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ORIGINAL ARTICLE

# An Initial Evaluation of Trial-Based Functional Analyses of Inappropriate Mealtime Behavior

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**Abstract** Treatment of inappropriate mealtime behavior (IMB) should involve a functional analysis to determine variables maintaining the target behaviors. The purpose of the present study was to evaluate the trial-based functional analysis of IMB and assess correspondence of the results with a traditional functional analysis. The participants were two boys, ages 3 and 5 years old, diagnosed with developmental disabilities. A trial-based functional analysis and traditional analogue functional analysis of IMB were conducted with each participant, with the order of functional analyses counterbalanced across participants. The trial-based functional analysis resulted in differentially higher levels of IMB in one or more test conditions, indicating a social function of IMB for both participants. In addition, the results of the trial-based and traditional functional analysis corresponded for both participants. The subsequent function-based intervention, developed based on the results of the trial-based functional analysis, was associated with a decrease in IMB and an increase in appropriate feeding behaviors for both participants. The results of this study provide initial support for the use of trial-based functional analysis to assess the function of IMB.

**Keywords** Trial-based functional analysis · Feeding problems · Function-based intervention · Inappropriate mealtime behavior

Feeding problems occur in 25–45% of typically developing children and up to 80% of children with intellectual and developmental disabilities (Manikam and Perman 2000). Feeding problems such as not eating enough food (i.e., food refusal) and eating limited variety of food (i.e., food selectivity) lead to a variety of adverse consequences

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including inadequate energy, malnourishment, weight loss, and failure to thrive (Ledford and Gast 2006). Oftentimes, individuals that demonstrate food refusal and selectivity engage in inappropriate mealtime behavior (IMB), or challenging behavior within the context of mealtime. IMB can be a major obstacle in treating food refusal and food selectivity, leading to difficulties with adequate nutrition and normal growth (Kern and Marder 1995). Parents of children who engage in IMB report that they struggle to manage their children's feeding problems and worry about the potential negative effects on health and development (Rogers et al. 2012). For children who engage in IMB and eat a limited variety of food, the treatment of IMB often leads to the successful treatment of food refusal and selectivity (Allison et al. 2012; Bachmeyer et al. 2009; LaRue et al. 2011).

Function-based interventions are considered best practice in the treatment of IMB, due to the strong research support for their efficacy (Bachmeyer et al. 2009; LaRue et al. 2011; Najdowski et al. 2003). Function-based interventions involve identifying the function, or purpose, of problem behavior, then developing an intervention based on that function (e.g., functional communication training, noncontingent reinforcement, differential reinforcement of incompatible behavior). For example, a child may engage in IMB to access parent attention and preferred food. For this child, a function-based intervention would involve providing attention and preferred food contingent upon acceptance of the bite of nonpreferred food. In order to develop a function-based intervention for the treatment of IMB, it is necessary to first identify the function of the IMB (Piazza et al. 2003).

A functional analysis is one assessment used to identify the function, or purpose, of IMB. The traditional functional analysis, described in Iwata et al. (1994), is a specific assessment involving the manipulation of environmental variables in order to determine the antecedents and consequences associated with challenging behavior. The traditional functional analysis methodology has been replicated across a variety of populations, settings, and topographies of challenging behaviors, including IMB (Beavers et al. 2013; Hanley et al. 2003; Najdowski et al. 2003; Piazza et al. 2003). Piazza et al. (2003) applied the procedures developed by Iwata et al. (1994) to IMB. In this study, the experimenters first identified specific consequences delivered by parents as typical responses to IMB. They then delivered these consequences following instances of IMB within 10-min sessions. The traditional functional analysis resulted in the identification of reinforcers for feeding problems. Function-based interventions based on the results of traditional functional analyses lead to increases in oral intake as well as reductions in IMB (Addison et al. 2012; Najdowski et al. 2003; Piazza et al. 2003).

To date, fourteen studies have conducted functional analyses to identify the potential function(s) of IMB (e.g., Addison et al. 2012; Allison et al. 2012; Bachmeyer et al. 2009; Piazza et al. 2003). All of the studies utilized the traditional functional analysis methodology, which involved a massed-trial format with repeated presentations of the antecedents and consequences within a single session. This body of research indicates that there is a need to determine the utility of variations to the traditional functional analysis for the assessment of IMB. One limitation of the traditional functional analysis is that the massed trial format can result in a number of instances of problem behavior within one session and therefore multiple instances of reinforcement for problem behavior within that session (Ruiz and Kubina 2017). One alternative to the traditional functional analysis is the trial-based functional analysis (TBFA; Hanley et al. 2003; Rispoli et al. 2013; Sigafoos and Saggers 1995).

There is a growing body of literature indicating that a TBFA can lead to the development of an effective function-based intervention (e.g., Bloom et al. 2013; Lambert et al. 2012; Schmidt et al. 2013; Sigafoos and Meikle 1996). Like the traditional functional analysis, TBFA methodology involves the manipulation of environmental variables in order to identify antecedents and consequences associated with challenging behavior (Rispoli et al. 2013). A TBFA consists of discrete trials rather than the repeated presentation of antecedents and consequences within a session. For this reason, TBFAs can result in fewer total instances of challenging behavior, and therefore, fewer instances of reinforcement for challenging behavior (Ruiz and Kubina 2017). Another benefit associated with TBFAs is that educational professionals, residential staff, and graduate students can implement TBFAs following minimal training (Kunnavatana et al. 2013a, b; Lambert et al. 2013; Rispoli et al. 2015). Although there have been at least 13 studies that used TBFAs to identify the function of challenging behavior (Rispoli et al. 2013), to our knowledge, a TBFA has not yet been conducted to identify the function of IMB.

