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A Model for the Treatment of Food Selectivity

A Thesis
By
Angie Van Arsdale

Submitted to the Faculty of the Department of Health Professions
at Rollins College in Partial Fulfillment
of the Requirements for the Degree of

MASTER OF ARTS IN APPLIED BEHAVIOR ANALYSIS AND CLINICAL SCIENCE

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Abstract

Research has shown antecedent interventions might be effective for treating food selectivity in the absence of consequent manipulations; however, escape extinction is the most commonly implemented intervention in feeding research. Escape extinction in the treatment of feeding disorders is an intrusive procedure that might not always be considered socially valid or feasible; therefore, it is important to evaluate other interventions prior to escape extinction. This study describes a methodology of evaluating antecedent and consequent interventions for subjects with food selectivity, progressing from least to most response effort and/or intrusiveness. For each subject, we moved through each intervention until acceptance increased to clinically significant levels. Results showed subjects' responsiveness to each intervention was idiosyncratic, with different procedures being more effective for different individuals. That is, one subject's acceptance increased as a result of an antecedent intervention, one subject's acceptance increased when an extinction component was added, and one subject's acceptance never increased to clinically significant levels. This advancement-based approach provides a means of identifying the least-intrusive yet effective intervention for subjects with food selectivity.

Keywords: Antecedent interventions, consequent interventions, escape extinction, food selectivity.

Introduction

Feeding disorders are characterized by insufficient caloric consumption, nutritional intake, and/or inadequate growth. Additional issues might include skill deficits and behavioral problems (Piazza, 2008). Feeding disorders can vary in severity, with extreme cases leading to malnourishment and failure to thrive diagnoses. According to Piazza (2008), many feeding problems are caused by medical, oral-motor, or behavioral problems, and often they have combined medical and behavioral causes. Bryant-Waugh, Markham, Kreipe, and Walsh (2010) found 80% of feeding disorders referred to specialists have a significant behavioral component. Feeding problems are prevalent in children, with 20-50% of typically developing children and 70-89% of children with intellectual disabilities being affected (Benjasuwantep, Chaithirayanon, & Eiamudomkan, 2013).

Feeding disorders range from selective eating that results in inadequate nutritional intake to total refusal and dependence on feeding tubes (Bachmeyer, 2009). Food selectivity refers to the consumption of a restricted range of foods (Bandini et al., 2010). Children who display food selectivity have preferences for certain foods and are often described as “picky eaters.” Pediatricians usually suggest children with food selectivity will simply grow out of it (Piazza et al., 2002); however, Schreck, Williams, and Smith (2004) found subjects maintained feeding problems to at least the age of 12. Children with food selectivity typically do not refuse to eat during appropriate times, but they will only consume preferred food items and refuse foods outside their selective preferences. Food selectivity differs from food refusal in that food refusal is defined by the total refusal of food, resulting in insufficient caloric intake by mouth (Sharp, Jaquess, Morton, & Herzinger, 2010).

Although negative health effects are often discussed in reference to food refusal, food selectivity can impact an individual's nutritional status and growth immensely (Bachmeyer, 2009). Food selectivity becomes a problem when the child does not consume enough variety of foods or only eats nutritionally deficient foods (e.g., junk food). Insufficient caloric consumption can have many harmful health and developmental effects (e.g., malnutrition, weight loss, lethargy). Children who consume primarily foods with high glycemic indexes, fat levels, and sugar levels (e.g., candy) are more likely to have obesity and Type 2 diabetes than children who consume a variety of healthy foods (Peterson, Piazza, & Volkert, 2016). Additionally, inappropriate mealtime behavior (IMB; e.g., negative vocalizations, aggression, self-injurious behavior [SIB]) can accompany food selectivity in the presentation of nonpreferred food items, which might place the child and others in danger (Piazza, 2008).

Autism spectrum disorder (ASD) is characterized by deficits in social interaction and communication as well as rigid, repetitive patterns of behavior, as stated by the American Psychiatric Association's *Diagnostic and Statistical Manual*, 5th Edition (DSM-V). Food selectivity can be conceptualized as a form of rigidity, or difficulty with flexibility and change (Mari-Bauset, Zazpe, Mari-Sanchis, Llopis-Gonzelez, & Moralez-Suarez-Varela, 2014). Although rigidity is a possible explanation for food selectivity in children with ASD, as many as 90% of children with ASD have feeding issues (e.g., Ahearn, Castine, Nault, & Green, 2001; Cermak, Curtin, & Bandini, 2010; Schreck et al., 2004). According to both Ahearn et al. (2001) and Schreck et al. (2004), children with ASD typically express selective preferences for carbohydrates, snacks, and processed foods, but refuse fruits and vegetables. Food selectivity, specifically, is the most predominant feeding issue associated with children with ASD (Volkert & Vaz, 2010).

Review of Literature

To prevent the associated negative effects, it is important to treat feeding problems as quickly as possible. Research has shown applied behavior analysis (ABA) is the most effective intervention for feeding problems (e.g., Addison et al., 2012; Peterson et al., 2016; Piazza et al., 2003; Sharp et al., 2010; Silbaugh, Swinnea, & Penrod, 2017). Behavior-analytic interventions operate under the assumption that behavior is maintained by its consequences. Piazza et al. (2003) demonstrated IMB is maintained by specific parental consequences. Specifically, the authors found 90% of individuals engaged in IMB to escape the aversive situation (i.e., to have the cup or plate removed). Both Addison et al. (2012) and Peterson et al. (2016) compared behavior-analytic treatments with commonly used sensory treatments. The sensory interventions consisted of many components before and during mealtime (e.g., sensory stimulation of the mouth, hands, and legs; visual tolerance, smell acceptance). The behavior-analytic interventions were comprised of noncontingent reinforcement (NCR) in the form of continuous attention as well as escape extinction (EE). Results of Addison et al. and Peterson et al. suggest behavior-analytic interventions are successful in treating the subjects' feeding problems, whereas sensory treatments are not.

