment package included a functional analysis. Functional analyses are infrequently reported in the assessment of food selectivity (Silbaugh et al., 2016), and this may be due to the assumption these behaviors are maintained by negative reinforcement, and assumption that seems supported by the demonstrations of the efficacy of escape extinction in treatment (Patel, Piazza, Martinez, Volkert, & Santana, 2002; Piazza, Patel, Gulotta, Sevin, & Layer, 2003; Reed et al., 2004). However, Piazza et al. (2003) found that problem behavior associated with mealtime was sensitive to multiple reinforcers in 77% (10/13 cases) of functional analyses. In naturalistic observations, the authors observed parents delivering multiple consequences (e.g., preferred foods, tangibles, attention) following problem behavior. Indeed, LaRue et al. (2011) found that acceptance was low and inappropriate behavior was high when escape alone was provided contingent on mouth clean. Hanley (2012), although noting the relevance of negative reinforcement in food selectivity and mealtime problem behavior, recommended conducting an open-ended interview to identify other ecologically relevant reinforcers. Our study incorporated that suggestion and also evaluated that combined contingency in an analysis prior to treatment.

All children's problem behavior demonstrated sensitivity to synthesized reinforcers.

Categorically the reinforcement contingencies were similar, but the types of food, attention, and tangibles were, however, individualized for each child. We did not evaluate the main effects of each consequence, rather we emulated the conditions under which problem behavior was reported and observed to occur, which always included the combination of consequences. It was not our aim to attempt to isolate a function of mealtime problem behavior, but rather to evaluate the extent to which functional control of mealtime problem behavior could be demonstrated using ecologically relevant contingencies. Examples from the functional analysis of severe problem behavior have shown meaningful treatment outcomes when functional control of problem behavior is shown with interview-informed, synthesized contingencies and without any attempt to understand the independent influences of the different reinforcers (Beaulieu et al., 2018; Ferguson et al., in press; Hanley et al., 2014; Herman et al., 2018; Jessel et al., 2018; Rose & Beaulieu, 2018; Santiago et al., 2016; Strand & Eldevik, 2016; Taylor et al., 2018).

This study also demonstrates the utility of a treatment model that allows its participants frequent choice-making opportunities within a therapeutic process targeting food selectivity. This is especially noteworthy given the probable relevance of negative reinforcement. Several other studies have incorporated choice-making opportunities into treatments to address food refusal and selectivity (Cooper et al., 2005; Koegel et al., 2012; McDowell, Duffy, & Kerr, 2007), but not the choice to leave treatment sessions at any point. Although the efficacy of these procedures in isolation has not been demonstrated, there are potential benefits to embedding choices into treatments. For example, people tend to prefer contexts in which they are allotted choices, and they may be more likely to participate in activities that contain choices-making opportunities (Bannerman, Sheldon, Sherman, & Harchik, 1990; Geiger, Carr, & LeBlanc, 2010; Hanley, 2010). Further, client choice and therapeutic intervention need not be in conflict

(Bannerman et al., 1990). Although one might assume that children who eat selectively would continue doing so given a choice, our evaluation shows that opportunities can be arranged that favor healthy choices while still allowing the child to make other choices.

With a process that does not rely on escape extinction for its efficacy, it may be important to use functional, rather than arbitrary, reinforcers. Functional analyses are rare in the assessment of food selectivity and refusal and that may be due to the assumption that these behaviors are largely maintained by negative reinforcement. Although negative reinforcement likely plays an important role in maintaining problem behavior associated with mealtime, Piazza et al. (2003) found that problem behavior associated with mealtime was sensitive to multiple reinforcers in 77% (10/13 cases) of functional analyses, and they observed parents delivering multiple, synthesized consequences (e.g., escape to preferred foods, tangibles, and attention) following problem behavior. This suggests the relevance of an analysis method that evaluates synthesized contingencies, such as the IISCA (Hanley et al., 2014). The IISCA has its strengths in its ability to demonstrate strong, experimental control (Jessel, Hanley, & Ghaemmaghami, 2016) and lead to effective treatment outcomes (Hanley et al., 2014, Slaton, Hanley, & Rafferty, 2017). Thus, identifying the qualitatively rich reinforcement contingencies maintaining problem behavior associated with mealtimes via interviews with caregivers and then verifying control by those contingencies in an analysis may increase the effect of an intervention without escape extinction.

Our research contributed to the remediation of food selectivity with respect to the targeted foods in children with and without developmental disabilities by evaluating a technology for assessing mealtime problem behavior and food preferences and a treatment that increased consumption of targeted foods for all children. Future research could further contribute by extending the current technology to children with limited verbal repertoires and to those who engage in total food refusal. Research is also warranted on extended these treatments to relevant caregivers and to relevant contexts.

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Table 1.

Participant Information and Assessment Durations

			Duration (min)				
Participant *Age*	Diagnosis	Number of Visits	Interview	Preference Analysis	Mealtime Observation	Functional Analysis	Total
Gabby, *4*	Autism	4	30-45	36.5	18.5	25	110-125
Liam, *5*	N/A	5	30-45	21	38	25	114-129
Ali, *4*	Autism	4	30-45	28	19.5	25	102.5-117.5
Luke, *5*	Autism, ADHD	4	30-45	29	20	25	104-119
Justin, *5*	N/A	4	30-45	20	20	30	100-115
Derek, *4*	Autism, Short-bowel syndrome	4	30-45	13	3	25	71-86
Aiden, *5*	Autism	4	30-45	22	20	25	97-112
		Mean	*~38*	*24*	*20*	*26*	*100-114*

Note: The interview duration is an estimate.

Table 2.

Levels of Preconsumption and Consumption.