The extant literature suggests that function-based interventions result in the reduction of IMB (e.g., Bachmeyer et al. 2009; Gonzalez et al. 2014; LaRue et al. 2011). Extant studies applying functional analysis methodology to IMB have used traditional functional analysis methodology, but no studies have conducted a TBFA to identify the function of IMB. There is a need for more research on effective and efficient assessment of IMB. The purpose of this study is to conduct a TBFA of IMB and determine the extent to which the results correspond to the results of a traditional functional analysis of IMB. Specific research questions included:

(a) Does a TBFA result in the identification of the environmental variables that maintain IMB?
(b) Do the results of the TBFA of IMB correspond with traditional functional analysis results?
(c) Does a TBFA of IMB result in the development of an effective function-based intervention?

## Method

### Participants

Information about the study was disseminated via a university affiliated applied behavior analysis clinic monthly newsletter. The participants were the first two children who met the inclusion criteria and whose parents agreed for their child to participate. In addition, approval from the participants' pediatrician to participate was obtained prior to study participation. The pediatrician confirmed that the child did not have any medical conditions or issues contributing to feeding difficulties or causing feeding interventions to be unsafe. Child participants had to be 21 years of age or younger and exhibit IMB when presented with a nonpreferred food. The extent to which the children engaged in IMB was assessed during a 20-min mealtime observation conducted prior to the start of the study.

Kade was a 3-year-old Caucasian and Hispanic boy, diagnosed with autism by a developmental specialist at the age of 3. Kade's mother sought treatment to increase variety in the foods he consumed. Prior to treatment, his diet consisted mainly of chicken nuggets, vegetable puffs, and mini chocolate chip cookies. Kade attended a public school preschool program for children with disabilities 5 days a week. He also attended speech therapy one hour per week. At the time of the study, he communicated using some single-syllable vocalizations and gestures, such as leading his mother by the hand. Kade scored 13 on the Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP), which corresponds to a Level 1, or a developmental level of 0–18 months. Kade engaged in IMB in the form of pushing the plate of nonpreferred food away from him. Kade's mother reported the IMB was concerning because it would occur each time she offered him a fruit or a vegetable, and she worried he was not receiving proper nutrition.

Tyson was a 5-year-old Caucasian boy, diagnosed with pervasive developmental disorder by a psychiatrist at the age of 3. Tyson's mother sought treatment to increase variety in the foods he consumed. Prior to treatment, his diet consisted mainly of chicken nuggets, cheddar-flavored crackers, and fruit-flavored gummies. Tyson attended a private preschool for the full day 5 days per week and did not receive any other services related to his disability. Vocal language was his primary mode of communication. He scored 85 on the VB-MAPP, which corresponds to a Level 3 or a developmental level of 30–48 months. Scoring within Level 3 on this assessment suggests that the individual demonstrates a solid foundation of skills that will allow for more advanced language, social, and academic instruction. Tyson engaged in IMB in the form of pushing the plate of nonpreferred food away or throwing the food away from him. Tyson's mother was concerned that the IMB resulted in inadequate nutrition for her son, and wanted his diet to consist of a greater variety of foods, including fruits and vegetables.

A doctoral student in educational psychology implemented the sessions. She was a Board Certified Behavior Analyst (BCBA) and had 5 years of experience working with children with developmental disabilities.

### Setting and Materials

The study took place at a university affliliated applied behavior analysis clinic. All sessions were condcuted in a therapy room that was 3 m × 3 m and was equipped with a child size table and two chairs. Additional materials in the treatment room included plates, napkins, preferred foods, and nonpreferred foods. Foods were confirmed as preferred and nonpreferred by a paired choice preference assessment conducted by the experimenter using 3 potentially preferred and 3 potentially nonpreferred foods suggested by the child's caregiver (Fisher et al. 1992). Foods were prepared at the clinic and presented to the participants in bite size (1 cm) pieces. Preferred foods were those chosen greater than 70% of opportunities and nonpreferred foods were those chosen less than 50% of opportunities during the preference assessment. Nonpreferred foods for Kade included green bean, banana, and cooked carrot. Preferred foods for Kade included mini chocolate chip cookie, veggie puff, and chicken nugget. Nonprefered foods for Tyson included grape, carrot, and strawberry. Tyson's preferred foods were chicken nugget, fruit-flavored gummies, and goldfish crackers. Both nonprefered and preferred foods as well as moderately preferred toys identified via parent interview were used during functional analysis and treatment sessions. The child's caregivers were asked to withold access to food and drink (except water) up to 2 h prior to all assessment and evaluation sessions.

## Dependent Variables and Data Collection

The dependent variables for this study included IMB and appropriate mealtime behavior. IMB was defined as the participant pushing or throwing food away, hitting the experimenter's hand, utensil, plate, or other mealtime materials, or making negative vocalizations about the food (e.g., "I don't like that; I don't want to eat that"). For the traditional functional analysis, the responses per minute of IMB was included in the graph. For the TBFA, the percentage of trials with IMB were included in the graph. During the treatment evaluation, frequency data were collected on both IMB and appropriate mealtime behavior. During the treatment evaluation, appropriate mealtime behavior was defined as the participant independently using his index finger to touch the food. During the shaping phases, the definition of appropriate mealtime behavior differed as described in the procedures section. The rate of IMB and appropriate mealtime behavior are included on the treatment evaluation graph.

