Summer 2010

An evaluation of motivating operations in the treatment of food refusal

Melanie Hope Bachmeyer
University of Iowa

AN EVALUATION OF MOTIVATING OPERATIONS IN THE TREATMENT OF FOOD REFUSAL

by

Melanie Hope Bachmeyer

An Abstract

Of a thesis submitted in partial fulfillment of the requirements
for the Doctor of Philosophy degree in
Psychological and Quantitative Foundations (School Psychology)
in the Graduate College of The University of Iowa

July 2010

Thesis Supervisors: Professor David P. Wacker
Associate Professor John A. Northup

ABSTRACT

Previous research on the assessment of pediatric feeding disorders has shown that negative reinforcement (escape) plays a major role in the maintenance of food refusal and that escape extinction (EE) may be necessary in the treatment of severe food refusal. The current study examined the influence of two potential motivating operations (MOs) on escape from bite presentations for 3 children with severe food refusal: (a) noncontingent positive reinforcement (NCR) and (b) food satiation (as a result of enteral nutritional support). The abolishing effects of NCR on negative reinforcement for refusal behaviors were demonstrated in Experiment 1 when escape was allowed for food refusal and in Experiment 2 during demand fading across a hierarchy of bite placements. The interactive effects of NCR and food satiation on negative reinforcement for escaping bite presentations (within a hierarchy of bite placements) were demonstrated in Experiment 3. NCR abolished escape as a reinforcer and food satiation established escape as a reinforcer. The combined MO effects of NCR and food deprivation resulted in decreased refusal behaviors and increased acceptance across all bite placements in Experiment 3 even though escape was allowed. Results extend the existing bodies of literature on the competition between positive and negative reinforcement and the effects of specific biological conditions on escape-maintained behavior. Implications for treatment and future research are discussed.

Abstract Approved: ____________________________________
Thesis Supervisor

____
Title and Department

____
Date

Thesis Supervisor

Title and Department

Date

AN EVALUATION OF MOTIVATING OPERATIONS IN THE TREATMENT OF FOOD REFUSAL

by

Melanie Hope Bachmeyer

A thesis submitted in partial fulfillment of the requirements
for the Doctor of Philosophy degree in
Psychological and Quantitative Foundations (School Psychology)
in the Graduate College of The University of Iowa

July 2010

Thesis Supervisors: Professor David P. Wacker
Associate Professor John A. Northup

Graduate College
The University of Iowa
Iowa City, Iowa

CERTIFICATE OF APPROVAL

PH.D. THESIS

This is to certify that the Ph.D. thesis of

Melanie Hope Bachmeyer

has been approved by the Examining Committee for the thesis requirement for the Doctor of Philosophy degree in Psychological and Quantitative Foundations (School Psychology) at the July 2010 graduation.

Thesis Committee: ______________________________
David P. Wacker, Thesis Supervisor

____
John A. Northup, Thesis Supervisor

____
Linda J. Cooper-Brown

____
Joel E. Ringdahl

____
Stewart W. Ehly

In loving memory of my father

ACKNOWLEDGMENTS

Each of us in life has been influenced by people, events, and environments that have changed and shaped us and caused us to become our ultimate selves. I am fortunate to have been influenced by so many remarkable people and experiences that have made me the researcher and clinician that I have become.

My parents, whose compassion for children inspired me to work with children. My father, who actively sought out new learning experiences and opportunities, especially those grounded in science, and who instilled this passion in me.

Cathleen, Meeta, and Greg, who introduced me to the field of applied behavior analysis and the technology to help children with feeding disorders; and Cathleen, who sparked my interest in clinical research and molded my foundation.

My mentor Dave, who took my passion to learn and ran with it, beyond my own expectations and those that would have made my father proud; who taught me to think, to really think; to persist; to share my knowledge for the right reasons; to reach for the stars with both confidence and humility; to serve children and families with enthusiasm and integrity; and to be an independent, original, empirical researcher.

Linda, who has shown me how to see the humor in any circumstance, and more importantly, who provided me the opportunity to spread my wings.

Joel, John, and Stewart, who introduced me to different perspectives of my work, which will presumably influence my thinking and future work.

Brenda and Anu, who assisted me with data collection for this study and others. My dear friend, Brenda, who also supported me in a countless number of other ways throughout my graduate career.

Agnes, who supported me in the editing process on this project as well as other research-related endeavors.

All of the families who allowed me to work with their children and share in their successes and moments of joy.

And Andre, who brought into my life just what I needed, exactly when I needed it.