Step		Description
1	Look at food, covered, 5 seconds; food is across the table.	
2	Look at food, uncovered, 5 seconds; food is across the table.	
3	Look at food, uncovered, 5 seconds; food is just outside arm's reach.	
4	Look at food, uncovered, 5 seconds; food is within arm's reach	
5	Touch plate	
6	Touch food with utensil or hand	
7	Hold food in spoon or hand	
8	Bring to nose for 1 second	
9	Bring to nose and smell	
10	Touch piece of food to lips	
11	Touch piece of food to tongue	
12	Deposit food on tongue, hold for 3 s, spit out	
13	Chew for 3 s, spit out	
	a	Touch to front teeth[a]
	b	Bite with front teeth[a]
	c	Bite into 2 pieces[a]
	e	Chew 1 s, spit out[a]
14	Chew for 5 s, spit out	
15	Swallow 1 bite of food	
16	a	Chew for 10, spit out[a]
	b	Chew for 15, spit ou[a]
	c	Chew for 20, spit out[a]
	d	Chew 25% for 20, spit out[a]
	e	Chew 50% for 20, spit out[a]
	f	Chew 75% for 20, spit out[a]
	g	Swallow 25%[a]
	h	Swallow 50%[a]
	i	Swallow 75%[a]
17-24	Swallow 2 - 10 bites of food	

[a] Levels added for Ali only.

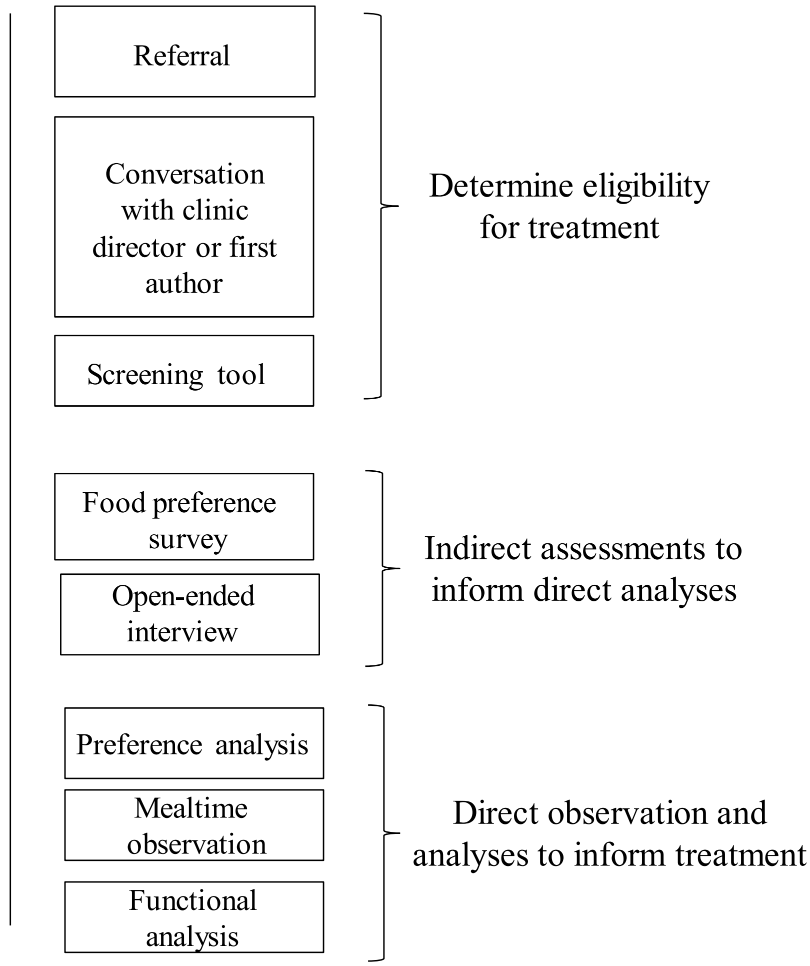


Figure 1. Assessment process.

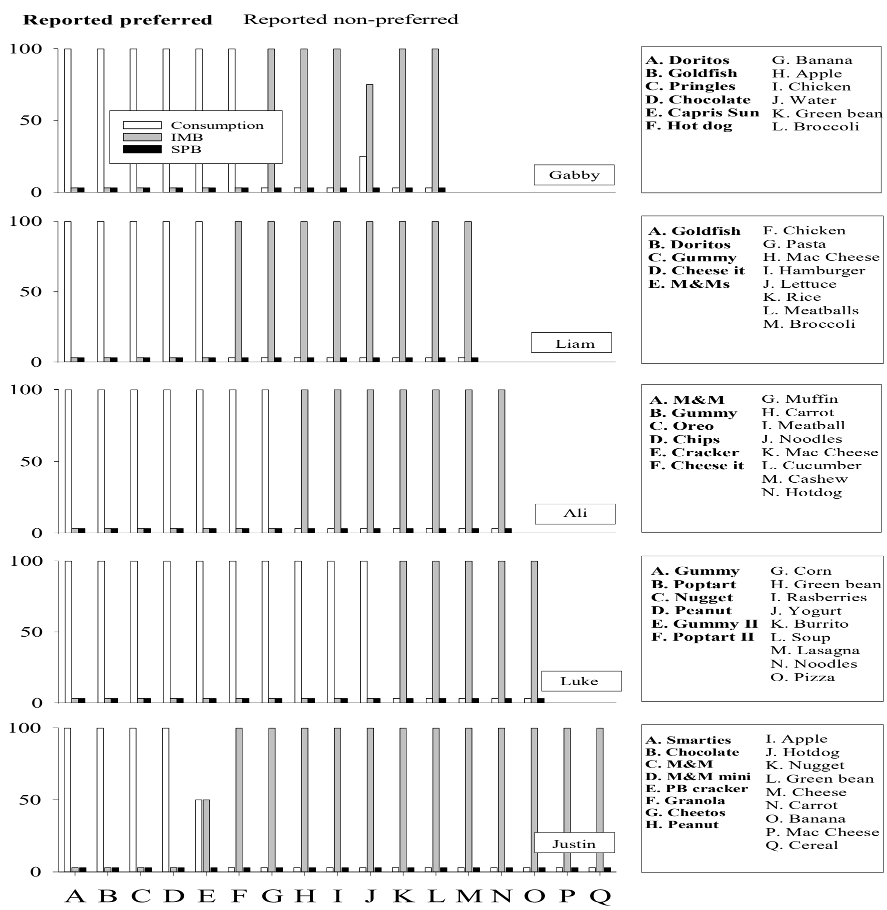


Figure 2. Preference analysis results for Gabby, Liam, Ali, Luke, and Justin. IMB: inappropriate mealtime behavior, SPB: severe problem behavior.