## Interobserver Agreement and Treatment Fidelity

A master's student in applied behavior analysis served as the primary data collector for all of the sessions. An independent rater, also master's students in applied behavior analysis, collected data on participant behavior for at least 30% of sessions during each phase for each participant. Data collectors were seated in the treatment room during the sessions and collected data using paper and pen. For the traditional functional analysis sessions and treatment evaluation sessions, total count interobserver agreement (IOA) was calculated by dividing the smaller frequency by the larger count and multiplying by 100. For the TBFA, an agreement was counted if both raters scored an occurrence or nonoccurrence of IMB for the trial. IOA was calculated by taking the total number of agreements and dividing by the total number of agreements plus disagreements and multiplying by 100%. IOA was 99% (range 93–100%) for IMB during traditional functional analysis sessions. IOA was 100% for IMB during TBFA sessions. IOA was 96% and 97% (range 60–100%) for IMB and appropriate mealtime behavior during the treatment evaluation, respectively. IOA was greater than 93% within each phase for each participant, and for each rater.

A researcher-developed task analysis of assessment and intervention procedures was used to rate the experimenter's implementation fidelity during 100% of sessions. The rater, a master's student in special education, scored the experimenter as correct or incorrect on each step. Treatment fidelity was calculated as the number of steps implemented correctly divided by the total number of steps times 100. Average treatment fidelity was 98% (range 83–100%) for traditional functional analysis sessions and 100% for TBFA sessions. Treatment fidelity was 99% (range 83–100%) during the treatment evaluation.

## Experimental Design

A multielement design was used during the traditional functional analysis. The TBFA consisted of trials with a control and test portion and the percentage of trials with IMB during the test portion was compared to the percentage of trials with IMB during the control portion of each condition. The order of assessment (i.e., traditional functional analysis, TBFA) was counterbalanced across participants. Finally, a reversal design was utilized to evaluate the efficacy of a function-based intervention (based on the results of the TBFA) in reducing IMB.

## Functional Behavior Assessment

**Parent Interview** The experimenter interviewed the parents (Kade's mom and dad and Tyson's mom) using a researcher-adapted version of the Functional Assessment Interview (FAI; O'Neill et al. 1997). The interview consisted of closed- and open-ended questions about the topography of IMB, typical antecedents and consequences associated with IMB, and the participant's preferred and nonpreferred activities and foods. The interview lasted for approximately one hour. The results of the interview were used to plan specific antecedents, consequences, and materials that would be used within the conditions of the functional analyses for each participant. For example, Kade's mother reported that when Kade pushed away a nonpreferred food at the dinner table, she typically responded by providing a plate of his preferred foods. Based on this information, the experimenter included a tangible condition utilizing preferred food as a reinforcer for IMB in both the traditional functional analysis and the TBFA to reflect typical caregiver responses to IMB.

**Traditional Functional Analysis** The traditional functional analysis procedures were based on the procedures described by Najdowski et al. (2003). Each session lasted 5 min. During escape conditions, the experimenter presented a plate consisting of one bite each of three nonpreferred foods to the participant. The participant was asked to take a bite every 5 s. A three-step prompting procedure was used (i.e., verbal instruction, model demonstrating how to take a bite, physically placing the bite near the participant's mouth) with a 3-s delay in between prompts. Contingent upon IMB, the experimenter placed the plate out of sight and turned away from the child for 30 s. Contingent upon bite acceptance, the experimenter provided verbal praise.

During the attention condition, a plate consisting of one bite each of three nonpreferred foods was present on the table within the participant's reach but not directly in front of him. The experimenter told the child "Here is your food, but I need to do some work." Contingent upon IMB, the experimenter delivered brief attention including a statement of concern or reassurance (e.g., "I wish you would not do that; carrots are good for you"). If any food was moved from the location, the food was moved back to the location or replaced with new bites of the same food.

A tangible condition was included for both participants because both parent interviews indicated that access to preferred food was a common consequence for IMB in the home. A plate consisting of one bite each of three nonpreferred foods was present on the table within the participant's reach but not directly in front of him. Prior to tangible sessions, the experimenter provided two bites of preferred food, then stopped providing access to preferred foods once the session began. If the participant engaged in IMB, the experimenter provided the participant with two bites of his preferred food. If any food was moved from the location, the food was moved back to the location or replaced with new bites of the same food.

During the play (control) condition, a plate with one bite each of the three nonpreferred foods was present on the table within the participant's reach but not directly in front of him as well as a plate of two bites of preferred foods. No demands were given. The experimenter provided brief verbal attention approximately every 30 s and ignored IMB, non-target inappropriate behavior, and any appropriate mealtime behavior. If any food was moved from the location, the food was moved back to the location or replaced with new bites of the same food.

**Trial-Based Functional Analysis** The TBFA sessions were conducted based on the procedures described by Rispoli et al. (2015). The TBFA included three different conditions: attention, tangible, and escape, with 20 trials in each condition. Each trial consisted of a 60 s control portion followed by the test portion, which continued for 60 s or until the first instance of IMB, whichever came first. Procedures in the control and test portions of each condition varied, depending on the function being assessed. Following the TBFA, the experimenter compared the percentage of trials with IMB in the test portion of each condition to the percentage of trials with IMB in the control portion of that condition to identify the function(s) of the child's IMB.

During the control portion of the escape condition, a plate of one bite of each of three nonpreferred foods was placed on the table near but not directly in front of the participant and he was told he could have a break from taking bites. The experimenter then turned away from the child and did not present any demands. After 60 s, the experimenter presented the same plate of nonpreferred food to the participant with the instruction to "take a bite." The experimenter prompted the child to take a bite using a three-step prompting procedure (i.e., verbal instruction, model demonstrating how to take a bite, physically placing the bite near the child's mouth) with a 3 s delay in between prompts. Contingent upon bite acceptance, the experimenter delivered verbal praise. Contingent upon IMB, the experimenter removed the nonpreferred food and indicated the child could take a break from taking bites. The experimenter ignored non-target inappropriate behavior and appropriate mealtime behavior during the test component of the trial.