Antecedent Interventions

Behavior-analytic interventions typically include manipulation of both antecedent and consequent variables. There are a few empirically supported antecedent interventions for reducing food selectivity, such as NCR, simultaneous presentation, fading, the high-probability sequence, and choice (Seubert, Fryling, Wallace, Jiminez, & Meier, 2014). These antecedent interventions are often evaluated in combination with consequent interventions (e.g., EE), but some studies have demonstrated their effectiveness without a consequence manipulation. As discussed previously, NCR is an effective behavior-analytic intervention that involves the delivery of reinforcement independent of behavior (Vollmer, Iwata, Zarcone, Smith, & Mazaleski, 1993). Noncontingent reinforcement can take many forms, such as the delivery of attention on a time-based schedule or continuous access to a preferred tangible. Richman, Barnard-Brak, Grubb, Bosch, and Abby (2015) conducted a meta-analysis of NCR outcomes and determined the intervention had a strong effect size (d=-1.58) for the reduction of problem behavior, quantitatively demonstrating the empirical support behind the intervention. Although proven successful in treating most problem behavior, few studies have demonstrated the effectiveness of NCR with feeding problems. Currently, the only study indicating the effectiveness of NCR without EE is Wilder, Normand, and Atwell (2005). The study evaluated the effects of NCR on SIB and acceptance of nonpreferred food items in a child with food selectivity. A brief functional analysis confirmed the SIB was maintained by negative reinforcement, and the treatment consisted of continuous access to the most preferred item identified by a paired-stimulus preference assessment (i.e., a children's video). SIB continued to produce escape, meaning an extinction component was not included. NCR effectively reduced the level of SIB and increased acceptance for a subject with food selectivity.

Simultaneous presentation and fading are antecedent manipulations that decrease the aversiveness of nonpreferred food items by presenting them at the same time as preferred food items. The preferred foods are then gradually faded out to increase consumption of nonpreferred foods alone (Piazza et al., 2002). Simultaneous presentation has been shown to be an easy and effective intervention for increasing consumption in many studies (e.g., Ahearn, 2003; Buckley & Newchok, 2005; Piazza et al., 2002). Across these studies, four out of the five subjects had increased consumption due to simultaneous presentation. Ahearn (2003), in particular, increased the consumption of one subject with food selectivity by simply presenting preferred condiments (e.g., ketchup) with nonpreferred vegetables (e.g., broccoli); however, this study did not incorporate fading. Fading is an important component because the preferred stimuli should be gradually removed to maintain consumption of the nonpreferred food alone. Although the previously mentioned studies did not include a fading component, Luiselli, Ricciardi, and Gilligan (2005) and Tiger and Hanley (2006) demonstrated the effectiveness of stimulus fading on liquid consumption with two subjects who displayed food selectivity. Both studies demonstrated the simultaneous presentation of preferred liquids (i.e., Pediasure or chocolate syrup) with a nonpreferred liquid (i.e., milk) increased acceptance, and the preferred items were effectively faded out completely, resulting in high levels of milk consumption. Although these studies suggest simultaneous presentation and fading might be effective in increasing food and liquid consumption, both antecedent manipulations were not often included in one study.

The high-probability (high-*p*) sequence involves presenting a series of instructions for which the likelihood of an individual complying is high followed by an instruction for which the likelihood of compliance is low (Mace et al., 1988). For example, high-probability instructions might include “high-five,” “clap,” or “stomp,” whereas low-probability instructions might include “clean up” or “sit down.” Mace et al. (1988) developed the high-*p* sequence based on the assumption that behavior typically persists following an environmental change (i.e., low-*p* instruction) due to increased rates of reinforcement in the presence of specific discriminative stimuli (i.e., high-*p* instructions). Although its effectiveness has been demonstrated for increasing compliance with instructions (e.g., Lee, Belfiore, Scheeler, Hua & Smith, 2004; Riviere, Becquet, Peltret, Facon & Darcheville, 2011), the high-*p* sequence has more recently been used in the context of treating feeding problems (e.g., Ewry & Fryling, 2016; Meier, Fryling, & Wallace, 2011; Patel et al., 2007). These studies used topographically similar high-*p* instructions to the low-*p* instruction of "take a bite" by including presentations of an empty spoon (Patel et al., 2007) or presentations of preferred edibles (Meier et al., 2011; Ewry & Fryling, 2016) as high-*p* instructions. The high-*p* sequence was effective in increasing acceptance for all three subjects with food selectivity in the three studies mentioned, and Ewry and Fryling (2016) indicated the effects partially maintained at a 7-month follow-up.

Finally, presenting choices is an empirically supported antecedent intervention for increasing compliance (e.g., Dunlap et al., 1994; Powell & Nelson, 1997; Romaniuk et al., 2002). A variety of choices have been studied, including choice of academic task, activity, or reinforcer. Presenting choices is a relatively simple intervention and can be highly successful in decreasing problem behavior. Additionally, choices provide a high degree of autonomy to individuals with disabilities (Fisher, Thompson, Piazza, Crosland, & Gotjen, 1997). A few studies have been conducted evaluating the presentation of choices in the context of feeding problems (Fernand, Penrod, Fu, Whelan, & Medved, 2016; Rivas et al., 2014; Vaz, Volkert, & Piazza, 2011). Rivas et al. (2014) and Vaz et al. (2011) evaluated the effects of choosing between self-feeding single bites or being fed multiple bites by a therapist on children with food selectivity and refusal and found choice increased self-feeding; however, both studies included an extinction component. To date, Fernand et al. (2016) is the only study that has assessed the effects of choice without EE in children with food selectivity. Using a paired-choice preference assessment, the authors identified nonpreferred food items for two subjects. The treatment consisted of providing the choice between four nonpreferred foods and was effective in increasing consumption for one subject. The other subject, however, required an extinction component to increase food consumption, demonstrating choice alone might not always be effective for increasing consumption among subjects with food selectivity.

The previous research has demonstrated antecedent-based interventions such as NCR, simultaneous presentation, fading, the high-probability sequence, and choice have been successful in increasing acceptance of nonpreferred food for children with food selectivity. However, due to the limited number of studies without an extinction component, further research is necessary to determine the effectiveness of each antecedent intervention in the absence of consequence manipulations.