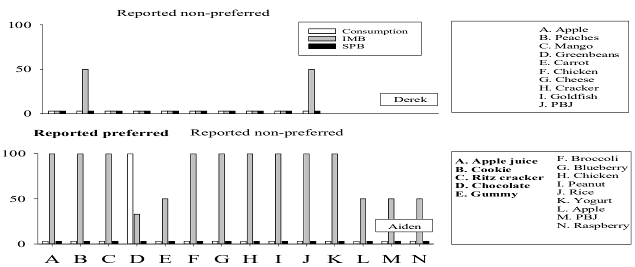


Figure 3. Preference analysis results for Derek and Aiden. IMB: inappropriate mealtime behavior, SPB: severe problem behavior.

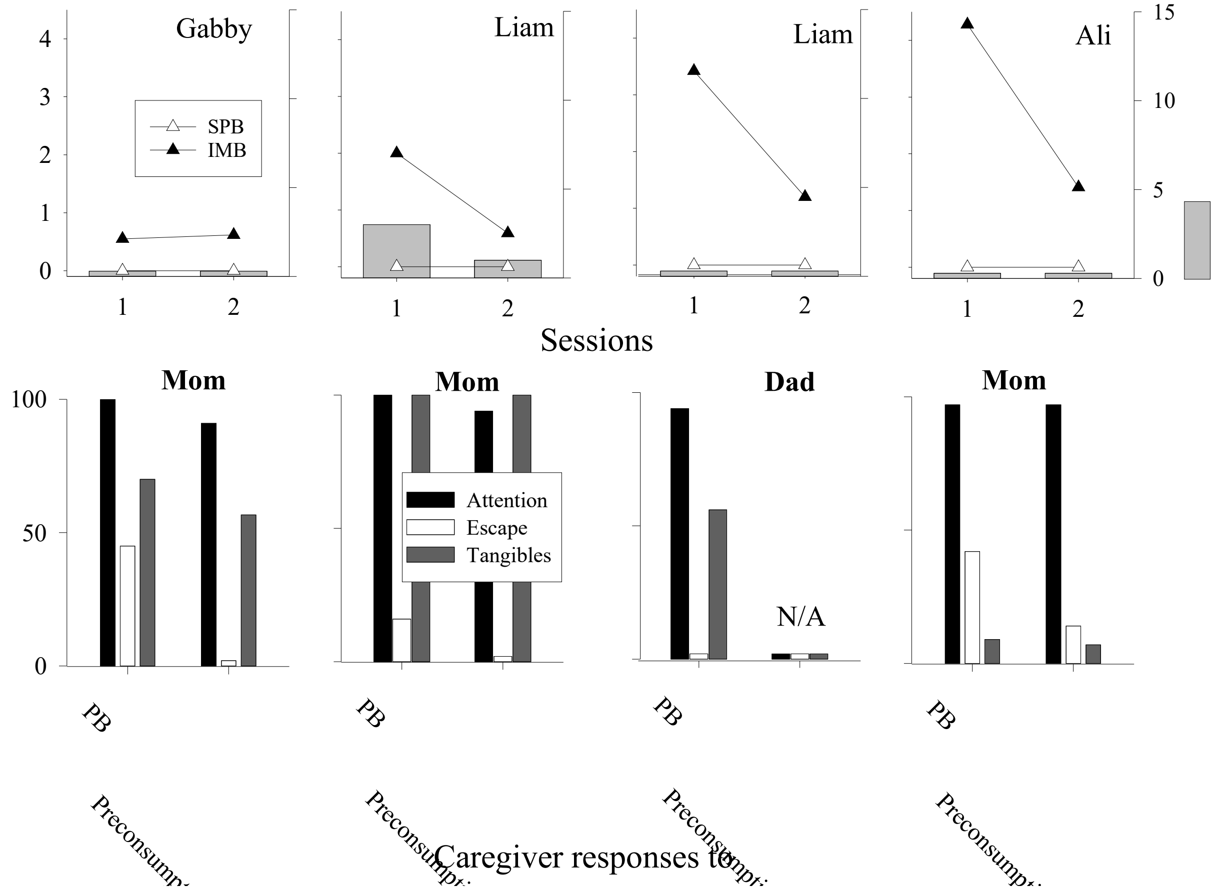


Figure 4. Results of the mealtime observation for Gabby, Liam, and Ali. The top panels represent child behavior during the sessions; the bottom panels represent caregiver responses to child behavior. IMB: inappropriate mealtime behavior, SPB: severe problem behavior.