TABLE OF CONTENTS

LIST OF TABLES

Table

LIST OF FIGURES

Figure

CHAPTER I

INTRODUCTION

Overview

A feeding disorder is diagnosed when, despite persistent attempts by caregivers, a child's behavior results in failure to eat or drink sufficient quantities or types of food to sustain weight, meet nutritional needs, and/or grow (Babbitt, Hoch, & Coe, 1994; Budd et al., 1992). The reported prevalence of feeding problems varies between 2% and 29% in typically developing children and is more frequent (between 33% and 80%) among children with developmental disabilities (Babbitt, Hoch, Coe, Cataldo, et al., 1994; Burklow, Phelps, Schultz, McConnell, & Rudolph, 1998; Luiselli, 1994; Palmer & Horn, 1978). The variability among prevalence estimates may be attributed to the range of complications associated with feeding problems, from mild (e.g., missed meals) to total food refusal. Children exhibiting total food refusal accept only a highly restricted range and quantity of foods or refuse all food, resulting in dependence on liquid oral feedings (e.g., bottle feeds), or enteral nutritional support (e.g., gastrostomy- [G-], or nasogastrostomy- [NG-] tube feeds).

Severe food refusal, if left untreated, can be detrimental to a child's development. Feeding problems can result in weight loss, malnutrition, lethargy, impaired mental or physical development, and even death (Christophersen & Hall, 1978). The successful treatment of feeding problems has a number of important implications, such as improved health in children, improved quality of life in children and families, decreased mental health problems in families, and reduced risk of long-term eating problems (Christophersen & Hall; O'Brien, Repp, Williams, & Christophersen, 1991).

Severe feeding problems are often not the result of a single etiology but represent a complex interaction among a variety of factors including medical issues, environmental variables, and oral-motor difficulties (Kedesdy & Budd, 1998). Some children with feeding problems have a history of medical problems (e.g., gastroesophageal reflux disease; GERD) or oral motor impairments (e.g., a cleft palate), which result in pain and discomfort being associated with oral feedings. Some children are born prematurely or have significant medical complications as infants, which may preclude or disrupt oral feedings for a period of time and thus interrupt the normal feeding cycle. Such complications, however, do not solely account for the development and maintenance of food refusal. Biological and environmental factors likely interact to develop and maintain feeding problems. Environmental factors include behavioral mismanagement during meals (i.e., inadvertent reinforcement of inappropriate eating patterns) and lack of exposure to appropriate food textures (Babbitt, Hoch, & Coe, 1994; Palmer, Thompson, & Linscheid, 1975; Piazza, Fisher et al., 2003). For example, a child with severe GERD may develop an aversion to food because of the pain and discomfort caused by reflux. Pairings of food and pain may lead to food refusal when a caregiver attempts to feed the child. If a caregiver typically responds to a child's refusal of food by removing bite offers or terminating the meal, then the child may be more likely to display refusal behaviors in the future to escape or avoid bite offers even after the GERD has been treated. Thus, the child's refusal behaviors may come to be maintained by negative reinforcement (i.e., contingent removal of food presentations) and food-related problem behaviors may continue long after the physiological problem has been treated.

The basic principles of operant conditioning, which emphasize the causal relationships between behavior and the social environment, have been widely researched in the assessment and treatment of problem behaviors. Such research has led to the successful application of techniques based on behavioral principles to treat childhood feeding disorders (e.g., Babbitt, Hoch, & Coe, 1994; Kerwin, 1999). Kerwin evaluated the methodological rigor of studies on the treatment of feeding problems, based on the proposed criteria of the Task Force on Promotion and Dissemination of Psychological Procedures (1995). She suggested that behavioral treatments are methodologically rigorous and represent a valid approach to treating feeding problems for at least some children.

Historically, the treatment of feeding problems within the operant literature has focused on consequence-based techniques (e.g., Ahearn, Kerwin, Eicher, Shantz, & Swearingin, 1996; Babbitt, Hoch, Coe, Cataldo, et al., 1994; Cooper et al., 1995; Hoch, Babbitt, Coe, Krell, & Hackbert, 1994). The success of these consequence-based treatments has led to a second generation of studies examining antecedent variables that influence the functional relationships between mealtime behavior and environmental consequences. Within the operant conditioning model, antecedent variables that momentarily alter the value of an event or item as a reinforcer are called motivating operations (Michael, 1982, 1993). Motivating operations either increase the value of a reinforcer (establishing operation) or decrease the value of a reinforcer (abolishing operation; Michael, 1982, 1993). Identification of an MO can lead directly to the treatment of food refusal or identify treatment components that increase the effectiveness of a treatment package.

