**Response Shaping to Improve Food Acceptance for Children with ASD:
Effects of Small and Large Food Sets**

Virginia R. Turner (virginia.r.turner@vanderbilt.edu)
Jennifer R. Ledford (jennifer.ledford@vanderbilt.edu)
Anne K. Lord (anne.k.lord@vanderbilt.edu)
Emilee R. Harbin (chelleharbin1@gmail.com)

Vanderbilt University, Peabody Box 228, Nashville TN 37203

Jennifer R. Ledford (jennifer.ledford@vanderbilt.edu) will serve as corresponding author throughout the publication process.

Abstract

Background: Food selectivity, characterized by food refusal, limited food repertoire, or preference for certain types of foods, is common among children with ASD. **Method:** In this study, researchers examined the effects of a response shaping procedure using a large rotating food set and a small constant food set on food acceptance for two boys with ASD. The small set consisted of three foods that were presented during every session; the large set consisted of 15 foods, of which three were presented during each session, in randomly ordered sets. Researchers measured the percentage of correct behaviors and the cumulative number of foods with which participants interacted. Two concurrently operating multiple baseline across behaviors designs were used to assess whether the shaping procedure resulted in increased correct responding compared to baseline conditions, and whether the intervention was differentially effective with large versus small food sets. **Results:** The procedures were similar in efficiency for one participant, although he ate many more foods in the large set condition. For the other participant, shaping was successful at increasing some acceptance behaviors (e.g., putting food in his mouth) but only the small set resulted in eating a new food. **Conclusions:** Practitioners should consider use of less restrictive or intrusive interventions to promote food acceptance and the use of larger sets of foods, modified to include fewer foods in the case of poor response to intervention.

Keywords: feeding, food acceptance, food selectivity, ASD, shaping, single case design

Response Shaping to Improve Food Acceptance for Children with ASD: Effects of Small and Large Food Sets

Many children with ASD exhibit *food selectivity*, characterized by food refusal, limited food repertoire, or high-frequency single food intake (Bandini et al., 2010; Ledford & Gast, 2006; Twachtman-Reilly, Amaral, & Zebrowski, 2008). Children who do not consume appropriate amounts of nutrients or calories may be at increased risk for delays in other areas (Volkert & Piazza, 2012). Additionally, food selectivity can cause stress for caregivers (Greer, Gulotta, Masler, & Laud, 2007), as it is often associated with disruptive and problematic behavior during mealtimes (Curtin et al., 2015; Sharp, Jaquess, Morton, & Herzinger, 2010). Contemporary recommendations include early treatment of even mild selectivity to reduce these related child- and family-level concerns (Kerzner et al., 2015).

A recent review found that more than half of studies designed to assess treatments of mealtime behaviors for individuals with autism utilized restrictive procedures or included requirements to remain in a specified area or complete a task (Ledford, Whiteside, & Severini, 2018); this was consistent with results from an earlier review (Ledford & Gast, 2006), although no analysis of time trends was conducted. In addition, reviews of the literature have suggested that the majority of studies included treatment packages comprised of multiple intervention components (Ledford et al., 2018; Seiverling, Kokitus, & Williams, 2012). Thus, much of the evidence for reducing food selectivity includes interventions that are complex, restrictive and potentially aversive in nature.

A common procedure for improving food selectivity is escape extinction. When this procedure is used, implementers purposefully fail to reinforce a child's challenging behavior (e.g., food refusal) by removing the eating demand; instead, they continue presenting the demand until the child has eaten (Kodak & Piazza, 2008). Two common procedures associated with escape extinction for food-related problem behavior are non-removal of the spoon (NRS) and re-presentation of expelled foods (RP); these two procedures are often used in tandem. That is, an implementer holds food at or near a child's mouth until the bite is taken (NRS), and the implementer scoops and re-presents foods that are spit out (RP).

Escape extinction may result in sessions that are much longer than a typical meal or snack and/or may involve restricting a child's freedom (e.g., restraining the child in a chair or otherwise preventing them from leaving the table). Thus, it may be most appropriate when other, less intrusive interventions, are not effective or when mealtime problems are severe and threaten the child's health and well-being. Because use of escape extinction interventions should involve a functional analysis to confirm an escape function, as well as specially trained implementers, they may also be inaccessible or unacceptable for families, especially families of children who do not have concomitant, related medical concerns (e.g., reliance on tube feeding or severe challenging behavior; Ledford et al., 2018).

Because intrusive interventions such as escape extinction may not be feasible or acceptable in some situations, less intrusive interventions are needed. One such intervention that has been used to improve food acceptance is response shaping. This procedure involves requiring successive approximations to a terminal target behavior (eating), while the form of the stimulus (i.e., the food), remains constant. To date, only a few studies have utilized shaping procedures to treat food selectivity for children diagnosed with ASD (Hodges, Davis, Crandall, Phipps, & Weston, 2017; Koegel et al., 2012; Penrod, Gardella, & Fernand, 2012; Valdimarsdottir, Halldorsdottir, & Sigurdardottir, 2010). One used shaping in conjunction with escape extinction (Valdimarsdottir et al., 2010), and one (Koegel et al., 2012) did not meet