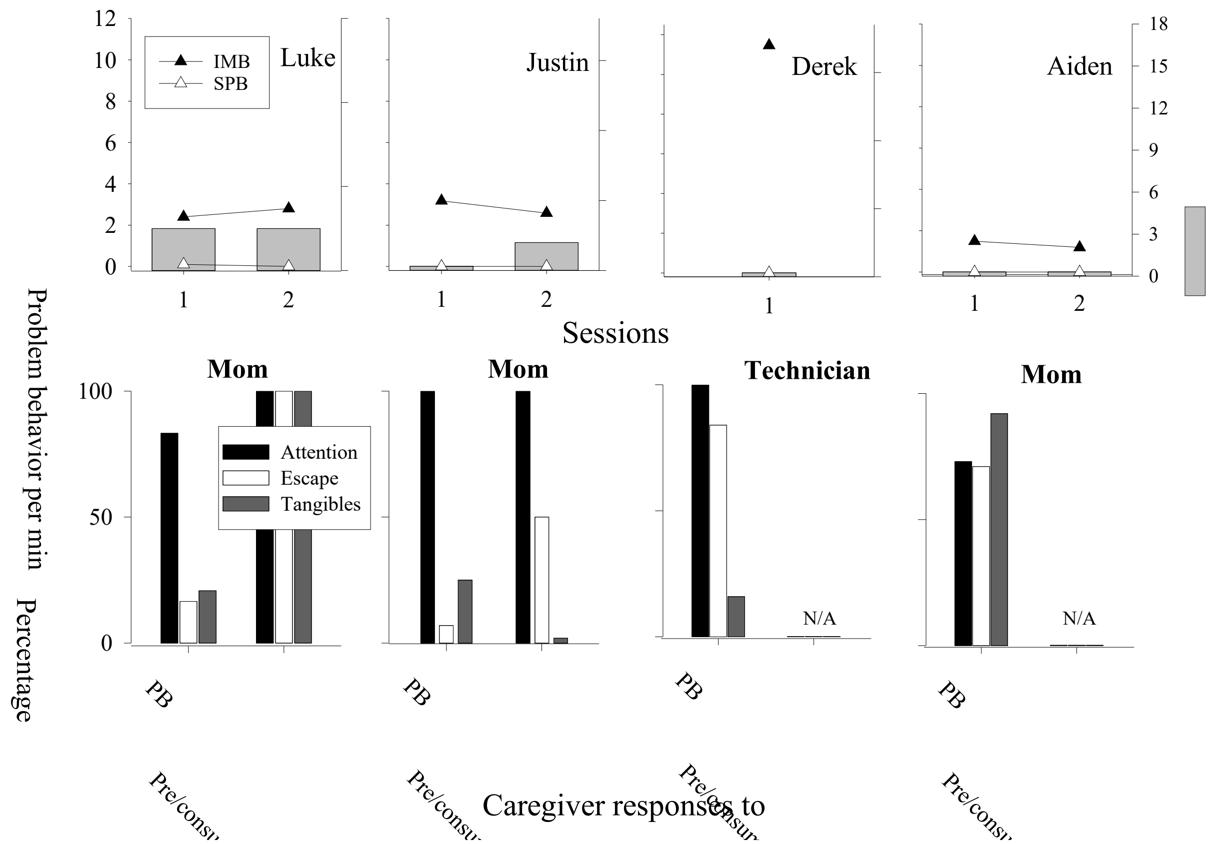
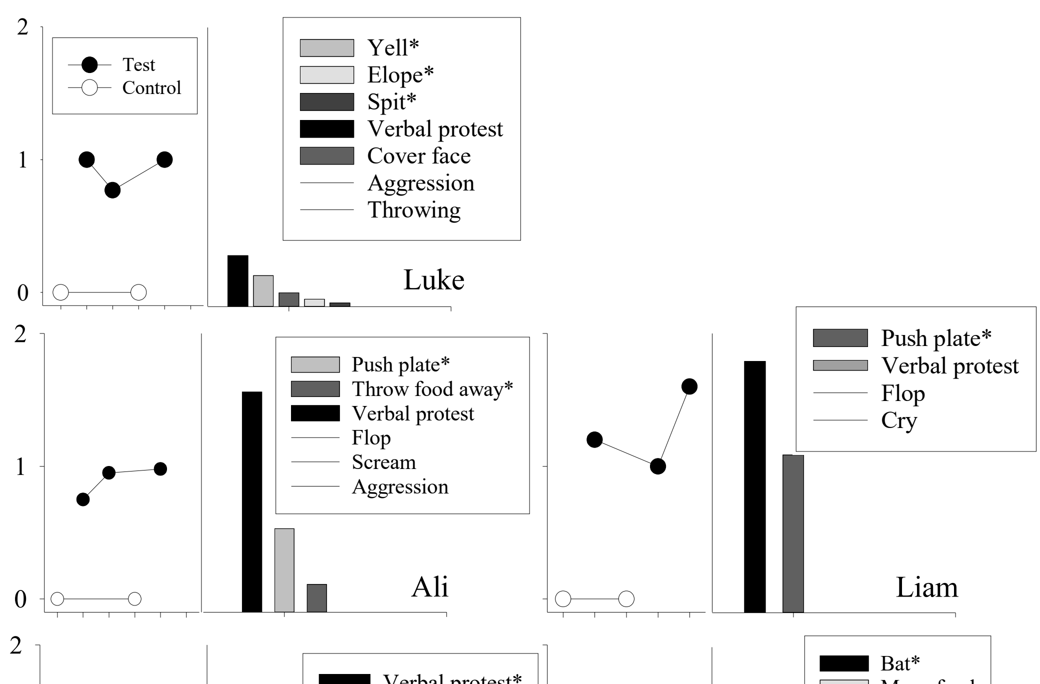
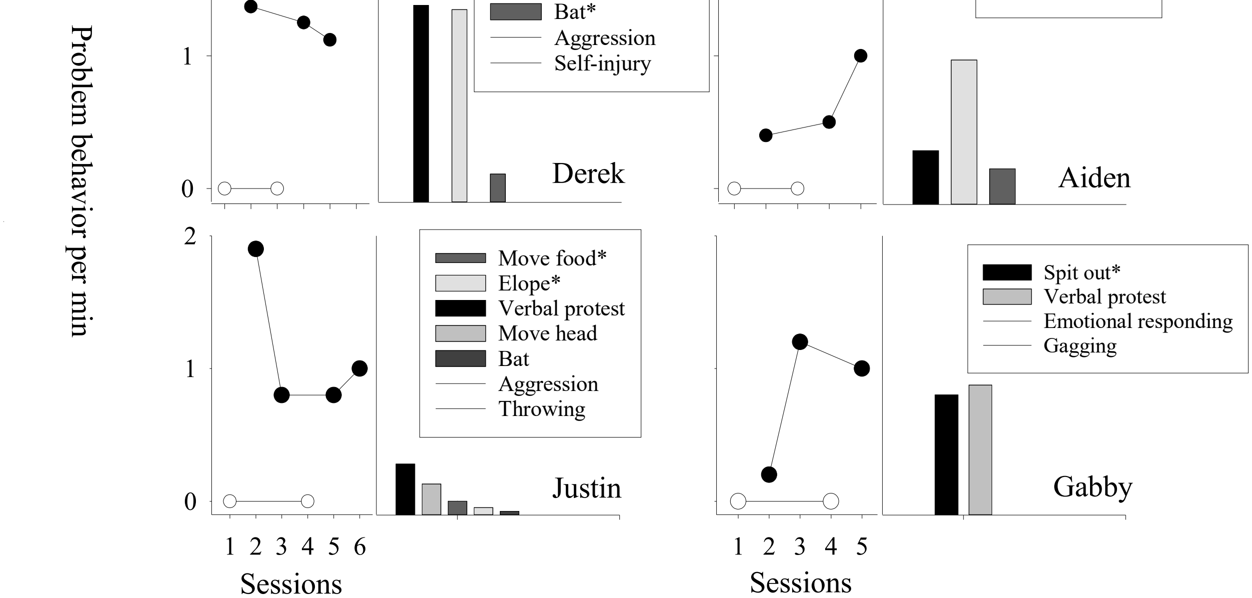
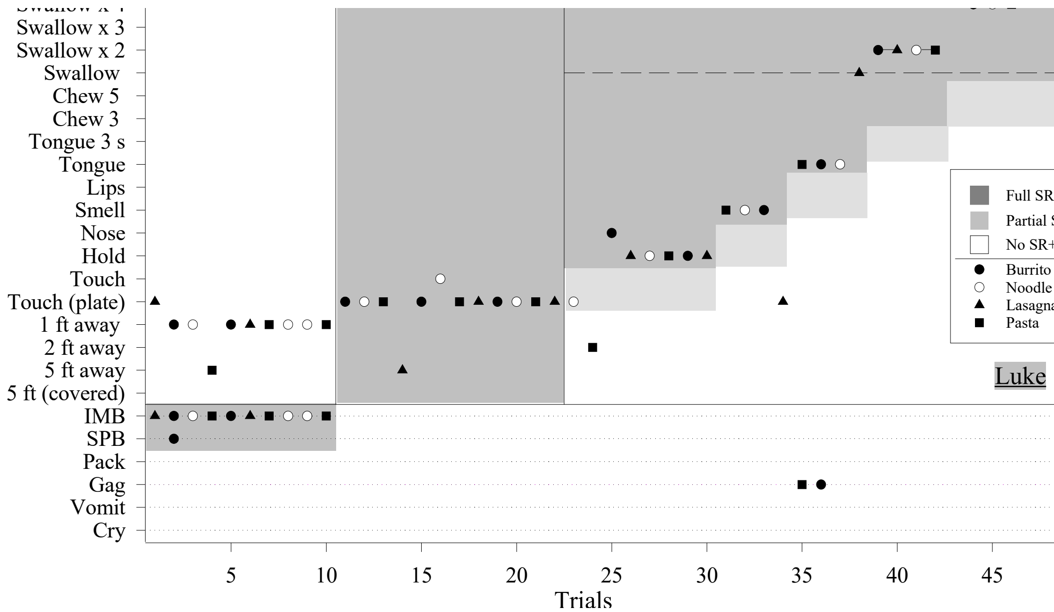