Consequent Interventions

Consequent interventions have been studied extensively for feeding disorders, with approximately 86% of studies including a consequence manipulation (Sharp et al., 2010; Silbaugh et al., 2018). Kerwin (1999) indicated differential reinforcement of alternative behavior (DRA) and EE were empirically supported interventions promising for the treatment of severe feeding disorders. DRA is the delivery of reinforcement contingent on an alternative response, and previous research in feeding disorders have used either preferred edibles or tangibles as reinforcers (e.g., Riordan, Iwata, Wohl, & Finney, 1980; Peterson, Volkert, & Zeleny, 2015). Consistent with most studies in feeding research, Riordan et al. (1980) delivered a preferred food item with praise contingent on acceptance of a nonpreferred food for two subjects with food selectivity. Both subjects' acceptance increased as a result of the DRA intervention with no extinction component. Riordan, Iwata, Finney, Wohl, and Stanley (1984) replicated these effects for three subjects with food selectivity; however, DRA was not effective for the one subject with total food refusal. Children with total food refusal often have no known preferred foods and presumably have no establishing operation for edibles as reinforcers. Levin and Carr (2001) conducted a motivating operations analysis to determine if the presence or absence of preferred foods prior to feeding sessions affected the success of DRA. Limiting the availability of preferred foods before treatment sessions increased the efficacy of contingent access to preferred foods on consumption of nonpreferred foods for four subjects, indicating deprivation increases the effectiveness of edibles as reinforcers in a DRA procedure.

Tangible items (e.g., toys, games, iPads) can also be used as reinforcers when delivered contingently on acceptance of nonpreferred food. Peterson et al. (2015) evaluated DRA with tangible items on self-drinking for two subjects with food selectivity. The authors identified the subjects' top three tangible items using multiple-stimulus-without-replacement preference assessments (MSWOs; DeLeon & Iwata, 1996). The authors then differentially reinforced the acceptance of nonpreferred liquids, and DRA increased self-drinking for both subjects.

Magnitude of reinforcement is another consideration when implementing DRA. For instance, a single preferred edible might not function as a reinforcer to increase acceptance of nonpreferred foods; however, a greater quantity of preferred edibles might establish such a response. Cooper et al. (1999) evaluated high-magnitude reinforcement using a concurrent operants paradigm with one subject with food selectivity. Two identical sets of food were presented at the same time, with each set being paired to a different quantity of reinforcement (i.e., number of preferred food items) delivered contingently on acceptance of one bite of nonpreferred food. Contingent access to more preferred food items resulted in greater increases of acceptance compared to a single preferred food item, demonstrating high-magnitude DRA might be more effective for some subjects without the need for escape extinction.

Escape extinction is the most empirically supported intervention for feeding disorders and has been included in 83% of studies (Sharp et al., 2010). There are two forms of EE commonly used in feeding research. Nonremoval of the spoon (NRS) involves holding a bite at the subject's lips until it is consumed and ignoring IMB, whereas physical guidance (PG) consists of a physical prompt to open the subject's mouth if initial acceptance does not occur. Ahearn, Kerwin, Eicher, Shantz, and Swearingin (1996) compared the two forms of EE and indicated both interventions were effective in establishing acceptance; however, PG was more time efficient and preferred by parents. Although PG was associated with parental preference, Sharp et al. (2010) suggested NRS is more commonly used than PG, with 48% of studies implementing NRS, whereas only 21% implemented PG.

Many studies have indicated EE is required to increase acceptance for children with food refusal (e.g., Cooper et al., 1995; Piazza, Patel, Gulotta, Sevin, & Layer, 2003; Reed et al., 2004). Cooper et al. (1995) conducted a component analysis of a treatment package for four subjects with food refusal to identify the active components responsible for increased acceptance. Escape extinction was identified as a controlling variable for each subject, whereas reinforcement was only a controlling variable for two subjects. Both Piazza et al. (2003) and Reed et al. (2004) compared the relative contributions of different treatment components (i.e., EE vs. DRA, EE vs. NCR) on consumption in eight subjects with food refusal. Results of Piazza et al. and Reed et al. indicated consumption only increased when EE was implemented, independent of the presence or absence of DRA and NCR, respectively. The previously mentioned studies demonstrate the importance of eliminating escape contingencies for problem behavior with subjects who have total food refusal while simultaneously arranging for reinforcement contingencies for acceptance.

Statement of the Problem

Antecedent interventions have been shown to be more effective for children with food selectivity than those with food refusal. Seubert et al. (2014) examined relevant research on antecedent interventions from 2000-2012 and determined only 14 out of 36 treatment implementations evaluated antecedent interventions without a consequence manipulation. The antecedent interventions were only effective alone with the subjects with food selectivity, indicating a consequence intervention might be necessary for subjects with food refusal. Additionally, out of the 26 total subjects included, only seven had food selectivity. An antecedent intervention alone was effective in increasing acceptance for 5 out of the 7 subjects with selectivity. Further research is necessary to determine if less intrusive, antecedent-based treatments are effective for subjects with food selectivity in the absence of consequence manipulations.

Children with food selectivity might also be more responsive to differential reinforcement without extinction than children with food refusal due to increased opportunities to contact reinforcement. Subjects with food refusal are not able to contact the reinforcement contingency for an alternative response during DRA because they never engage in consumption. For that reason, EE might be required for subjects with food refusal, whereas positive reinforcement might be sufficient for subjects with food selectivity; however, research is limited.

Although EE has strong empirical support, it is an intrusive procedure that is not always socially valid or feasible. For instance, some parents do not want to incorporate an extinction component, particularly if the child has food selectivity. NRS can be quite intrusive to the individual. Also, there might be negative effects, such as extinction bursts or extinction-induced variability, that are not safe in all settings (e.g., situations with other children present). Therefore, although the majority of feeding research has included an extinction component, it is important to identify alternative, effective interventions for increasing food acceptance before the implementation of EE.

To date, no studies have evaluated sequential implementation of antecedent and consequent interventions with a progression from least to most response effort and/or intrusiveness. Penrod, Wallace, Reagon, Betz, and Higbee (2010) conducted a parent-implemented sequential component analysis of bite fading, manipulation of reinforcer magnitude, and escape prevention to determine the least intrusive yet effective procedure for food selectivity. However, each treatment was never evaluated alone (i.e., DRA was always in effect and other treatment components were sequentially added). The current study explored a progression to more involved treatments similar to Vollmer, Marcus, Ringdahl, and Roane (1995). Vollmer et al. developed an assessment sequence progressing from brief to more complex functional analyses contingent on a lack of differentiation in response patterns. This assessment sequence provides a way to increase the efficiency of identifying behavioral function, which leads to quicker treatment implementation. Similarly, it would be beneficial to determine the least effortful intervention that increases food acceptance for children with food selectivity. The purpose of this study was to apply Vollmer et al.'s methodology to antecedent and consequent interventions for subjects with food selectivity, progressing from least to most response effort and/or intrusiveness, until each subject's acceptance increased to clinically significant levels.