contemporary standards for outcomes assessment in the recent Ledford et al. (2018) review. The other two studies each targeted consumption of four different non-preferred foods per participant, with foods presented simultaneously (Penrod et al., 2012) or sequentially (Hodges et al., 2017), and in the absence of intrusive procedures such as NRS and RP. Participants in the study using simultaneous targeting of four foods (Penrod et al., 2012) reached mastery of eating the criterion amount of the four target foods in approximately 30-40 intervention sessions, which is similar to the number of measurement occasions to criterion for one of two participants in the study using sequential introduction (Hodges et al., 2017; the other participant required approximately 70 intervention sessions). Neither study reported average duration of measurement occasions although one reported an approximate duration of 10 minutes (Penrod et al., 2012); given 30-40 treatment sessions, the total treatment time would have been approximately 5-6.5 hours, or about 75-90 min per food type. Neither simultaneous or sequential presentation of a small set of foods is likely to closely mirror typical family routines, which may involve eating a consistently different array of foods for each meal rather than one set of specific foods. However, research has not yet determined whether repeated introduction of consistent foods in sequential sessions is a necessary component of these shaping interventions.

Given the relatively sparse evidence, it is not clear whether using small, constant food sets or large, varying food sets is likely to be more efficient when shaping procedures are used. The purpose of this study is to evaluate the use of a shaping package (including modeling and prompting) for improving food acceptance for young children with autism, while comparing presentation of small, constant food sets versus large, rotating food sets. The research questions are as follows: (1) Does a shaping package result in increases in acceptance behaviors (touch, taste, lick, leave in mouth, eat) for small and large food sets? (2) Does a shaping package with a large set result in faster acquisition or a larger repertoire of foods accepted given a similar amount of intervention time, compared to the same package with a small set? (3) Do behavioral staff report that using large food sets to treat food selectivity is more feasible than small sets? (4) Do acquired behaviors generalize when the participant's regular therapist acts as the implementer?

Methods

All procedures performed were in accordance with the ethical standards of the university institutional review board and with the Helsinki declaration as revised in 2000. Informed consent was obtained from parents. Daily assent was assessed for by reading an assent script and waiting for a verbal or non-verbal affirmative response. If dissent occurred (e.g., attempting to escape the area), researchers waited a short time and asked again. If dissent occurred multiple times for a single session, that session was not conducted. Provisions were made to remove a participant from the study in the case of consecutive dissents across days, but this did not occur. Two participants were recommended by the partnering agency, recruited, screened, and participated in the study; no other participants were recruited.

Participants

Two White boys with Autism Spectrum Disorder (ASD) participated in the study. Both participants demonstrated food selectivity, based on parent report (questionnaire modified by Harbin, 2016, from Lukens & Linscheid, 2008). Additional inclusion criteria were: a) diagnosis of ASD and age between 2.5 and 8 years, b) receipt of behavioral services in home or clinic, c) self-feeding, and d) followed one-to-two step directions. Children were excluded from the study if they had a medical condition associated with eating, vision or motor impairment, or if they were currently receiving related treatment. ASD diagnoses were verified via parent report; both

participants received a diagnosis independent of current research and the clinic where they were receiving services.

Brian turned 6 years old during the course of the study. He received services based on the science of applied behavior analysis (ABA) five days per week in a clinic, in individual and small group arrangements. Brian communicated verbally and by using an iPad with the Proloquo2Go application. He engaged in communicative interactions with both words and the iPad for a variety of functions such as greeting, requesting and commenting. Brian's mother indicated he was often unwilling to try new foods, often disliked certain foods, often preferred crunchy foods, and often preferred only sweet foods. She identified opportunities to play games on an iPad, M&Ms®, pretzels and Cheez-Its® as potential reinforcers.

Carl also turned 6 years old during the course of the study. He received ABA services four days per week in the same clinic setting as Brian, in individual and small group arrangements. Carl's mother indicated that he often disliked certain foods and would not eat them, he often preferred crunchy foods, and often preferred starchy foods. She indicated that he had approximately nine months of previous feeding therapy for gagging and vomiting at the presentation of foods. Carl's therapists reported that he still gagged when other people ate non-preferred foods near him. Carl's mother identified opportunities to play games on an iPad, Oreos®, Rice Krispies®, chips, and toy globes as possible reinforcers.

Based on parent report, both participants had diets that consisted of processed foods, meats, and carbohydrates. Neither participant consumed vegetables, with the exception of potatoes, and only one participant consumed some fruits.

Settings and Implementers

All study sessions took place in a clinic located in a metropolitan area in the southeastern United States. Sessions occurred in participants' regular, individual therapy rooms as well as a larger, central therapy room. All rooms included a small table and two chairs. For the majority of sessions, the researcher, participant, and the participants' regular therapist were present. For some sessions, additional clinic personnel were also present. The primary implementer (hereafter: researcher) for this study was a 23-year-old White female graduate student studying early childhood special education and ABA. Generalization implementers were two White females in their late twenties employed by the clinic and who regularly worked with Brian.

Materials

Sessions were recorded using a Canon Vixia Mini camera. Data were collected using a paper data collection form. Target foods were selected based on caregiver input via a researcher-developed form (Harbin, 2016). A variety of non-preferred foods were present in screening, baseline, generalization and intervention sessions (see Table 1). Highly preferred foods were available as reinforcers. Colored plates were used to indicate to the participant which food set would be present (blue indicated small, constant set and green indicated large, rotating set). The researcher provided and prepared bite-sized portions for all sessions and placed them in small disposable cups (147 mL).