In the attention condition, the experimenter set a plate with one bite of each nonpreferred food on the table near but not directly in front of the participant and said "here is your food." The participant had access to a moderately preferred toy throughout the control and test portion of the trial. During the control portion, the experimenter interacted with the child and provided brief attention at least once every 5 s regardless of IMB. After 60 s, the control portion of the trial ended and the test portion began. The experimenter instructed the child to play independently. The plate of nonpreferred food remained on the table in the original location. Contingent upon IMB, the experimenter turned towards the child and provided verbal attention (e.g., "carrots are good for you") and the trial ended. The experimenter ignored non-target inappropriate behavior and appropriate mealtime behavior during the test component of the trial.

For the control portion of the tangible condition, the experimenter set a plate of nonpreferred food on the table and the child was provided two bites of preferred food every 10 s. A 10 s interval was included between bites to allow proper chewing time and to avoid providing more than an appropriate child size portion of food. The experimenter did not provide attention following IMB, other inappropriate behavior, or appropriate mealtime behavior. After 60 s, the test portion began and the experimenter removed the preferred food and stated "you can have these foods later." The preferred food remained visible but out of the child's reach. The nonpreferred food remained in the original location on the table. Contingent upon IMB, the experimenter provided two bites of preferred food and the trial ended. The experimenter ignored non-target inappropriate behavior and appropriate mealtime behavior during the test component of the trial.

## Treatment Evaluation

A function-based intervention (i.e., differential reinforcement of alternative behavior (DRA) + shaping; Hodges et al. 2017; Koegel et al. 2012) was developed and implemented with each participant based on the results of the TBFA.

**Baseline** The purpose of the baseline sessions was to assess typical rates of IMB. In baseline, the experimenter presented a plate of one bite each of three nonpreferred foods to the participant. The experimenter said: "time to eat, touch the food." The experimenter used a three-step prompting procedure (i.e., verbal instruction, model demonstrating how to take a bite, physically placing the bite near the participant's mouth) with a 3 s delay in between prompts. Foods were rotated throughout the 5-min session (i.e., bite of banana on first presentation, bite of green bean on the second presentation, etc.). Contingent upon IMB, the experimenter removed the plate of nonpreferred food for 30 s and provided 2 bites of the preferred food. For Tyson only, the experimenter provided attention (i.e., "it's okay, I know you don't like carrots") for IMB during baseline. Brief verbal praise was provided for compliance with the demand (i.e., touching the nonpreferred food). All other problem behavior was ignored.

**DRA** The purpose of the DRA sessions was to teach the participants an alternative appropriate response to engaging in IMB. Conditions were similar to baseline except that the participants were told if they touched the food, then they could have two bites of their preferred food and a 30 s break. Contingent upon the child touching the food with at least one finger, the experimenter provided a 30-s break and two bites of preferred food. For Tyson only, contingent upon appropriate responding (i.e., touching the food), the experimenter said "great job with your food!" Contingent on IMB or food expulsion, the experimenter continued the three-step prompting procedure and did not provide any other consequences (i.e., extinction). The experimenter immediately replaced any food displaced due to IMB.

**Baseline** The second baseline condition was the same as the previous baseline condition.

**DRA** Procedures for the second DRA phase were the same as the previous DRA phase.

## Shaping

The shaping procedure was developed based on previous research (Hodges et al. 2017; Koegel et al. 2012).

**DRA + Shaping (Lips)** Shaping 1 was similar to the previous two DRA phases, except that the response requirement for the participant changed from touching the food with one finger to touching the food to his lips. The experimenter stated the instruction (i.e., "time to eat, touch food to lips"). Following 3 consecutive sessions with 4 or more independent appropriate responses, the response requirement increased to the next level in the hierarchy.

**DRA + Shaping (Mouth)** Shaping 2 was similar to Shaping 1, except that the response requirement for the participant changed to putting the food in his mouth.

**DRA + Shaping (Swallow)** Shaping 3 was similar to the previous shaping phases, except that the response requirement for the participant changed to chewing and swallowing food. The prompting hierarchy remained the same as in previous phases except a modified full physical prompt was used. The experimenter held the bite near the participant's lips and provided a verbal reminder (i.e., "chew and swallow food") approximately every 30 s. If the participant opened his mouth at any time (except for coughing, yawning, or vomiting) the bite was deposited into his mouth. Vomiting did not occur during the study. If the participant did not chew and swallow the bite during the 5-min session, the experimenter continued to hold the bite in front of the participant's mouth. After 20 min of no appropriate mealtime response, the participant was asked to complete the previous level of food acceptance mastered (i.e., putting the food in his mouth) and the feeding session was terminated (Allison et al. 2012). The treatment evaluation was complete once the participant demonstrated 4 or more independent appropriate mealtime behaviors for 3 consecutive sessions.

# Results

Results for Kade and Tyson's TBFA and traditional FA are presented in Figs. 1 and 2, respectively.