Method

Subjects and Setting

Three subjects between the ages of four and six participated in this study. Mandy was a four-year-old girl who was diagnosed with ASD and chronic constipation, and her parents had been instructed by a pediatrician to increase her fiber intake. She consumed at least two foods from each food group except vegetables and communicated using full sentences. Cole was a six-year-old boy who was also diagnosed with ASD and chronic constipation. He consumed at least two food items from two food groups (i.e., fruits and vegetables) and communicated using full sentences. Hank was a six-year-old boy who had been diagnosed with ASD. He only consumed food items from one group (i.e., grains) and communicated using gestures and two-word phrases.

Subjects were recruited from an ABA clinic for children with ASD in Orlando, FL (Mandy and Hank) and by word of mouth (Cole). Parents filled out questionnaires regarding their child's preferences and the number of foods he or she currently consumed. To be included, a parent or physician reported the subject displayed food selectivity, which was defined as consuming zero food items in two or more food groups (see Appendix A) across three presentations in the preassessment. Further, subjects were included if they consumed at least one food item from each group but engaged in IMB across 50% or more trials of nonconsumed food items presented from Appendix A. Subjects also were required to have the ability to self-feed with no difficulties chewing or swallowing as determined by a physician, occupational therapist, or speech therapist. All sessions were conducted in a room at a local clinic (Mandy and Hank) or college (Cole) equipped with a table and two chairs.

Response Measure, Interobserver Agreement, and Experimental Design

The main dependent variables were acceptance, consumption, and IMB. *Acceptance* was scored if the entire bolus of food entered the subject's mouth within the bite-presentation interval. *Consumption* was scored if there was no visible food left in the subject's mouth 30 s after acceptance. *Inappropriate mealtime behavior (IMB)* was scored if the subject engaged in aggression, head turning, food pushing, mouth blocking, or negative vocalizations (e.g., whining, shouting “no” or “blah”). All data were collected on paper using an event-recording procedure. The data for each dependent variable were calculated as a percentage by dividing the number of occurrences by the number of total trials (i.e., bite presentations) and multiplying by 100.

A second observer collected data in person or from videos on the dependent variables and treatment integrity. Interobserver agreement (IOA) was assessed for 51%, 70%, and 38% of sessions for Mandy, Cole, and Hank, respectively and was calculated on a trial-by-trial basis for all measures by dividing the number of agreements by the number of agreements plus disagreements and converting the ratio to a percentage. Agreements were defined as both observers indicating the occurrence or nonoccurrence of a behavior during the same trial, whereas a disagreement occurred when only one of the two observers recorded the behavior in a corresponding trial. The mean IOA was 99.6% (range, 90% to 100%) for Mandy, 100% for Cole, and 100% for Hank. Treatment integrity data were collected for at least one session for each condition except EE due to the inability to record the long sessions. A second observer scored a task analysis developed for each intervention, and the number of steps completed correctly was divided by the number of total steps to determine a percentage of treatment integrity. Treatment integrity averaged 100%.

The effectiveness of each intervention was evaluated using a reversal design. We progressed through each treatment until subjects’ acceptance increased to 80% or above and IMB decreased below 20% for three consecutive sessions. When a treatment was identified as effective, we reversed back to baseline before reimplementing the effective treatment to demonstrate experimental control.

Procedure

Prior to the start of the study, parents of the subjects and other children completed a survey on the perceived response effort and intrusiveness of the treatments to determine the order of treatment progression. The order rankings from each survey were averaged to establish a fixed order of treatments for all subjects. A single-stimulus preference assessment was then conducted for each subject with the items from Appendix A where each item was individually presented three times to determine nonpreferred foods (i.e., foods that did not result in acceptance). Throughout the study, parents reported the subjects' preferences in person or on the phone to the experimenter for inclusion in the multiple preference assessments.

Sessions were conducted three to five times per week, no less than 1 hr after the subject's last meal. Across interventions, each session consisted of 10 trials. One nonpreferred food from each food group (i.e., fruit, vegetable, grain, meat, and dairy) were selected for each subject, if possible, and each food was presented twice in each session. If there were no nonpreferred food items in a food group or there was a dietary restriction preventing inclusion of a particular food group, an additional nonpreferred food item from another group was selected for the subject. In each session, the subject was seated at the table, and all unrelated materials were removed. The experimenter presented a bite of nonpreferred food (2.5 cm by 2.5 cm) on a spoon on a plate 0.3 m from the subject and prompted him or her to "take a bite." The experimenter delivered brief verbal praise contingent on the subject's acceptance across baseline and all treatment sessions. All trials included a 30-s intertrial interval between bite presentations. Prior to each session, we provided a description of the intervention to the subject. For example, in the Edible DRA treatment, we said "If you take a bite of X, you can have a bite of Y."

Subjects were exposed to at least 3 sessions of each intervention. Subsequently, they progressed to the next treatment if a) acceptance was below 80% across all three sessions, b)

IMB was at or above 80% across all three sessions, c) a decreasing trend in acceptance was observed across the three sessions, or d) an increasing trend in IMB was observed across the three sessions. Contingent on 3 consecutive sessions with acceptance at or above 80% and IMB below 20%, we conducted a reversal to baseline, as outlined above.

Baseline. In baseline, no differential consequences (besides praise) were delivered for acceptance or consumption. Contingent on IMB, the bite was removed, and a new bite was presented at the next 30-s interval. Control probes yoked to the duration of the baseline sessions were conducted where no prompts to take a bite were delivered, and the plate was more than 0.5 m away from the subject but still present at the table. High levels of IMB in the baseline sessions relative to the control probes suggested the subject's behavior was sensitive to negative reinforcement in the form of escape.

NCR. For the NCR intervention, an MSWO (DeLeon & Iwata, 1996) was conducted with five videos the subject's parents reported were preferred. Before each session, we allowed the subject to pick from the top three videos to determine the video used for that session. Sessions were identical to baseline, except the subject had continuous access to the preferred video.

Simultaneous Presentation and Fading. Prior to the simultaneous presentation condition, an MSWO was conducted with seven condiments the subject's parents reported were preferred. Before each session, we allowed the subject to pick from the top three condiments to determine which condiment was used for each food item for that session. If no condiments were selected during the preference assessment, the experimenter chose for the subject based on parental report. Sessions were identical to baseline, except 5 cc of a preferred condiment was put on top of the nonpreferred food.