Response Definitions and Measurement Systems

Dependent variables were the percentage of trials with correct responses, number of bites eaten, and cumulative number of acceptance behaviors. Behaviors were targeted in the same sequence for both sets. The original sequence was: 1) touching, 2) tasting, 3) licking, and 4) eating (definitions in Table 2). Two modifications were made: For Brian, no intervention was implemented for licking since intervention for taste resulted in changes in both tasting and licking—he put the food inside his mouth, which met criteria for licking. For both participants,

initial lack of success in the eat condition resulted in the addition of another tier—putting food in the mouth for a designated amount of time (touching a number line with the numbers 1–3 or 1–6 with food in the mouth). Data were collected using trial-based event recording, with primary data collected in vivo and reliability data collected via video recordings. Behaviors lower in the sequence than the target behavior were marked as correct (e.g., if a participant *licked* the food, *touch* and *taste* were scored as correct).

Experimental Design

Researchers used two concurrently running multiple baseline designs (MBD) across behaviors for each participant (Ledford & Gast, 2018). The simultaneous and concurrent use of MBDs was similar to the use of a parallel treatment design (PTD), in which successive condition changes occur simultaneously (i.e., the move from the first to the second tier would have happened at the same time for both interventions/food sets). It was different because decisions about moving between tiers were made based on responses during each condition. Visual analysis was conducted regarding whether the percentage of trials in which the behavior occurred changed when and only when intervention commenced for that behavior. A changing criterion design (Hartmann & Hall, 1976) was used during the final ‘eat’ tier because it was expected that this behavior would change in a slow, stepwise manner, in alignment with the consistently increasing criteria. The criterion for number of pieces eaten was systematically increased (e.g. 1, 2, 3, 5, 7, 10). Based on this design, visual analysis was conducted regarding whether the number of bites taken by the participant changed when and only when criterion changes occurred.

To answer the comparison question, an adapted alternating treatments design (AATD; Sindelar, Rosenberg, & Wilson, 1985) was used to assess food acceptance for the small and large sets. Visual analysis was conducted regarding whether cumulative number of foods with which participants interacted differed across conditions. We note that the maximum cumulative number of foods was much larger (15) for the large set compared to the small set (3); however, it would have been possible for a participant to choose a relatively small number of foods from the large set or to master all behaviors more quickly with the small set and move on to a second small set, resulting in increases in the possible cumulative number of foods. We also note that typical use of an AATD requires that the sets are equivalent in difficulty to determine which procedures are more effective (Ledford & Gast, 2018); given the procedures were the same, the comparison determined which *food set* resulted in greater behavior change.

Procedures

Sessions occurred twice per day; once per day for each condition (e.g. one session with the small food set and one session with the large food set). During intervention conditions, two different “interventions” were employed—the procedures for each condition were identical, except that in one condition, the researcher presented the same three foods every session (small set), and in the other condition, the researcher presented three of 15 total foods (large set; each food presented approximately once every fifth session). Each week, foods for the large condition were randomly organized into five groups of three and one randomly assigned group was used in each session. Order of conditions was randomly selected each day. Sessions included 10 trials, except the ‘eat’ condition, which consisted of a single trial, with gradually increasing criteria for number of bites eaten.

Mastery criteria increased with increasing difficulty of behaviors in the sequence (determined a priori). For touch, taste, and lick, mastery criteria were 100% correct responding across two, three, and four consecutive sessions (respectively). For Carl, three sessions at 100%

for touch were conducted to establish stability due to an extended absence after two sessions at 100% (for large and small food sets). For mouth, mastery criteria were 100% correct responding across five consecutive sessions for “touch 1, 2, 3” and five additional sessions for “touch 1, 2, 3, 4, 5, 6”. After 100% correct responding for the ‘eat’ behavior across three consecutive sessions, the researcher increased the number of pieces of food by one to three pieces. Participants reached mastery criteria for *eat* when they ate 10 pieces of food for three consecutive sessions.

Screening. For each participant, a list of 18 foods was compiled and randomized into groups of 3-4. The researcher read the assent script (e.g. “Today we are going to practice trying new foods!”), obtained assent, presented food choices to the participant, stated the food name, and told the participant to choose one. Once the participant selected a food, the researcher placed one piece of the food on a white paper plate and said, “try this”. If the participant engaged in any of the target behaviors, the researcher provided brief verbal praise (e.g. “good job!”) and moved to the next trial. If the participant did not engage in any of the target behaviors, the researcher waited 10 s and moved to the next trial. During all 10 trials, the researcher provided brief verbal praise for other appropriate behaviors (e.g., sitting). After screening, the researcher randomly assigned non-preferred foods to large or small sets. Three foods were randomly assigned as a second small set in case acquisition of eating behaviors occurred more quickly in that set than in the large set.

Baseline. During baseline sessions, three foods from the small set or three randomly selected foods from the large set were presented. Baseline procedures were identical to screening procedures; the researcher read the script, obtained assent, presented and labeled foods, requested the participant pick one, and provided 10 opportunities for the participant to engage in acceptance behaviors.

Intervention. In both intervention conditions, the researcher began the session by reading a script and obtaining assent. Then, she presented and labeled two or more reinforcer choices (e.g. “Do you want to work for X or X? Pick one.”). Following selection, she provided a verbal contingency review (e.g. “If you (target behavior) the food on the plate, you can have X!” or “First (target behavior) the food on the plate and you can have X!”) The researcher then presented three foods, labeled each, and instructed the participant to select one. After the participant chose a food, she removed other foods and placed one piece of the selected food on the plate and said, “You can (target behavior) the food just like this!” and modeled the target behavior. Then, she gave the directive, “Ok, (target behavior) the food!”