## Trial-Based Functional Analysis

The trial-based functional analyses resulted in the identification of social consequences maintaining IMB for both participants. Kade engaged in higher levels of IMB during the escape test condition (100% of trials) as compared to the control condition (45% of trials). Similarly, he engaged in more IMB during the tangible test conditions (95% of trials) as compared to the tangible control conditions (25% of trials). In the attention test and control conditions, he engaged in lower levels of IMB as compared to the escape and tangible conditions (30% of test trials; 5% of control trials). These results suggest Kade's IMB were maintained by both negative and positive reinforcement in the form of escape from taking a bite and access to preferred foods. The results also suggest a

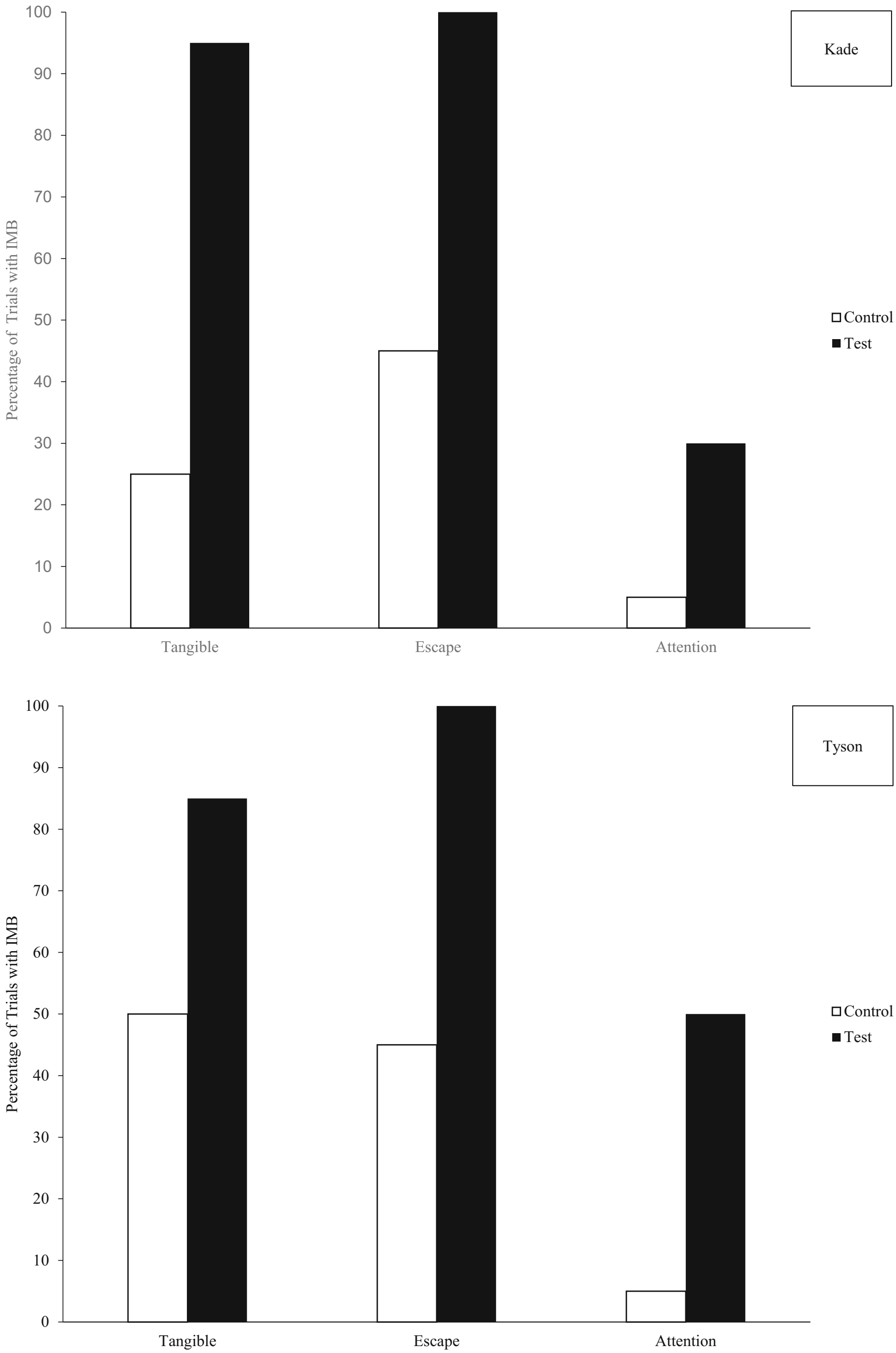


**Fig. 1** Trial-based functional analysis results for Kade (top panel) and Tyson (bottom panel) across tangible, escape, and attention conditions