High-*P* Sequence. Prior to the high-*p* sequence condition, an MSWO was conducted with 10 food items the subject's parents reported were preferred. Moderately preferred foods were the middle three foods selected. During the high-*p* treatment, the experimenter presented three individual bites of three moderately preferred foods, each separated by 3 to 5 s, followed by one bite of nonpreferred food. If only one food item was selected during the preference assessment, the experimenter presented that food item three times followed by one bite of nonpreferred food.

Choice. In the choice presentation, sessions were identical to baseline, except two nonpreferred foods were presented, and the subject was instructed to select one. If no food was selected after 10 s, the experimenter provided a second verbal prompt to make a selection one additional time. After 30 s, the experimenter presented one of the food choices and initiated a trial (i.e., the experimenter chose randomly for the subject).

Edible Differential Reinforcement of Alternative Behavior (DRA). In the edible DRA condition, sessions were identical to baseline, except a bite of preferred food (identified in the previous MSWO) was delivered contingent on the subject's acceptance of a bite of nonpreferred food. The subject was allowed to choose between the top three items before each session.

Tangible DRA. We began with an MSWO of five tangible items, and the subject was allowed to choose between the top three items prior to each session. The tangible DRA condition was identical to the edible DRA condition with one exception. Rather than a bite of preferred food, access to a preferred tangible was delivered for 30 s contingent on acceptance.

High-Magnitude DRA. In the high-magnitude DRA condition, sessions were identical to the edible DRA condition, except three bites of a preferred food were delivered contingent on acceptance of a nonpreferred food. Each subject was given a choice between the edible condition (i.e., three bites of a preferred food) or the tangible condition (i.e., 5 min of a preferred tangible), and both selected the edible condition.

Escape Extinction (EE). In the EE condition, sessions were identical to baseline, except IMB no longer resulted in escape and a lack of acceptance was not allowed to occur. If possible, IMB was blocked to prevent escape from the bite presentation. Nonremoval of the spoon (NRS) involved holding the bite on a spoon to the subject's mouth until the food was accepted. If expulsion occurred, the food was re-presented for the remainder of the trial. If the subject held the bite in his or her mouth, the experimenter would deliver a verbal prompt to finish the bite every 30 s until the bite was consumed; however, this never occurred. Sessions were terminated if either an hour had elapsed from the start of the session or the subject was injured (e.g., redness, bruising, bleeding, etc.); however, no sessions were ever terminated due to subject injury.

Results

Table 1 displays the data obtained from the multiple preference assessments throughout the study. Only the items included in the treatments are shown, and the asterisks indicate the moderately preferred items identified in the edible preference assessments that was used in the high-*p* sequence intervention. No condiments were identified as preferred for Hank, and only two condiments were identified for Cole. Additionally, only two edibles were identified as preferred for Hank; therefore, the highest preferred edible was used in the DRA conditions and the other edible was used in the high-*p* sequence condition. Table 2 displays the average session duration data in minutes for each condition for each subject. Additionally, the total session duration until the identification of an effective treatment is displayed for each subject.

Figures 1 through 3 display the results of the treatments for each subject, and the top, middle, and bottom panels display each subject's acceptance, consumption, and IMB, respectively. For Mandy (Figure 1), near-zero or zero levels of acceptance and consumption occurred in the first two phases of baseline, and levels of IMB were at 100% in baseline. IMB did not occur during the control probes, suggesting IMB was maintained by negative reinforcement. In the NCR, simultaneous presentation, high-*p* sequence, and choice conditions, there were low or zero levels of acceptance and zero levels of consumption and high, stable levels of IMB across the conditions. There was, however, a decreasing trend in IMB levels (60%) in the simultaneous presentation condition, but this was due to the consumption of only the preferred condiment during the 30-s interval. In the edible, tangible, and high-magnitude DRA conditions, acceptance and consumption levels increased (21.1% and 20%, respectively) but remained stable, and IMB decreased to 80%. In the EE condition, levels of acceptance and consumption increased to 100%, and there were low levels of IMB. In the reversal to baseline after EE, levels of acceptance and consumption decreased (60% and 58.9%, respectively), and IMB increased (41.1%). In the final EE phase, levels of acceptance and consumption reversed back to 100%, and there were low levels of IMB.

For Cole (Figure 2), zero levels of acceptance and consumption occurred in the first phase of baseline, and levels of IMB were at 100% in baseline. IMB did not occur during the control probes, suggesting IMB was maintained by negative reinforcement. In the NCR and simultaneous presentation conditions, there were low or zero levels of acceptance and consumption, whereas there were high levels of IMB across the conditions. In the high-*p* sequence condition, levels of acceptance and consumption increased but were variable before stabilizing at 100%, and conversely, levels of IMB decreased but were variable before reaching zero levels. In the reversal to baseline, levels of acceptance and consumption decreased (6.7%), and IMB increased (93.3%).

For Hank (Figure 3), zero levels of acceptance and consumption occurred in the baseline condition, and levels of IMB were at 100% in baseline. IMB did not occur during the control probes, suggesting IMB was maintained by negative reinforcement. In all of the treatment conditions, there were zero levels of acceptance and consumption, and IMB was at 100%. Only two EE sessions, each terminated after an hour, were able to be conducted due to scheduling conflicts.

Discussion

The current study describes a methodology of evaluating antecedent and consequent interventions for subjects with food selectivity, progressing from least to most response effort and/or intrusiveness. An effective intervention was identified for the first two subjects using this model, but the third subject did not respond to any intervention. Mandy's acceptance and consumption increased following the implementation of the most intrusive procedure (i.e., EE), whereas Cole's acceptance and consumption increased following the implementation of the third antecedent intervention (i.e., high-*p* sequence), demonstrating idiosyncratic effects. Hank's acceptance and consumption never increased to clinically significant levels, suggesting a more restrictive type of EE (e.g., PG) might be necessary. PG involves the delivery of physical prompt to open the subject's mouth to accept the food, and this procedure might have been more effective for Hank than NRS.