For each trial, the researcher waited up to 10 s after delivering the directive. If the participant engaged in the target behavior during that interval, the researcher delivered high quality social praise and said, “Great job (target behavior)-ing the food! You get an X!” and gave the participant his reinforcer. If the participant did not engage in the target behavior after 10 s, the researcher said, “You can (target behavior) just like this” and picked up the food and touched it to the participant’s hand (if the target behavior was touch) or to his mouth (if the target behavior was taste, lick, mouth, or eat). Thus, the participant was not required to engage in any behavior, but for some behaviors (touch, taste), this might be considered escape extinction because the food touched the relevant parts of the participant’s body. Finally, the researcher offered brief social praise for appropriate behavior and moved to the next trial.

All procedures for the *eat* target behavior conditions were the same except there was only one trial and that the researcher re-modeled eat following the initial 10 s interval if the participant had not completed the behavior. During this condition, the researcher put all required pieces on the plate at the same time (for rice, one ‘piece’ was measured using a ¼ teaspoon

portion). The participant had to consume all pieces of food on the plate before receiving all reinforcers.

Intervention Two. Because Carl's responding was variable and the researcher observed gagging and one incident of vomiting, original intervention procedures were discontinued. This break began after session 69; during the break, the researcher implemented "eat" session procedures with only highly preferred foods for seven sessions. Once Carl had consistently engaged in the "eat" target behavior with preferred foods, the researcher began the revised intervention protocol (Intervention Two). First, she targeted the mastered initial acceptance behaviors with non-preferred foods, starting with "touch" using only foods from the small food set. Then, a changing criterion was implemented for *eat* behaviors—but only rice (the single consumed food to this point) was offered. Due to unexpected time constraints and given that Carl had only consumed food in the small food set condition, the large food set condition was discontinued.

Generalization. During baseline conditions, two sessions were implemented by participants' regular therapist using baseline procedures. Following terminal mastery of the 'eat' behavior for Brian only, his regular therapist acted as implementer for two post-test generalization sessions. In the first, the food from each condition that was selected the most was presented. In the second, two non-targeted foods that the caregiver indicated the participant did not eat were assessed. In both sessions, the therapist presented food options, provided a contingency review, offered a choice, and instructed the participant to eat 10 bites in order to earn reinforcers.

Interobserver Agreement and Procedural Fidelity

Reliability and fidelity data were collected via video recordings by a master's student for 33-39% of sessions for each implementer, condition, behavior, and participant (Barton, Meadan, & Ledford, 2018; Ledford, Lane, & Gast, 2018). The researcher conducted and videotaped mock baseline and intervention sessions with a non-participant and trained the secondary observer to collect data using these videos. She explained the operational definitions of each behavior and steps of implementation, provided tables with definitions, and coded the first video alongside the secondary observer. Additional videos were coded independently until agreement was 95% or greater for both reliability and fidelity. For fidelity, the data collector indicated if the following set up behaviors occurred in each session: used correct materials, had correct foods, provided choice of reinforcer, and delivered contingency review. The data collector also indicated if the following behaviors occurred in each trial: secured attention, presented stimulus, presented direction, provided wait interval, gave praise, delivered reinforcement, provided corrective model if needed. Agreement calculations and results are reported in Table 3. Fidelity was low (81%) for one session, in the final "eat" tier of the large set for Brian. In this session, the researcher provided Brian with praise and preferred edibles after he exclaimed, "I did it!". After she presented the edible reinforcers, Brian removed the piece of target food from his mouth. After he ate the reinforcers, however, he re-inserted the target food into his mouth and ate it. Following this session, the researcher began asking Brian to open his mouth following each trial to check for consumption.

Social Validity

Following the study, the researcher provided six local BCBAs with a questionnaire including descriptions of conditions. BCBAs were asked to report which intervention they would be more likely to use—shaping with a small or large number of foods. Additionally, following

the completion of the study, caregivers of participants were asked to complete a short questionnaire related to the goals and effects of the intervention.

Results

Researchers visually analyzed two sets of graphs for each participant, to separately answer research questions regarding effectiveness in comparison to baseline (Figures 1 & 2) and relative effectiveness of small and large sets (Figure 3). MBDs across behaviors for each food set condition, including the changing criterion design in the final “eat” tier were used to determine the effectiveness of the shaping package for improving food acceptance behaviors. Cumulative records for each intervention condition were used to assess differences in the number of foods that each participant interacted with across intervention conditions.

Brian

Acquisition. During all three baseline sessions across both food set conditions and implementers, Brian exhibited 0% correct responding (Figure 1) For the first four intervention tiers across both intervention conditions, levels of behavior changed when and only when intervention was implemented, with mastery level responding occurring nearly simultaneously across both conditions. In the “eat” target behavior tier, change in behavior was delayed, but after the delay, the level of behavior closely corresponded to the set criterion. Brian reached terminal mastery criteria of eating 10 pieces of food for three consecutive session after 60 intervention sessions for the small set and 61 intervention sessions for the large set.

Number of foods interacted with. As shown in Figure 3, in the small food set condition, Brian interacted with a total of two foods. This included touching, tasting, licking, inserting in mouth, and eating both pasta and egg. In the large food set condition, Brian interacted with a total of 10 different foods. This included touching, tasting, licking, inserting in mouth, and eating all 10 foods. Sessions for the small set were an average of 3 min, 48 s in duration and were an average of 3 min, 13 s in duration for the large set. Thus, he reached criterion in both conditions given less than a total of 4 hours of treatment time. In the small set condition, this translates to less than two hours of treatment time per food eaten; in the large set condition, it translates to less than 20 minutes of treatment time per food eaten.