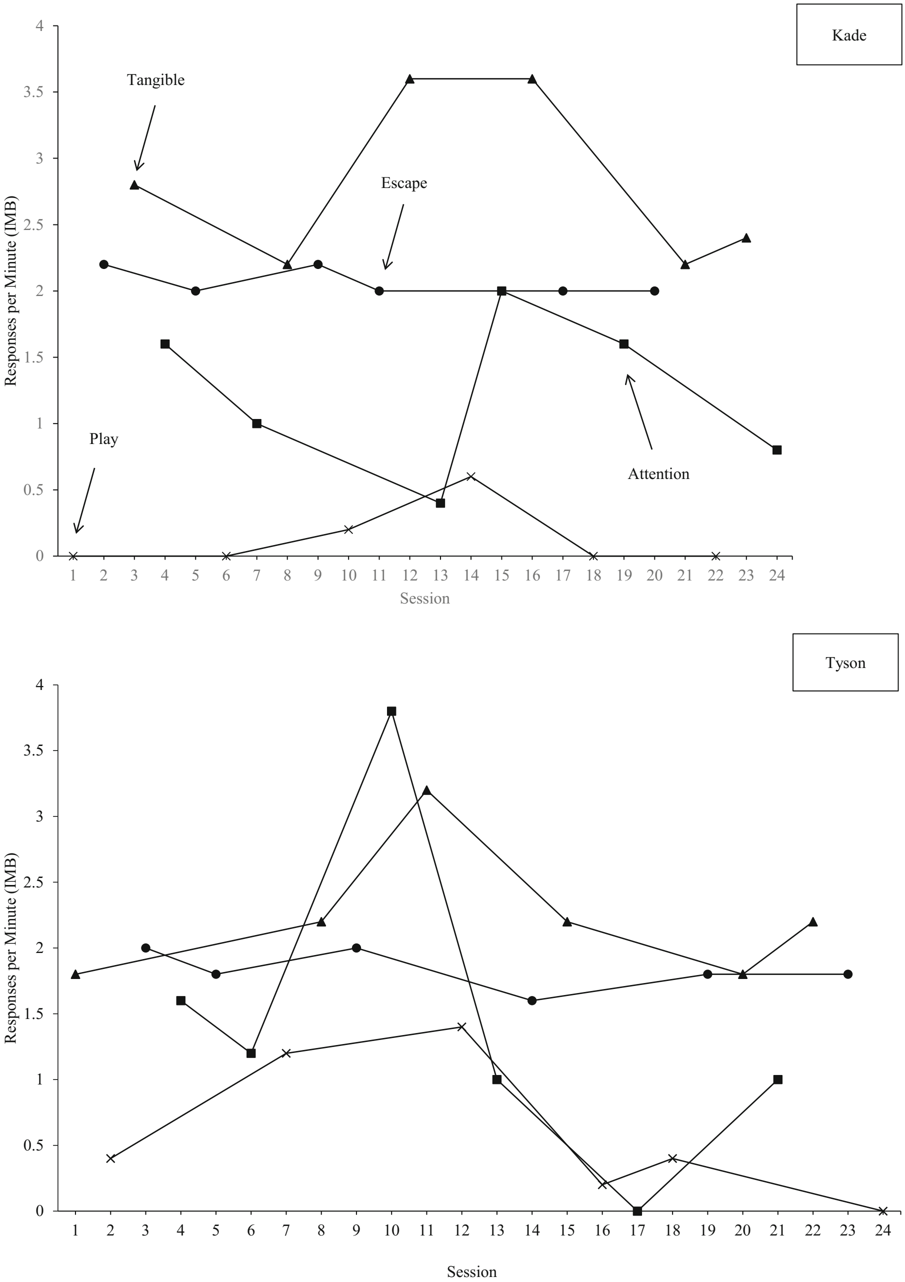


**Fig. 2** Traditional functional analysis results for Kade (top panel) and Tyson (bottom panel)

possible tertiary function of attention. However, this potential function was not targeted in the intervention due to the low percentage of trials in which it occurred during the establishing operation present condition of the trial-based functional analysis.

Tyson emitted IMB more frequently in the escape test condition (100% of trials) than in the escape control condition (45% of trials). Similarly, Tyson engaged in higher levels of IMB in the tangible test condition (85% of trials) as compared to the tangible control condition (50% of trials). During the attention condition, Tyson engaged IMB during 50% of the test trials and 5% of control trials. The results of Tyson's TBFA suggest his IMB was maintained by both negative reinforcement in the form of escape from bite presentations and positive reinforcement in the form of access to preferred foods and access to attention. Tyson engaged in IMB during approximately half of the control portion trials for both the tangible and escape conditions of the TBFA. The IMB during the control portions may have been due to the low attention during these conditions, which may have served as an establishing operation for IMB given the identified attention function.

## Traditional Functional Analysis

Kade engaged in higher rates of IMB in both the tangible ($M$ = 3.4, range = 2.2–3.6) and escape ($M$ = 2.5, range = 2.0–2.2) conditions as compared to the play conditions ($M$ = 0.2, range = 0–0.6). IMB occurred at a lower and more variable rate during the attention condition ($M$ = 1.5, range = 0.4–1.6). The results indicate that the IMB is primarily maintained by access to tangible items and escape from demands, corresponding with the TBFA results. The results also indicate that there is a possible additional function of access to attention suggested by these results, which was not identified as an additional function for Kade based on the TBFA results.

Tyson displayed the highest rates of IMB during tangible ($M$ = 2.7, range = 1.8–3.2) and escape ($M$ = 2.2, range = 1.6–2.0) conditions. IMB occurred at a moderate rate during the attention condition ($M$ = 1.7, range = 0–3.8), overlapping with the play condition. There were few instances of IMB during the play condition ($M$ = 0.7, range = 0–1.4). These results indicate that the primary functions of Tyson's IMB were to access preferred food and escape mealtime demands, corresponding with TBFA results. An additional function of attention was not identified based on the results of the traditional functional analysis, but was identified based on the results of the TBFA.

## Treatment Evaluation

The intervention, developed based on the results of the TBFA, resulted in a decrease in IMB and an increase in appropriate mealtime behavior for both participants (see Fig. 3). Kade exhibited a consistent rate of IMB during the first baseline phase ($M$ = 1.1, range = 1.0–1.2). During the first DRA phase, IMB occurred at a rate of 0.8 IMB per minute, then decreased zero instances for the final four sessions ($M$ = 0.2, range = 0–0.8). There was no overlap between the initial baseline phase and the initial DRA phase. During the return to baseline, IMB occurred at a similar rate as in the initial baseline phase ($M$ = 1.0, range = 1.0–1.0). During the second DRA phase, IMB decreased to zero instances ($M$ = 0, range = 0–0.2). There were few instances of IMB during the Shaping 1. During phases Shaping 2 and 3 there was an initial increase in IMB followed by a decrease in IMB. Kade engaged in zero instances of IMB in the final sessions of each of the shaping phases.