We hypothesized subjects with a lower degree of food selectivity who consumed food items from most food groups might be more responsive to less intrusive, antecedent-based treatments (e.g., NCR, choice). However, Cole was highly selective in the single stimulus preference assessment (i.e., he did not eat any items from three food groups), and an antecedent intervention (i.e., high-*p* sequence) was effective in increasing his acceptance to clinically significant levels. Additionally, Mandy was the least selective of the three subjects, but she required the most invasive procedure to reach clinically significant levels of acceptance. Conversely, Hank demonstrated the highest degree of food selectivity (i.e., he only consumed one food in the single stimulus preference assessment), and the most restrictive intervention implemented (i.e., EE) was ineffective, suggesting highly selective subjects might require more invasive procedures.

These findings provide further empirical support for the use of the high-*p* sequence without an extinction component with children with food selectivity. Previous research had demonstrated success using topographically similar high-*p* and low-*p* instructions (i.e., presenting preferred edibles prior to a nonpreferred edible); however, more research was necessary to establish the utility of the intervention in the feeding context. In the current study, the presentation of three moderately preferred edibles as high-*p* instructions was effective for 1 of the 3 subjects, indicating it might be an effective antecedent intervention for the treatment of food selectivity. Additionally, we evaluated two other antecedent interventions with all three subjects (i.e., NCR and simultaneous presentation) with no success, suggesting these interventions might not be effective for increasing food acceptance in children with food selectivity. We implemented these interventions, however, using only videos in the NCR treatment and condiments in the simultaneous presentation treatment, and it is possible including other forms of reinforcement or edible preferences in these conditions might have been more effective. For instance, Hank did not prefer any condiments, and Cole preferred only 2 out of the 7 condiments. Therefore, further research is warranted to determine the utility of these antecedent interventions.

The order of the antecedent interventions was determined by parental report of the perceived response effort and intrusiveness of each intervention. Assessing parental report ensures both that each treatment is socially valid and that the treatments progress from least to most response effort and invasiveness from the parent's perspective. Many past studies have not assessed the social validity of feeding interventions, and researchers whose studies include an advancement-based approach of least to most restrictiveness determine treatment progression without surveying parents. The goal after identifying an effective intervention to treat food selectivity is to train caregivers to implement the intervention with other foods to support continued success for the child; therefore, it is important to ensure both that the parents regard the treatments as less effortful and that they are willing to implement them in the home. Although the data were not reported, the respective therapists for Mandy and Cole and the parents for Mandy were trained to implement the effective treatment.

This study aids in the identification of the most effective yet least intrusive antecedent interventions for subjects with food selectivity. Previous research had not yet evaluated the sequential implementation of antecedent interventions, but rather, had typically focused on each intervention in isolation. We have demonstrated a methodology that might save time and resources, as well as increase ethical practices by only increasing the intrusiveness of an intervention based on poor subject responding. For instance, we only implemented EE with Mandy following unsuccessful attempts with less intrusive interventions, demonstrating the need for a more invasive procedure to be effective. Additionally, it would have been unethical to implement EE with Cole when a less intrusive, antecedent intervention would have been effective. Behavior analysts have an obligation to implement the least restrictive, effective treatment, and it is important to identify these less intrusive interventions as efficiently as possible. Further, we evaluated seven interventions prior to EE. It is important to determine alternatives to extinction procedures; EE is an intrusive procedure not always socially valid or feasible. Future research should continue to evaluate feeding interventions without an extinction component.

The current study included several limitations. First, sessions were conducted in therapy rooms at a local clinic with the subject seated at a table next to the experimenter. Due to the topography and intensity of Hank's IMB, this environment and lack of resources were not conducive for the implementation of EE. For instance, he engaged in multiple attempts to cover his face in the experimenter's lap, lay on the floor, knock over the chair, and pick up the table. The implementation of the NRS procedure might have been more effective with a more controlled environment (e.g., secured or weighted tables) as well as more appropriate materials (e.g., a highchair with a tray). Additionally, the inclusion of the duration termination criterion might have affected the success of the EE intervention. We terminated both EE sessions with Hank after an hour, which might have negatively reinforced his problem behavior. However, due to the age of the subject and parental preference, we decided to include a termination criterion dependent on the duration of the session. It is possible longer sessions of EE might have resulted in an increase of acceptance and consumption for Hank.

Next, no data were collected on the intensity or topography of each subject's IMB throughout the study. Anecdotally, the intensity of IMB increased with the initial implementation of EE for both Mandy and Hank but subsequently decreased for Mandy as the treatment progressed. It would have been beneficial to have an accurate depiction of potential extinction bursts or extinction-induced variability that cannot be observed from the current data. Finally, the study was cost- and labor-intensive due to its length. Multiple food items for each subject had to be purchased weekly, and the food was disposed of following presentation in a session. Also, the typical length of subject participation in the study was about two months with sessions being conducted three to five times per week. Future research should evaluate ways to increase the efficiency of this model.

Although this study might require the inclusion of several subjects prior to concluding definitively that this model is an effective approach, Cole's data demonstrate the need to evaluate less intrusive interventions prior to implementing escape extinction. The inclusion of more subjects could serve to inform clinical practices about successful interventions for food selectivity and demonstrate the utility of this model. Further, future research should compare the effects of the treatment progression for subjects with food selectivity and food refusal to evaluate if antecedent interventions are more successful with less severe feeding difficulties. This research would provide further empirical support that, although intrusive, EE is necessary for children with total food refusal and higher degrees of food selectivity, whereas lower degrees of food selectivity could be alternatively treated with less intrusive, antecedent interventions (e.g., high-*p*).

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Table 1

Preference Assessment Data

	Videos	**Condiments**	**Edibles**	**Tangibles**
Mandy	Blippi Spot Peppa	Chocolate Ketchup Honey	Cheese Chocolate Yogurt Pudding* Strawberry* Pretzel*	Keyboard iPad Xylophone
Cole	Dude Perfect Ethan & Cole Dwarf Planet	Chocolate Honey	Yogurt* Watermelon* Bun*	N/A
Hank	ABC Song Ryan Toy Story Bots	None identified	Swedish fish Cracker*	iPad Marble Tracks

Table 2

Average Session Duration Data in Minutes

	Mandy	**Cole**	**Hank**
Baseline	8:09	4:37	4:57
Control	8:13	4:34	4:52
NCR	7:07	4:39	5:16
SP	8:49	4:41	4:58
High-P	9:53	7:30	6:31
Choice	6:46	-	4:54
E DRA	6:16	-	4:46
T DRA	6:57	-	4:37
H-M DRA	5:56	-	4:34
EE	5:23	-	1 hr 0 min
Total session duration until effective treatment identified	4 hr 2:20 min	1 hr 51:11 min	4 hr 26:15 min (effective treatment not identified)