Generalization. Two pre-intervention and two post-intervention generalization sessions were conducted by Brian’s regular therapists following designated baseline or intervention (*eat*) procedures. During the baseline session (conducted with the three foods from the small set or three randomly selected foods from the large set), Brian did not engage in any target behaviors. During the first post-intervention session (conducted using the most frequently chosen target food from each condition—egg & dried pineapple), Brian selected dried pineapple and ate 10 bites. For the second generalization session, Brian was offered a choice of two foods not included in either set (blueberry and yellow bell pepper). He selected blueberry and ate 10 bites.

Carl

Acquisition. As shown in Figure 2, during all four baseline sessions in the small food set condition, Carl did not engage in any of the target behaviors. During the first baseline session in the large food set condition, Carl engaged in 70% touch, as he pinched a raisin between his thumb and index finger for seven out of the ten trials in this session. Following this session, Carl engaged in 0% correct responding for all target behaviors across the remaining three baseline sessions. In the first two tiers, “touch” and “taste”, Carl exhibited high and stable responding across both food sets. During the third tier, the “lick” target behavior condition, Carl engaged in high and stable responding in the large food set condition and reached mastery criteria in four sessions. For the small food set condition, Carl exhibited relatively high rates of correct

responding, but data were slightly more variable (70-100%); he reached mastery criteria in nine sessions. For the fourth tier, “mouth” Carl exhibited variable responding in both food set conditions. Carl reached mastery criteria for the “mouth” tier in the small food set condition in 33 sessions and in the large food set in 36 sessions. In the “eat” target behavior tier, Carl exhibited 0% eat across all sessions in the large food set condition. In the small food set condition, Carl exhibited 0% correct responding for nine consecutive sessions. Following this, Carl exhibited variable responding consuming one or zero bites of rice. Rice was the only food that Carl chose to eat during the initial “eat” target behavior sessions.

During the intervention modification (Intervention Two), Carl exhibited 100% correct responding for all sessions and consumed 10 bites of rice after a total of 79 intervention sessions. This condition was abbreviated compared with planned procedures and Carl did not reach mastery criterion of three sessions with 10 bites because researchers were informed that the participant and his family were taking an extended trip out of the country.

Number of foods interacted with. As shown in Figure 3, Carl interacted with all three foods assigned to the small set. This included touching, tasting, licking and inserting in mouth all three foods. Rice was the only food out of the three in this food set that Carl ate. Carl interacted with a total of 14 different foods from the large set. This including touching, tasting, licking and inserting in mouth all 14 foods. The only food that Carl did not interact with was cucumber. Carl did not eat any of the foods in the large set. Carl’s sessions were longer than Brian’s, but nearly the same length across sets (small set average = 6 min, 41 s; large set average 6 min, 44 s). Thus, Carl’s total treatment time in the condition leading to mastery (eating one food) was approximately 9 hours.

Social Validity

The parent questionnaire included a rating of the successfulness of the intervention on a scale of 1-10 (1 being the least successful- “my child is just as picky as they were before and 10 being the most successful- “my child is not picky anymore”) and were asked what they wished had been done or done differently. Brian’s parents rated the success as a ‘9’ and did not report any suggestions for improvement. They indicated that Brian was trying new foods at home following completion of the intervention. Carl’s parents rated the success as an ‘8’ and reported that they would have liked feedback during the intervention in order to work on the same foods at home. They indicated that Carl was more willing to try new foods following the intervention and that his gag reflex was reduced. The BCBA questionnaire was a forced choice between the conditions. Two BCBA’s reported that they considered a small food set and four reported that they considered a large food set to be more feasible.

Discussion

A response shaping package was used to improve food acceptance for two differently-sized food sets on the food acceptance of two young boys with ASD. One participant, Brian, achieved terminal mastery criteria in a total of 60 sessions for the small food set and 61 sessions for the large food set. Throughout the course of the study, Brian interacted with and consumed a total of 11 different targeted foods and 1 non-targeted generalization food. The other participant, Carl, interacted with a total of 17 foods throughout the course of the study but ate only one type of food in the small set after 79 sessions.

Limitations

Results of the study should be interpreted in light of several limitations. First, variability in success was considerable. One participant ate many different foods with an average time per food eaten of less than 20 min, while one participant ate one food given approximately 9 hours of

intervention. This is consistent with variability in other studies assessing effects of shaping (e.g., Hodges et al., 2017) and more intrusive interventions (e.g., Peterson, Piazza, & Volkert, 2016). Secondly, multiple procedural variations were implemented, including combining interventions for two tiers (taste and lick) for one participant, adding an additional unplanned tier for both participants, and implementing a modified intervention following an instance of vomiting. These procedures were conducted to maintain the nature of the intervention (e.g., gradually increasing behaviors not yet in a participant's repertoire) and to reduce intrusiveness and potentially aversiveness. Third, it often took Carl a considerable amount of time (e.g., 1 min) to choose a food at the beginning of sessions. This might indicate his eventual selections were not meaningful indications of relative preference. Finally, researchers discontinued the large set condition while continuing the (modified) small set condition for the final 12 sessions. It is possible that continuing the large set condition would have resulted in behavior change for that condition. We only assessed generalization for one participant and only across a different implementer and one non-targeted food; we did not formally assess whether acceptance improved with untrained implementers in different contexts (e.g., families in homes). Finally, although behavior change occurred at three different points in time, consistent with contemporary single case standards, there was also covariation for two tiers in the MBD. Additional research is needed to inform selection of shaping behaviors to avoid covariation while also preventing non-response that occurs when selecting steps that are too discrepant. We do not believe observed covariation impacts the comparative conclusions drawn, given the covariation was consistent across food sets.