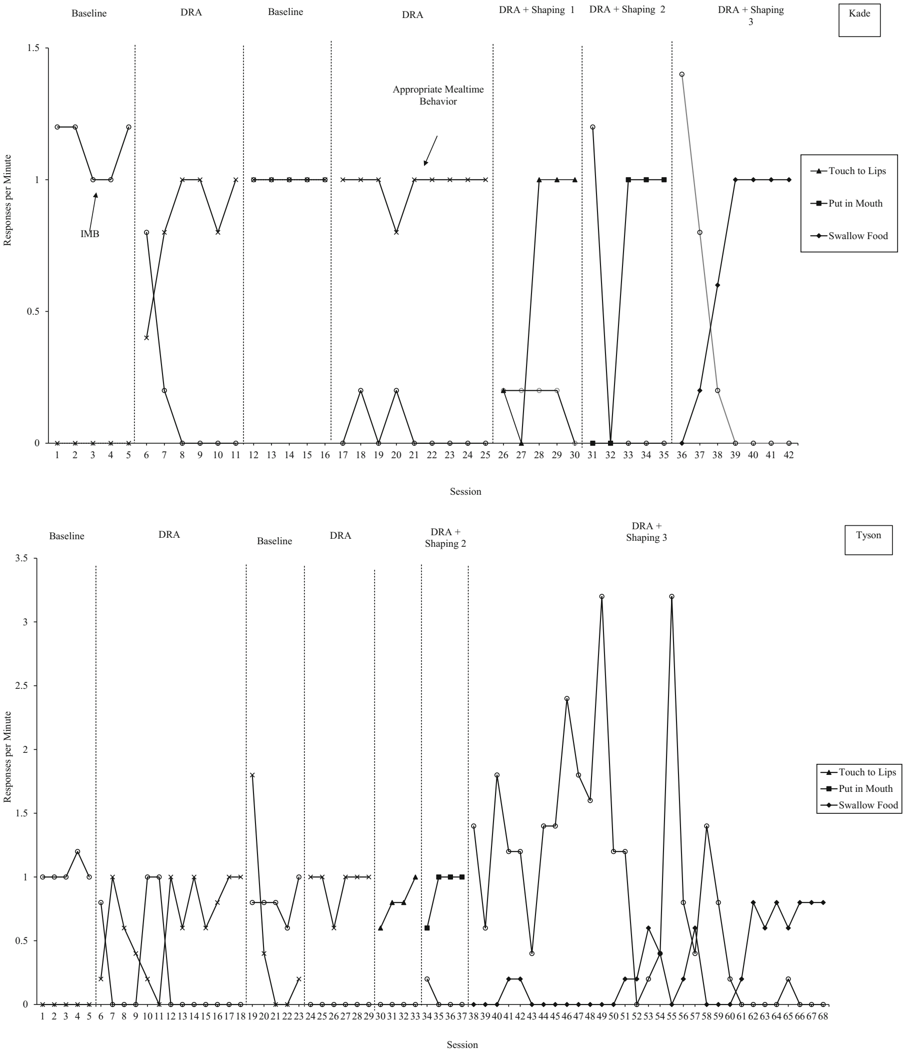


**Fig. 3** IMB and appropriate mealtime behavior during the treatment evaluation for Kade (top panel) and Tyson (bottom panel)

Kade engaged in zero instances of appropriate mealtime behavior during the first baseline phase. Appropriate mealtime behavior increased during the first DRA phase ($M = 0.8$, range = 0.4–1.0). Upon returning to baseline, appropriate mealtime behavior did not return to initial baseline levels and remained consistent with the final session of the initial DRA phase ($M = 1.0$). Appropriate mealtime behavior continued to stay at consistent levels during the second DRA phase ($M = 1.0$, range = 0.8–1.0). Each subsequent shaping phase was associated with an initial decrease in appropriate mealtime behavior, then a return to higher rates of appropriate mealtime behavior.

**Tyson** Tyson exhibited a higher rates of IMB in the first baseline phase ($M = 1.0$, range = 1.0–1.2) than the initial DRA phase, which was associated with a decrease in IMB ($M =$

0.2, range = 0–1.0). In the second baseline phase, IMB returned to levels similar to the first baseline phase (*M* = 4.0, range = 3.0–5.0). During the second DRA phase, there were zero instances of IMB. There were very few instances of IMB during Shaping 1 and Shaping 2. IMB occurred at variable rates during Shaping 3, but eventually decreased to near zero instances for the final sessions (*M* = 0.9, range = 0–3.2).

No appropriate mealtime behavior occurred during the first baseline phase. The first DRA phase was associated with variable rates of appropriate mealtime behavior (*M* = 0.6, range = 0–1). Appropriate mealtime behavior decreased during the second baseline phase and was associated with a decreasing trend throughout the phase (*M* = 0.5, range = 0–1.8). An immediate increase in appropriate mealtime behavior occurred during the second DRA phase (*M* = 0.9, range = 0.6–1.0). Shaping 1 was associated with an increasing trend in appropriate mealtime behavior (*M* = 0.8, range = 0.6–1.0). Appropriate mealtime behavior continued to occur at similar rates consistent to the previous phase during Shaping 2 (*M* = 0.9, range = 0.6–1.0). Shaping 3 was associated with initially low instances of appropriate mealtime behavior, followed by an increase in appropriate mealtime behavior (*M* = 0.3, range = 0–0.8).

## Discussion

The present study evaluated the utility of a TBFA to identify the consequences maintaining IMB for two participants with developmental disabilities. In addition, this study compared the results of TBFA with those obtained from a traditional functional analysis for IMB. For Kade and Tyson, the highest level of IMB occurred during the escape and tangible test conditions of TBFA. This indicated that IMB was maintained primarily by negative reinforcement in the form of escape from mealtime demands and positive reinforcement in the form of access to preferred food items for both participants. Moreover, the results of the traditional functional analysis indicated both participants engaged in high levels of IMB during escape and tangible sessions, corresponding with the results of the TBFA. For Kade, an additional attention function was identified based on the traditional functional analysis results, and was identified as a tertiary function based on the TBFA results. An additional attention function was identified based on the TBFA results for Tyson, but was not identified based on the traditional functional analysis results. DRA, based on the function identified by the TBFA, resulted in a decrease in IMB for both participants. Previous literature on feeding problems including IMB in children with developmental disabilities has indicated the importance of implementing a function-based intervention based on the results of a functional analysis (Addison et al. 2012; Allison et al. 2012; Najdowski et al. 2003; Piazza et al. 2003). The data from the current investigation provide preliminary evidence that the results of a TBFA of IMB can be used to develop an effective function-based intervention.