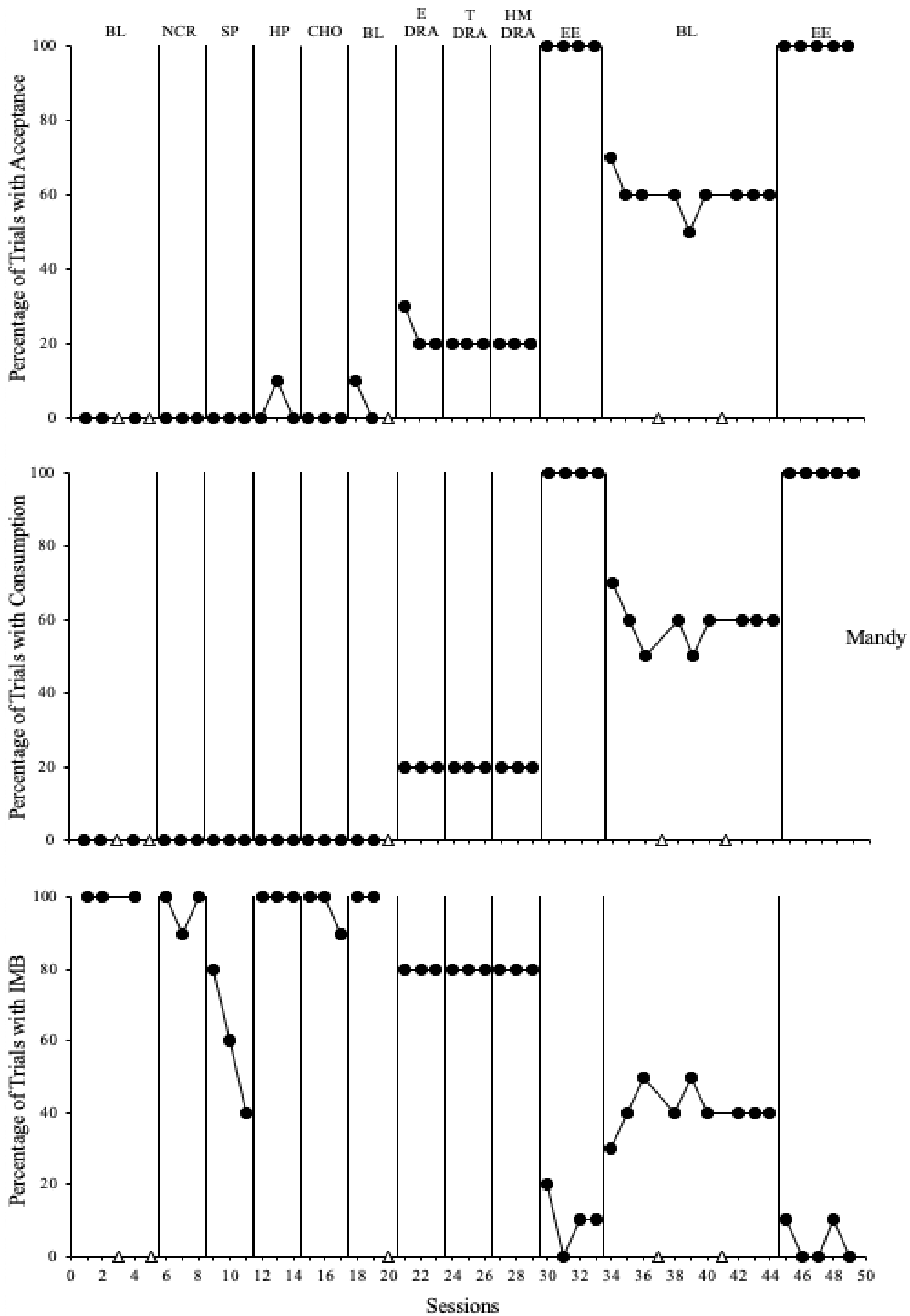

Figure 1. Treatment progression for Mandy. Closed circles are treatment data, and open triangles are no-demand control probes.