Implications

Because little research exists on the effects of less intrusive interventions to treat mild to moderate food selectivity (Ledford et al., 2018), the purpose of this study was to assess a less-intrusive intervention in the form of a shaping package, and to compare effectiveness when the procedure was implemented with two different variations (i.e., with small versus large sets). This shaping package included targeting a series of acceptance behaviors, modeling and prompting the behaviors using non-restrictive means (e.g., without touching the participant), and reinforcing those behaviors with highly-preferred edibles. It may have provided less aversive opportunities for the participants to engage with nonpreferred foods compared with techniques such as escape extinction for consumption. This intervention was successful for both participants, in that at least one new food was consumed at mastery levels. However, "success" was quite different for the two participants, with one participant interacting with and consuming many more foods than the other. Moreover, results were different in that, for one participant, the large set resulted in a more efficient intervention (i.e., more foods consumed in the same amount of time), while for the other, only the variation with the small food set was effective.

Researchers incorporated several components designed to improve ecological and social validity and to increase generalizability to children unlikely to access high-intensity services (e.g., in clinics or hospitals). All sessions were conducted in a clinic where the participants received daily instruction and did not include intrusive or restrictive procedures, such as escape extinction for consumption. Additionally, researchers requested caregiver input and incorporated foods identified by the parents as those they wanted their child to learn to eat.

There are several potential differences that might explain participants' differential responses to intervention. Carl had previously engaged in an feeding therapy program while Brian had no history with interventions designed to improve food acceptance. This history may have impacted the effectiveness of the shaping package and/or responsiveness to small versus

large sets of foods. Clinic staff reported that Carl had a highly caloric breakfast each day prior to intervention sessions and that non-compliance was a common challenging behavior—neither of these was true for Brian. Given these characteristics, it is possible Carl needed a more intensive (but not necessarily intrusive) treatment. Conducting more frequent sessions (i.e., at every meal and snack) may have been beneficial and resulted in more efficient behavior change. Moreover, attempts to change behavioral patterns and alter motivating operations may have increased effectiveness. For example, choices regarding whether to receive his favorite high caloric breakfast contingent on trying non-preferred foods or a lesser-preferred breakfast with no response requirement may have resulted in faster acquisition. Additional research is needed to determine participant characteristics that influence success and procedural variations for increasing effectiveness.

Results indicate that a less intrusive shaping package can be successful in treating food selectivity. Using different sized food sets allowed participants to be exposed to and interact with a large number of foods. One participant ate 12 different foods over the course of intervention; the rate of foods eaten per intervention session exceeds those from studies that used small food sets (Harbin, 2016; Hodges et al., 2017; Penrod et al., 2012). Thus, using large food sets while providing opportunities for participant choice may improve the efficiency of intervention. However, Carl's data suggest that, for some children, smaller sets may be warranted; future researchers should attempt to identify for which participants larger sets are likely to be effective and efficient. In addition, while a set of randomly selected and randomly ordered foods is somewhat more typical than presenting a single food or food set, additional research is needed to determine whether this finding is generalizable to sets of purposefully ordered foods chosen based on typical family meals (e.g., spaghetti with sauce, beans with rice).

Anecdotally, Brian's mother reported he started trying new foods at home at the conclusion of the study. She also reported packing foods that Brian consumed during this study in his lunchbox. The researcher anecdotally noted that icons for several foods from the study were added to his iPad to allow for him to request those items. Carl's regular BCBA discussed continuing treatment with him during regular therapy or lunch times. Although anecdotal, these details demonstrate potentially socially valid outcomes.

Conclusions

This study demonstrated the effectiveness of a non-intrusive response shaping package for increasing acceptance behaviors for two young participants with autism, although the optimal intervention variation was different across participants and BCBA preference for procedure was mixed. Additional research is needed including a larger and more heterogeneous group of participants. However, given the initial information from this study, we advise practitioners should consider use of less restrictive or intrusive interventions to promote food acceptance and to consider the use of larger sets of foods, modified to include fewer foods in the case of poor response to intervention.