Figure 5. Results of the mealtime observation for Luke, Justin, Derek, and Aiden. The top panels represent child behavior during the sessions; the bottom panels represent caregiver responses to child behavior. IMB: inappropriate mealtime behavior, SPB: severe problem behavior.







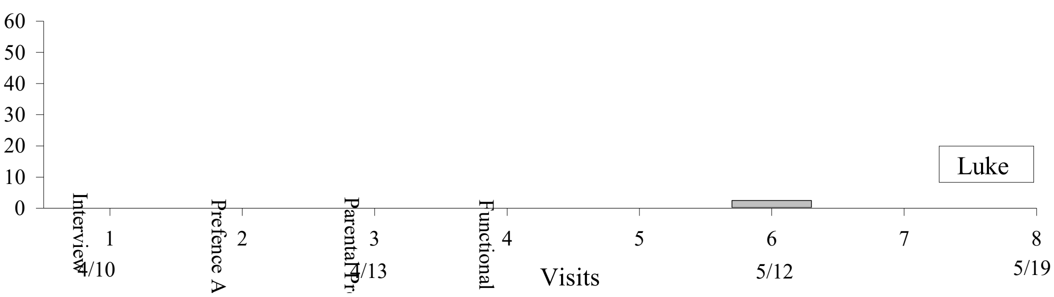


Figure 7. Results from bite shaping and duration of time spent in the hang out context during bite shaping treatment phase for Luke. Lines connecting data points in top graph denote when Luke consumed multiple foods in one trial. Horizontal dotted line represents terminal criterion of consumption. SR = reinforcement.