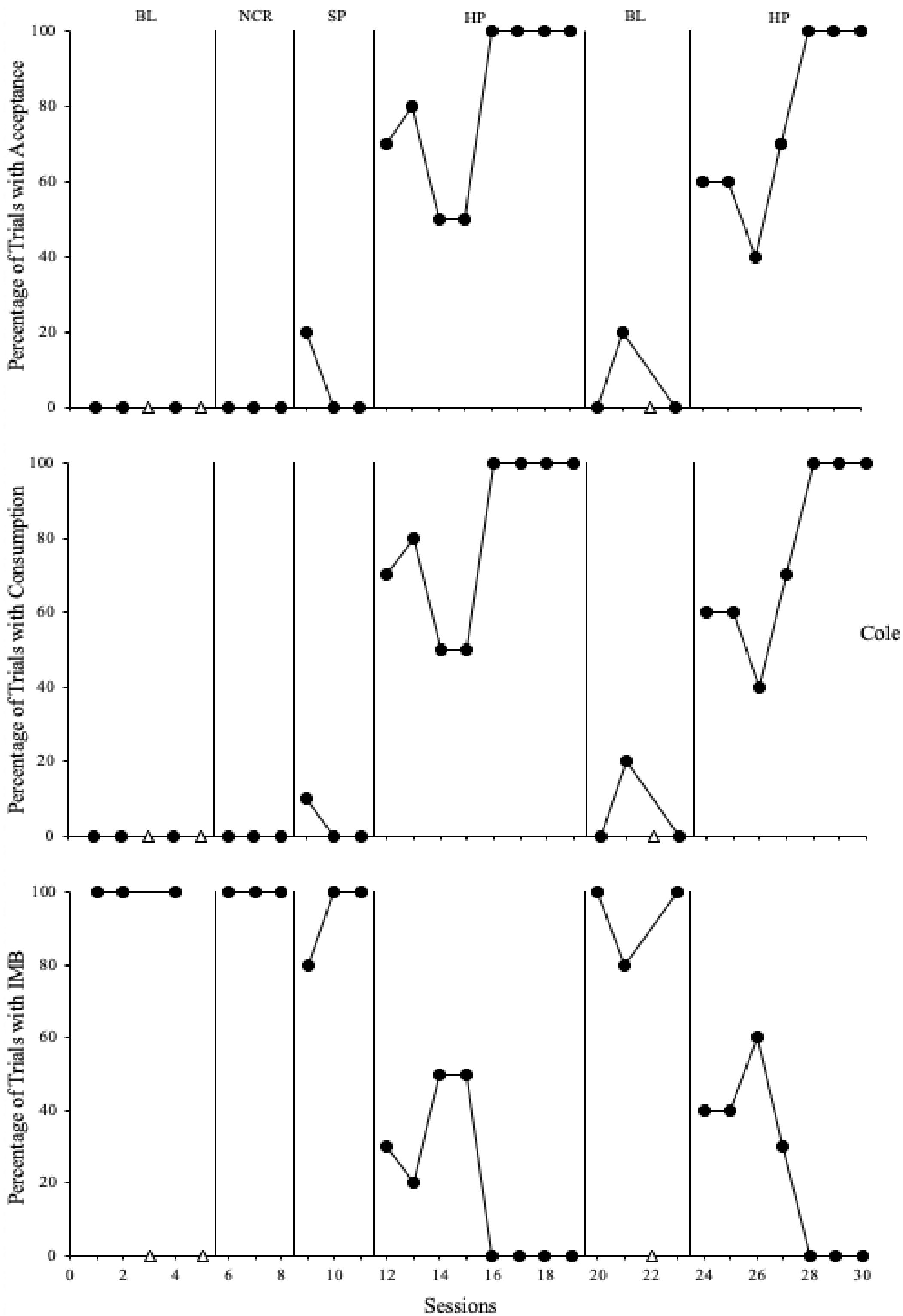

Figure 2. Treatment progression for Cole. Closed circles are treatment data, and open triangles are no-demand control probes.

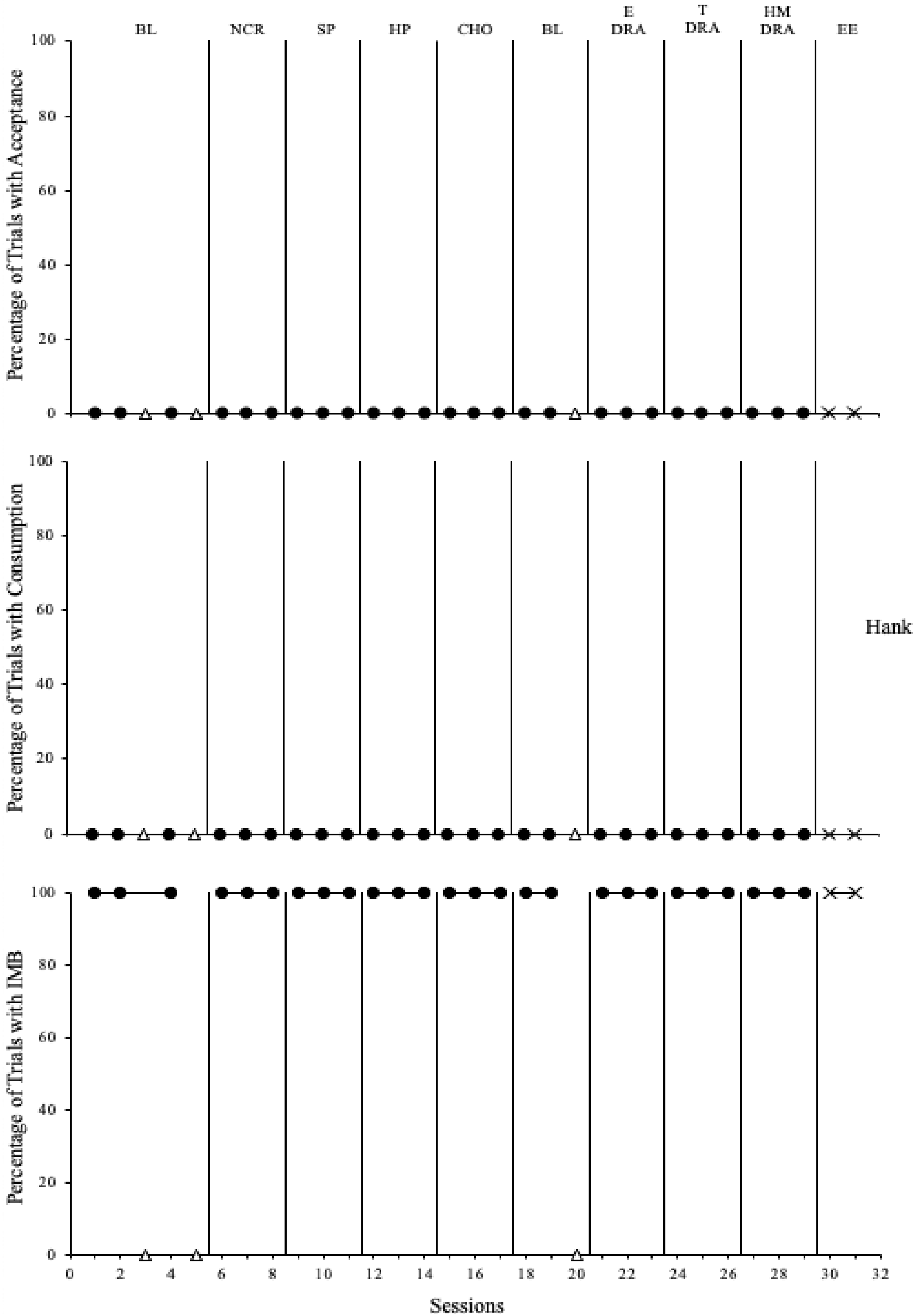

Figure 3. Treatment progression for Hank. Closed circles are treatment data, open triangles are no-demand control probes, and X's are sessions terminated at an hour.

Appendix A. List of food items from five food groups used to determine food selectivity.

Fruits
- Orange
- Banana
- Apple
- Strawberry
- Blueberry
- Raspberry
- Watermelon
- Grape

Vegetables
- Celery
- Tomato
- Carrot
- Cucumber
- Green Bean
- Green Pepper
- Corn
- Broccoli

Grains
- Bread
- Cereal
- Oatmeal
- Rice
- Pasta
- Tortilla
- Crackers
- Pretzels

Meats
- Chicken
- Ham
- Turkey
- Roast beef
- Fish sticks

Dairy
- Mozzarella String Cheese
- Cheddar Cheese
- Yogurt
- Pudding
- Greek Yogurt