References

- Barton, E. E., Meadan-Kaplansky, H., & Ledford, J. R. (2018). Independent variables, fidelity, and social validity. In J. R. Ledford & D. L. Gast (Eds.), *Single case research methodology: Applications in special education and behavioral sciences* (3rd ed., pp. 133-156). New York, NY: Routledge.
- Bandini, L. G., Anderson, S. E., Curtin, C., Cermak, S., Evans, E. W., Scampini, R., ... & Must, A. (2010). Food selectivity in children with autism spectrum disorders and typically developing children. *The Journal of Pediatrics*, 157, 259-264.
- Curtin, C., Hubbard, K., Anderson, S. E., Mick, E., Must, A., & Bandini, L. G. (2015). Food selectivity, mealtime behavior problems, spousal stress, and family food choices in children with and without autism spectrum disorder. *Journal of Autism and Developmental Disorders*, 45, 3308-3315.
- Greer, A. J., Gulotta, C. S., Masler, E. A., & Laud, R. B. (2007). Caregiver stress and outcomes of children with pediatric feeding disorders treated in an intensive interdisciplinary program. *Journal of Pediatric Psychology*, 33, 612-620.
- Harbin, E. R. (2016). *Using Shaping and Peer Modeling to Decrease Food Selectivity in Young Children* (Doctoral dissertation, Peabody College of Vanderbilt University).
- Hartmann, D. P., & Hall, R. V. (1976). The changing criterion design. *Journal of Applied Behavior Analysis*, 9, 527-532.
- Hodges, A., Davis, T., Crandall, M., Phipps, L., & Weston, R. (2017). Using Shaping to Increase Foods Consumed by Children with Autism. *Journal of Autism and Developmental Disorders*, 47, 2471-2479.
- Kerzner, B., Milano, K., MacLean, W. C., Berall, G., Stuart, S., & Chatoor, I. (2015). A practical approach to classifying and managing feeding difficulties. *Pediatrics*, 135, 344-353.
- Kodak, T., & Piazza, C. C. (2008). Assessment and behavioral treatment of feeding and sleeping disorders in children with autism spectrum disorders. *Child and Adolescent Psychiatric Clinics*, 17, 887-905.
- Koegel, R. L., Bharoocha, A. A., Ribnick, C. B., Ribnick, R. C., Bucio, M. O., Fredeen, R. M., & Koegel, L. K. (2012). Using individualized reinforcers and hierarchical exposure to increase food flexibility in children with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, 42, 1574-1581.
- Ledford, J. R., & Gast, D. L. (2006). Feeding problems in children with autism spectrum disorders: A review. *Focus on Autism and Other Developmental Disabilities*, 21, 153-166.
- Ledford, J. R., Lane, J. D., & Gast, D. L. (2018). Dependent Variables, Measurement, Reliability. In Ledford, J. R., & Gast, D. L. (2018), *Single case research methodology* (3rd ed.). New York: Routledge.
- Ledford, J. R., Whiteside, E., & Severini, K. E. (2018). A systematic review of interventions for feeding-related behaviors for individuals with autism spectrum disorders. *Research in Autism Spectrum Disorders*, 52, 69-80.
- Lukens C., & Linscheid T. (2008) The brief autism mealtime behavior inventory (BAMBI). *Journal of Autism and Developmental Disorders*. 38, 342-352.
- Penrod, B., Gardella, L., & Fernand, J. (2012). An evaluation of a progressive high-probability instructional sequence combined with low-probability demand fading in the treatment of food selectivity. *Journal of Applied Behavior Analysis*, 45, 527-537.
- Peterson, K. M., Piazza, C. C., & Volkert, V. M. (2016). A comparison of a modified sequential

- oral sensory approach to an applied behavior-analytic approach in the treatment of food selectivity in children with autism spectrum disorder. *Journal of Applied Behavior Analysis*, 49, 485-51.
- Seiverling, L., Kokitus, A., & Williams, K. (2012). A clinical demonstration of a treatment package for food selectivity. *The Behavior Analyst Today*, 13, 11-16.
- Sharp, W. G., Berry, R. C., McCracken, C., Nuhu, N. N., Marvel, E., Saulnier, C. A., ... & Jaquess, D. L. (2013). Feeding problems and nutrient intake in children with autism spectrum disorders: a meta-analysis and comprehensive review of the literature. *Journal of Autism and Developmental Disorders*, 43, 2159-2173.
- Sharp, W. G., Jaquess, D. L., Morton, J. F., & Herzinger, C. V. (2010). Pediatric feeding disorders: A quantitative synthesis of treatment outcomes. *Clinical Child and Family Psychology Review*, 13, 348-365.
- Sindelar, P. T., Rosenberg, M.S., & Wilson, R. J., (1985). An adapted alternating treatments design for instructional research. *Education and Treatment of Children*, 8, 67-76.
- Twachtman-Reilly, J., Amaral, S. C., & Zebrowski, P. P. (2008). Addressing feeding disorders in children on the autism spectrum in school-based settings: Physiological and behavioral issues. *Language, speech, and hearing services in schools*, 39, 261-272.
- Valdimarsdóttir, H., Halldórsdóttir, L. Y., & Sigurðóttir, Z. G. (2010). Increasing the variety of foods consumed by a picky eater: Generalization of effects across caregivers and settings. *Journal of Applied Behavior Analysis*, 43, 101-105.
- Volkert, V. M., & Piazza, C. C. (2012). Pediatric feeding disorders. *Handbook of Evidence-Based Practice in Clinical Psychology*. Hoboken, NJ: John Wiley & Sons, Inc.

Figure Captions

Figure 1. Brian's percentage of correct responding (Tiers 1-4) and number of pieces eaten (Tier 5) per session for the small (left) and large (right) food set conditions. The BCBA label indicates a generalization session conducted by the participant's regular therapist. Labels for "1, 2, 3" and "1, 2, 3, 4, 5, 6" indicate the increasing duration for which the participant was required to keep food in their mouth.

Figure 2. Carl's percentage of correct responding (Tiers 1-4) and number of pieces eaten (Tier 5) per session for the small (left) and large (right) food set conditions. The BCBA label indicates a generalization session conducted by the participant's regular therapist. Labels for "1, 2, 3" and "1, 2, 3, 4, 5, 6" indicate the increasing duration for which the participant was required to keep food in their mouth.