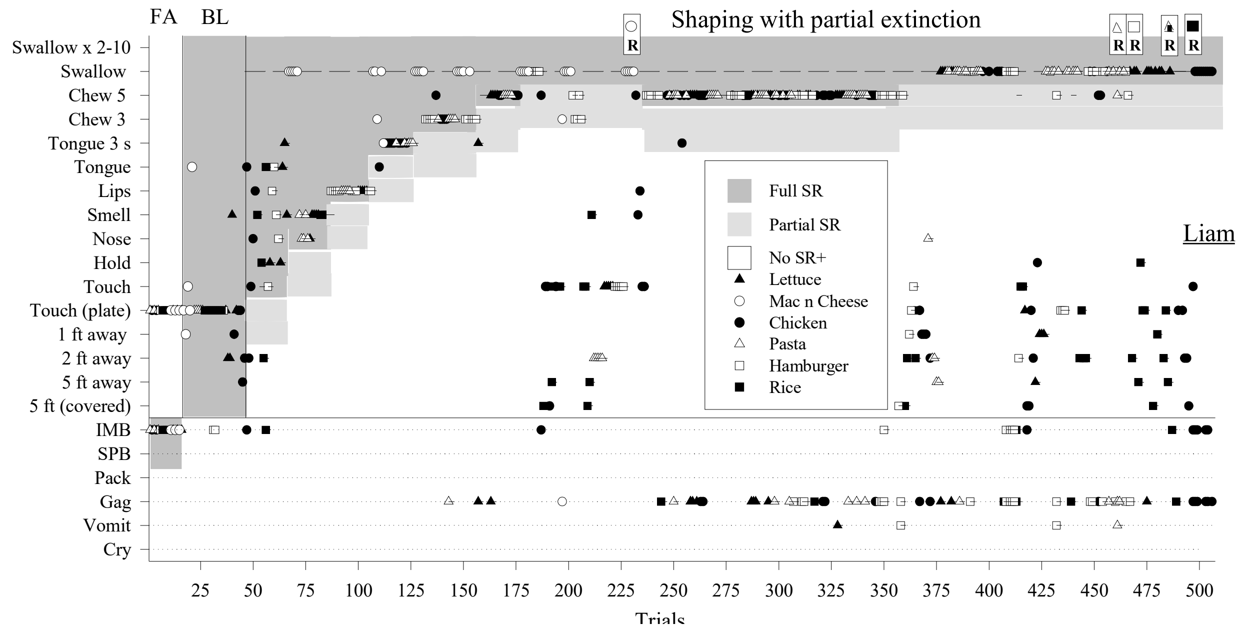


Figure 8. Results from bite shaping and duration of time spent in the hang out context during bite shaping treatment phase for Liam. R and corresponding data point denote when that food was removed from the bite shaping phase of treatment. Horizontal dotted line represents terminal criterion of consumption. SR = reinforcement.

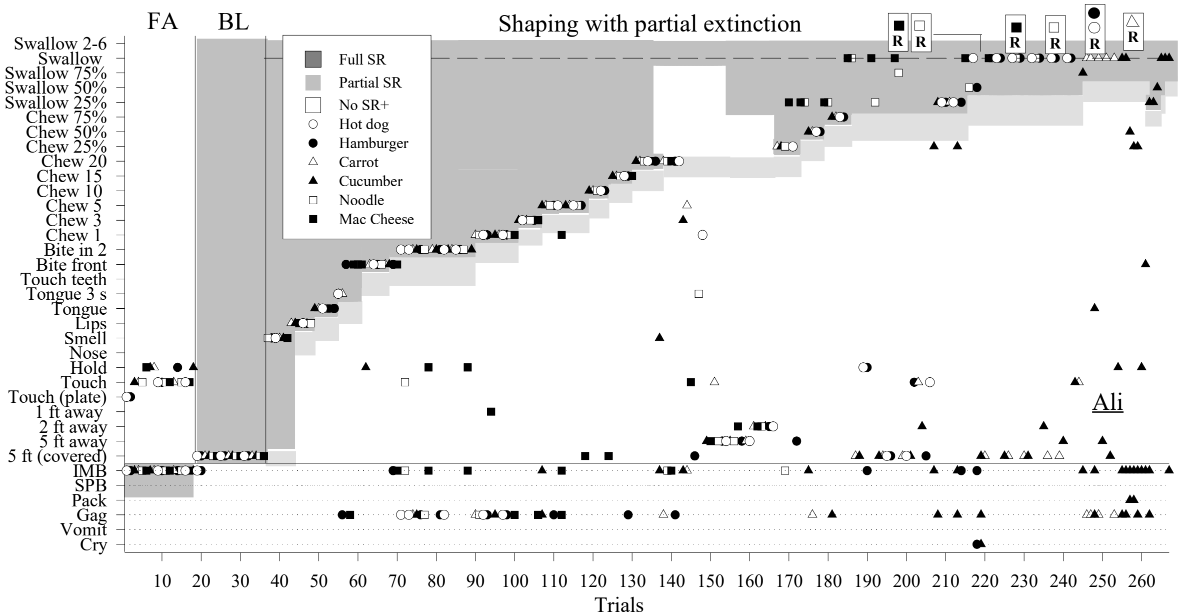


Figure 9. Results from bite shaping and duration of time spent in the hang out context during bite shaping treatment phase for Ali. R and corresponding data point denote when that food was removed from the bite shaping phase of treatment. Horizontal dotted line represents terminal criterion of consumption. SR = reinforcement.

Supporting Information 1-- Screening Tool

Child's Name: ______________________ Date: ____________________ Male / Female

Respondent: ___________________ Respondent's relation to child: _______________________

His/her date of birth and current age: ____-____-____ ____ yrs ____ mos

His/her current height and weight: ____ ft ____ in ____ lbs

Please respond to the following yes/no and short answer questions. If you need more space, continue on page 2 of this form.