The majority of previous studies that included a functional analysis of IMB have identified escape as the sole function of IMB (e.g., Addison et al. 2012; Allison et al. 2012; Najdowski et al. 2003). The results of functional analyses in at least five studies have indicated IMB was maintained by multiple variables (Borrero et al. 2016; Bachmeyer et al. 2009; Girolami and Scotti 2001; Gonzalez et al. 2014; Piazza et al. 2003). The current study provides additional evidence that IMB can be multiply maintained and describes a method to incorporate multiple types of reinforcement in the treatment of multiply maintained IMB.

To date, only one other study included an access to preferred food condition in the functional analysis of IMB (Girolami & Scott, 2001). Based on parent report, an access to preferred food condition was included in both functional analyses in the present study for each participant. Higher rates of IMB in this condition compared to other conditions indicated that the child's behavior was maintained, at least in part, by access to preferred foods. Future studies should consider including access to preferred food items as one of the conditions in the functional analysis of IMB if other data indicate access to preferred food is a possible function of IMB (e.g., parent report, direct observation).

In a TBFA and traditional functional analysis, the occurrence of IMB should be different in test and control conditions in order to identify the variable(s) maintaining the IMB. In the present study, each child engaged in IMB during the control conditions of both the traditional functional analysis (i.e., the play sessions) and the TBFA. Nonpreferred food items were present during every condition of both functional analyses. It may be the case that nonpreferred food items served as an establishing operation (EO) across conditions, increasing the value of escape from taking a bite, even in situations in which the demand to take a bite was not explicitly placed (Bachmeyer et al. 2009). However, there was sufficient differentiation between test and control conditions in both TBFA and traditional functional analyses to identify the function of the IMB for both participants. In addition, based on most definitions of IMB, the presence of the nonpreferred food is necessary in order for the child to engage in IMB. Therefore, it is typically important to include nonpreferred food in every condition to avoid altering the results of the functional analysis based on the presence or absence of IMB in certain conditions.

Both the TBFA and the traditional functional analysis resulted in the identification of tangible and escape functions for both participants. However, the attention condition was not associated with exact correspondence between the two functional analysis formats. The results of Kade's traditional functional analysis indicated an additional attention function, whereas the results of the TBFA did not. Similarly, Tyson's TBFA results suggested a potential additional function of attention, whereas his traditional functional analysis did not. This inconsistency may be because attention was not the primary variable maintaining IMB and other variables were associated with higher rates of IMB in both functional analysis formats. In addition, there was some IMB in the attention conditions in both functional analysis formats for both participants. Therefore, the difference in identifying the function in one format versus another may have been due to typical variability in rates of behavior across days.

The present study was a preliminary evaluation of a TBFA of IMB for two participants diagnosed with developmental disabilities. Since this study included only two participants, the results should be interpreted with caution. Additional studies are needed to evaluate the effectiveness of TBFA to identify variables maintaining IMB with a larger and more varied sample of participants who demonstrate IMB. Furthermore, both participants in the present study engaged in IMB maintained by similar consequences, indicating a need for replication across different functions of IMB. Additionally, the TBFA and traditional functional analysis resulted in the identification of multiple sources of reinforcement maintaining the participants' IMB. Future research should continue to evaluate the extent to which TBFAs result in the identification of single functions of IMB in cases in which the traditional functional analysis suggests a single function. One of the steps in the shaping procedure required the child to put the food in his mouth, but did not require him to swallow the food to receive reinforcement. This procedure was based on previous shaping literature (Hodges et al. 2017; Koegel et al. 2012). It may have been the case that this procedure resulted in the incidental reinforcement of spitting out food during sessions in which the child did not swallow his food. Future research should evaluate the extent to which this step in the shaping procedure is necessary to increase consumption of non-preferred foods. A final limitation of this study was that total count IOA was used rather than a more stringent measure such as the percentage of intervals with exact agreement (Cooper et al. 2007).

A TBFA involves conducting a series of brief trials, which can take place during the course of a child's typical mealtime routine. Therefore, TBFAs may be a more feasible alternative to implementing a traditional functional analysis in a child's natural environment. Future research should examine the use of TBFAs in naturalistic settings (e.g., home, school, cafeteria, etc.) by typical change agents (e.g. parents, teachers, etc.). In addition, the number of trials in each TBFA condition has varied across studies with a range of three to 20 trials (Rispoli et al. 2013). In their review of the literature, Rispoli and colleagues (2014) reported that majority of the studies conducted 20 trials of each condition during TBFA. Future research should evaluate the extent to which 20 trials of each condition during TBFA is necessary to accurately identify the function of IMB.

Identifying the function of IMB is recommended prior to developing an intervention to reduce IMB (Gonzalez et al. 2014; Piazza et al. 2003). In some cases, it may be more feasible or appropriate to conduct a TBFA rather than a traditional functional analysis due to the brief trials that can be embedded into the child's typical routine (Ruiz et al. 2017). This study provides preliminary evidence that a TBFA can be used to identify the function of IMB and can lead to the development of an effective function-based intervention.

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**Compliance with Ethical Standards**

**Ethical Approval** Ethical Approval was obtained from the University's Review Board prior to the start of the study. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

**Informed Consent** Informed consent was obtained from the caregivers of all individual participants included in the study.

**Conflict of Interest** The authors declare that they have no conflict of interest.

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