Figure 3. Cumulative number of foods interacted with for the small and large food sets for Brian (left) and Carl (right).

Table 1
Foods by Condition

	Brian	Carl
Screening	Strawberry ^a , Tomato ^a , Carrot ^a , Turkey ^a , Dried Yogurt ^a , Pasta ^a , Egg ^a , Green Bean ^a , Corn ^a , Pineapple ^b , Edamame, Snap Pea Crisp, Lima Bean, Celery, Cucumber, Broccoli, Bell Pepper, Snap Pea, Craisin, Asparagus, Watermelon, Peas	Edamame, Watermelon ^a , Raisin, Strawberry ^a , Grape ^a , Snap Pea ^a , Apple ^a , Green Bean ^a , Carrot, Cucumber ^a , Craisin, Dried Pineapple, Rice ^a , Asparagus ^a , Tomato, Snap Pea Crisp, Bell Pepper, Pea, Egg
Baseline	Egg ^a , Pasta ^a , Green Bean ^a , Carrot ^a , Tomato ^a , Strawberry ^a , Celery, Edamame, Lima Bean, Pea, Snap Pea Crips, Cucumber	Rice ^a , Asparagus ^a , Dried Pineapple, Apple ^a , Raisin, Strawberry, Cucumber ^a , Grape ^a , Tomato, Carrot, Green Bean ^a , Pea, Eggs, Watermelon, Craisin
Small	Egg ^a , Pasta ^a , Green Bean ^a	Rice ^a , Asparagus ^a , Dried Pineapple
Large	Carrot ^a , Tomato ^a , Strawberry ^a , Corn ^a , Turkey ^a , Dried Pineapple ^b , Yogurt ^a , Celery, Edamame, Lima Bean, Pea, Snap Pea Crips, Cucumber, Snap Pea, Asparagus	Tomato, Strawberry ^a , Watermelon ^a , Apple ^a , Cucumber ^a , Edamame, Craisin, Carrot, Pea, Snap Pea Crisp, Raisin, Green Bean ^a , Egg, Grape ^a , Snap Pea ^a
Generalization	Set #1: Egg ^a , Dried Pineapple ^b Set #2: Bell Pepper, Blueberries	---

Note: a = this food was specifically requested by the caregiver. b = Caregiver requested “dried fruit”

Table 2

Dependent Variables, Operational Definitions, Examples and Non-Examples

Behavior	Definition	Example	Non-examples and Close Non-examples
Touch	Any part of the participant's hand makes contact with the piece of food.	Touches food with finger or palm, picks up food, pushes food around on plate.	Throws food, pushes food off table, attempts to remove food.
Taste	Picks up food with hands, brings food towards mouth and makes contact between food and mouth or lips.	Touches food to lips, holds food to the lips, touches food to teeth.	Makes contact with food while still on plate, touches food to nose, smells food, touches food to chin
Lick	Brings food towards mouth and makes contact between food and tongue or inside of mouth.	Touches food to tongue, inserts food into mouth, touches food to inside of mouth.	Touches food to lips, kisses food, touches food to mouth.
Mouth	Opens mouth and inserts food, releases food into mouth and touches numbers on the number line.	Releases food onto tongue and touches numbers, inserts food in mouth and touches numbers.	Holds food in mouth with hand while touching numbers, holds food to lips, holds food between lips.
Eat	Opens mouth and inserts the food piece, chews food, and swallows the food.	Opens mouth, inserts food, chews, and swallows.	Inserts food in mouth and spits out, bites food but does not swallow, licks food, kisses food, refuses food, touches food.

Note: If the participant engaged in problem behavior (e.g., throwing food, spitting, etc.) while also or prior to engaging in a target behavior, the target behavior was counted as correct, with the exception of "touch" behaviors that are inappropriate (e.g., throwing food).

Table 3

Dependent and Independent Variable Reliability by Participant and Condition

	Condition/ Behavior	Average IOA (Range)	Average PF (Range)	Average IOA for PF
Brian	Baseline	100%	100%	100%
	Touch	100%	100%	100%
	Taste	97% (93-100)	96% (93-100)	95%
	Lick	NA	N/A	N/A
	Eat (#1)	100%	100%	100%
	Mouth	100%	98% (95-100)	97.5%
	Eat (final)	100%	100%	100%
	Baseline	100%	97% (92-100)	100%
	Touch	100%	100%	100%
	Taste	100%	100%	100%
	Lick	NA	N/A	N/A
	Eat (#1)	100%	100%	100%
	Mouth	100%	100%	100%
	Eat (final)	100%	97% (81-100)	100%
Carl	Baseline	100%	100%	100%
	Touch	100%	97% (91-100)	100%
	Taste	100%	100%	100%
	Lick	100%	97% (91-100)	100%
	Mouth	97% (90-100)	98% (91-100)	99%
	Eat	100%	98% (91-100)	100%
	Baseline	100%	97% (91-100)	100%
	Touch	100%	100%	100%
	Taste	100%	100%	100%
	Lick	100%	100%	100%
	Mouth	100%	97% (91-100)	100%
	Eat	100%	100%	100%

Note: IOA for participant behaviors and fidelity was calculated using point by point agreement: $(\text{agreements}/[\text{agreements} + \text{disagreements}]) \times 100\%$. Fidelity was calculated as the percentage of steps completed correctly: $(\text{correctly performed steps}/\text{planned steps}) \times 100\%$,