1. Is your child a highly selective or picky eater? **Y / N** *If yes, how so?*
2. Does your child exhibit problem behavior during meals (e.g., push food away, protest, cry, etc.)? **Y / N** *If yes, please explain.*
3. Does your child consume all calories by mouth? **Y / N** *If no, please explain (e.g., some or all meals delivered by gastrostomy or nasogastric tube feedings).*
4. Is there any identified medical explanation for your child's selective eating? **Y / N** *If yes, please explain.*
5. Please describe any interactions with medical professions related to your child's eating problems (e.g., pediatrician, GI specialist, nutritionist, etc.).
6. Has your child had an oral-motor evaluation? **Y / N** *If yes, please explain. Did s/he have positive results from a swallow study?*
7. Has your child had a nutrition evaluation? **Y / N** *If yes, please explain.*
8. Please list all of your child's medical diagnoses related to and not related to eating problems.
9. What medications does your child take currently (daily or as needed)?

10. Has your child undergone a food allergy exam? **Y/N** Please list all known food allergies:

Name 10 of your child's favorite foods.

1. ______________________________ 6. ______________________________
2. ______________________________ 7. ______________________________
3. ______________________________ 8. ______________________________
4. ______________________________ 9. ______________________________
5. ______________________________ 10. ______________________________

Name 10 foods that you would most like your child to eat that s/he does not currently eat.

1. ______________________________ 6. ______________________________
2. ______________________________ 7. ______________________________
3. ______________________________ 8. ______________________________
4. ______________________________ 9. ______________________________
5. ______________________________ 10. ______________________________

Additional space if needed:

Supporting Information 2-- Food Preference Survey

Respondent: _______________ Date: _______________ Child's Name: ____________________-

FOOD SELECTIVITY

To identify foods that your child/client does and does not eat, please circle your response (0 to 3) for the following statement: When available, my child will eat this food.

Fruits	**Not sure/No opportunity**	**Never**	**Sometimes**	**Always**	**Place a check here is family DOES NOT eat this food.**
Apple	0	**1**	**2**	**3**	
Avocado	0	**1**	**2**	**3**	
Banana	0	**1**	**2**	**3**	
Blueberries	0	**1**	**2**	**3**	
Cantaloupe	0	**1**	**2**	**3**	
Cherries	0	**1**	**2**	**3**	
Grapefruit	0	**1**	**2**	**3**	
Grapes	0	**1**	**2**	**3**	
Kiwi	0	**1**	**2**	**3**	
Mango	0	**1**	**2**	**3**	
Oranges	0	**1**	**2**	**3**	
Peaches	0	**1**	**2**	**3**	
Pear	0	**1**	**2**	**3**	
Pineapple	0	**1**	**2**	**3**	
Plums	0	**1**	**2**	**3**	
Raspberry	0	**1**	**2**	**3**	
Strawberry	0	**1**	**2**	**3**	
Watermelon	0	**1**	**2**	**3**	

Other fruits consumed by the child:	Top 3 foods you would like your child to eat from this food group: 1.____ 2.____ 3.____
Notes (e.g., specific brands, ways of preparing or combining foods):	

List any known food allergies to any foods above:

Vegetables	Not sure/No opportunity	Never	Sometimes	Always	Place a check here is family DOES NOT eat this food.
Asparagus	0	**1**	**2**	**3**	
Beans	0	**1**	**2**	**3**	
Beets	0	**1**	**2**	**3**	
Broccoli	0	**1**	**2**	**3**	
Bell Peppers	0	**1**	**2**	**3**	
Carrots	0	**1**	**2**	**3**	
Cauliflower	0	**1**	**2**	**3**	
Celery	0	**1**	**2**	**3**	
Corn	0	**1**	**2**	**3**	
Cucumbers	0	**1**	**2**	**3**	
Eggplant	0	**1**	**2**	**3**	
Green Beans	0	**1**	**2**	**3**	
Lentils	0	**1**	**2**	**3**	
Lettuce	0	**1**	**2**	**3**	
Olives	0	**1**	**2**	**3**	
Peas	0	**1**	**2**	**3**	
Pickles	0	**1**	**2**	**3**	
Potatoes	0	**1**	**2**	**3**	
Radish	0	**1**	**2**	**3**	
Spinach	0	**1**	**2**	**3**	
Sweet Peppers	0	**1**	**2**	**3**	
Sweet potatoes	0	**1**	**2**	**3**	

Tomato	0	**1**	**2**	**3**	

Other vegetables consumed by the child:

Top 3 foods you would like your child to eat from this food group:
1.______________________________________
2.______________________________________
3.______________________________________

Notes (e.g., specific brands, ways of preparing or combining foods):

List any known food allergies to any foods above:

Grains, cereals, pastas	**Not sure/No opportunity**	**Never**	**Sometimes**	**Always**	**Place a check here is family DOES NOT eat this food.**
Bread	0	**1**	**2**	**3**	
Cake	0	**1**	**2**	**3**	
Cereal	0	**1**	**2**	**3**	
Corn Bread	0	**1**	**2**	**3**	
Donuts	0	**1**	**2**	**3**	
Egg Noodles	0	**1**	**2**	**3**	
Hot Dog/ Hamburger Bun	0	**1**	**2**	**3**	
Oatmeal	0	**1**	**2**	**3**	
Pancakes	0	**1**	**2**	**3**	
Pita	0	**1**	**2**	**3**	
Ramen Noodles	0	**1**	**2**	**3**	
Rice	0	**1**	**2**	**3**	

Pasta	0	**1**	**2**	**3**	
Tortilla	0	**1**	**2**	**3**	
Waffles	0	**1**	**2**	**3**	

Other gains, cereals, pastas consumed by the child:

Top 3 foods you would like your child to eat from this food group:
1.____
2.____
3.____

Notes (e.g., specific brands, ways of preparing or combining foods):

List any known food allergies to any foods above:

Protein	**Not sure/No opportunity**	**Never**	**Sometimes**	**Always**	**Place a check here is family DOES NOT eat this food.**
Bacon	0	**1**	**2**	**3**	
Chicken	0	**1**	**2**	**3**	
Egg	0	**1**	**2**	**3**	
Fish	0	**1**	**2**	**3**	
Ham	0	**1**	**2**	**3**	
Hamburger	0	**1**	**2**	**3**	
Hot Dog	0	**1**	**2**	**3**	

Lunch Meat	0	**1**	**2**	**3**	
Peanut Butter	0	**1**	**2**	**3**	
Peanuts	0	**1**	**2**	**3**	
Pork Chops	0	**1**	**2**	**3**	
Roast Beef	0	**1**	**2**	**3**	
Sausage	0	**1**	**2**	**3**	
Shrimp	0	**1**	**2**	**3**	
Steak	0	**1**	**2**	**3**	
Tofu	0	**1**	**2**	**3**	
Tuna	0	**1**	**2**	**3**	

Other proteins consumed by the child:

Top 3 foods you would like your child to eat from this food group:
1.____
2.____
3.____

Notes (e.g., specific brands, ways of preparing or combining foods):

List any known food allergies to any foods above:

Dairy	**Not sure/No opportunity**	**Never**	**Sometimes**	**Always**	**Place a check here is family DOES NOT eat this food.**
Cottage cheese	0	**1**	**2**	**3**	

Cheese	0	**1**	**2**	**3**	
Cheese spread	0	**1**	**2**	**3**	
Flavored milk	0	**1**	**2**	**3**	
Frozen Yogurt	0	**1**	**2**	**3**	
Ice Cream	0	**1**	**2**	**3**	
Pudding	0	**1**	**2**	**3**	
Milk	0	**1**	**2**	**3**	
Yogurt	0	**1**	**2**	**3**	

Other dairy products consumed by the child:

Top 3 foods you would like your child to eat from this food group:
1.____
2.____
3.____

Notes (e.g., specific brands, ways of preparing or combining foods):

List any known food allergies to any foods above:

Misc. Beverages. Junk foods.	Not sure/No opportunity	Never	Sometimes	Always	Place a check here is family DOES NOT eat this food.
Applesauce					
Cheeseburger	0	**1**	**2**	**3**	
Candy	0	**1**	**2**	**3**	
Chili	0	**1**	**2**	**3**	
Chips	0	**1**	**2**	**3**	
Cookies	0	**1**	**2**	**3**	
Corn Dogs	0	**1**	**2**	**3**	
Crackers	0	**1**	**2**	**3**	
French fries	0	**1**	**2**	**3**	
Grilled cheese	0	**1**	**2**	**3**	
Jello	0	**1**	**2**	**3**	
Lasagna	0	**1**	**2**	**3**	
Macaroni and Cheese	0	**1**	**2**	**3**	
Peanut Butter and Jelly	0	**1**	**2**	**3**	
Pie	0	**1**	**2**	**3**	
Pizza	0	**1**	**2**	**3**	
Pretzels	0	**1**	**2**	**3**	
Quesadilla	0	**1**	**2**	**3**	
Soup	0	**1**	**2**	**3**	
Apple juice	0	**1**	**2**	**3**	
Orange juice	0	**1**	**2**	**3**	
Flavored Water	0	**1**	**2**	**3**	

Other foods not listed consumed by the child:	Top 3 foods you would like your child to eat from this food group:

1.____
2.____
3.____

Notes (e.g., specific brands, ways of preparing or combining foods):

List any known food allergies to any foods above:

Supporting Information 3-- Open-Ended Interview for Mealtime Problem Behavior

Developed: October, 2016
Developed by Holly Gover, M.S., Juliana Marcus, M.S., BCBA, Kelsey Ruppel, M.S., BCBA, and Gregory P. Hanley, Ph.D., BCBA-D

Date of Interview: ____________________

Interviewer: _________________________

Child/Client: ________________________

Respondent/relation to child/client: _____________

RELEVANT BACKGROUND INFORMATION

1. **His/her date of birth and current age: ____-_____-_________ ____yrs ____mos Male/Female**
2. **Describe his/her language abilities.**

QUESTIONS TO INFORM THE DESIGN OF A FUNCTIONAL ANALYSIS AND TREATMENT
(a-c offer optional follow-up questions if not all desired information was obtained)

To get an overview of mealtime challenges (subsequent questions may be answered during this initial overview)

3. **Please describe the challenges your child has with eating.**

To develop objective definitions of observable problem behaviors:

4. **What does your child do when s/he is offered food s/he doesn't want to eat?**
   a. **How does s/he tell you s/he doesn't want to eat?**
   b. **What happens if that doesn't work?**
   c. **What does that look like? Intensity?**

To assist in identifying precursors to dangerous problem behaviors that may be targeted in the functional analysis instead of more dangerous problem behaviors:

5. **Does (behaviors identified in #4) tend to occur in bursts or clusters and/or does any type of problem behavior happen before another type of problem behavior (e.g., will s/he yell before throwing something)?**

To determine the antecedent conditions that may be incorporated into the functional analysis test conditions:

6. **What is most likely to trigger (behaviors identified in #4) during mealtimes?**

   a. **Specific foods?**
   b. **Specific mealtime requests?**

7. **Does your child have any specific mealtime routines or preferences that, when interrupted or not available, cause (behaviors identified in #4)?**
   a. **Specific food preparation?**
   b. **Specific brands of food?**

To determine the test condition(s) that should be conducted and the specific type(s) of consequences that may be incorporated into the test condition(s):

8. **What do you do when s/he (behaviors identified in #4) during a meal? How do you and others react or respond?**
   a. **What do you and others do to calm her/him down once s/he (behaviors identified in #4)?**
   b. **Do you have any special tricks to get her/him to eat during mealtimes?**

In addition to the above information, to assist in developing a treatment using synthesized reinforcers:

9. **What are your child's favorite foods that are sometimes consumed at or following meals?**
10. **What are your child's favorite toys or activities?**
11. **What foods would you most like your child to eat that s/he does not currently eat?**