In the current study, I examined the influence of two potential MOs on bite acceptance for 3 children with severe food refusal: (a) noncontingent reinforcement, a variable that may decrease the aversiveness of the meal thereby abolishing escape as a reinforcer (abolishing operation); and (b) food satiation, a variable that may increase the aversiveness of the meal thereby establishing escape as a reinforcer (establishing operation). In the following sections, I discuss the role of negative reinforcement in the maintenance and treatment of feeding problems, the role of positive reinforcement in the treatment of escape-maintained behaviors, the effects of biological variables in the assessment and treatment of escape-maintained behaviors, and noncontingent positive reinforcement and food satiation as potential motivating operations.

The Role of Negative Reinforcement in the Maintenance and Treatment of Feeding Problems

Previous research on the assessment of pediatric feeding disorders has shown that negative reinforcement (escape from or avoidance of bites of food) plays a major role in the maintenance of food refusal. Piazza, Fisher, et al. (2003) conducted functional analyses of the inappropriate mealtime behaviors of 12 children. Negative reinforcement (escape from bites of food) served as the most frequently identified maintaining variable. Ninety percent of the children whose functional analysis was differentiated showed sensitivity to negative reinforcement.

Previous research on the treatment of pediatric feeding disorders suggests that procedures based on negative reinforcement (i.e., escape extinction techniques such as nonremoval of the spoon [NRS] or physical guidance) often are effective in the treatment of food refusal (e.g., Ahearn et al., 1996; Cooper et al., 1995; Hoch et al., 1994; Patel, Piazza, Martinez, Volkert, & Santana, 2002; Piazza, Patel, Gulotta, Sevin, & Layer, 2003; Reed et al., 2004). Results of some studies suggest that escape extinction (EE) may be necessary to increase food acceptance for some children (e.g., Ahearn et al., 1996; Hoch et al., 1994; Patel, Piazza, Martinez, et al., 2003; Piazza, Patel, et al., 2003; Reed et al., 2004). For example, Piazza, Patel, et al. (2003) examined the individual and combined effects of positive reinforcement and EE during the treatment of severe or total food refusal exhibited by 2 children. Piazza and colleagues compared the effects of contingent positive reinforcement (DRA), EE, and DRA combined with EE on each child’s food and fluid refusal. Results showed that acceptance increased only when EE (NRS or physical guidance) was implemented independent of whether DRA was present or absent. Similarly, Reed et al. (2004) examined the individual and combined effects of noncontingent positive reinforcement (NCR), EE, and a combination of NCR and EE in the treatment of total food refusal exhibited by 4 children. Results suggested that acceptance increased only when EE was implemented independent of whether NCR was present or absent. Results of Piazza, Patel, et al. (2003) and Reed et al. (2004) showed that EE may be necessary to increase food/liquid acceptance for some children.

Although previous research has shown that EE is effective, it has been associated with a number of side effects, such as extinction-induced collateral behaviors (Lerman, Iwata, & Wallace, 1999). Extinction bursts are initial increases in target and collateral problem behaviors (e.g., extinction-induced aggression; Goh & Iwata, 1994; Lerman & Iwata, 1995; Lerman & Iwata, 1996; Lerman et al., 1999). Treatment fidelity may be compromised as a result of the child's size or strength when rates and intensity of problem behaviors increase. Moreover, when increases in desired behaviors (e.g., bite acceptance) do not occur immediately, and problem behaviors increase or emotional responding (e.g., crying) emerges, the situation may become unacceptable to some caregivers. Thus, EE procedures may not be ideal in less controlled situations, such as when a parent is attempting to feed a child at home.

The Role of Positive Reinforcement in the Treatment of Escape-Maintained Behavior

Some researchers have shown that positive reinforcement for compliance can increase compliance and decrease escape-maintained problem behavior across a variety of demand contexts even when problem behavior continues to result in escape, precluding the need for EE (e.g., DeLeon, Neidert, Anders, & Rodriguez-Catter; 2001; Fischer, Iwata, & Mazaleski, 1997; Harding et al., 1999; Lalli et al., 1999; Piazza, Contrucci, Hanley, & Fisher, 1997). For example, Lalli et al. (1999) compared the effects of reinforcing compliance with either positive reinforcement (edible items) or negative reinforcement (a break) on the escape-maintained problem behavior of 5 individuals. Both procedures were examined with and without EE. Results showed that compliance was higher and problem behavior was lower for all participants when compliance resulted in edible items rather than a break. Treatment gains were achieved without the use of EE. Similarly, DeLeon and colleagues (2001) compared the effects of reinforcing compliance with either positive reinforcement (edible items) or negative reinforcement (a break) on the escape-maintained problem behavior of a child with autism without the use of EE. Results suggested that compliance was higher and problem behavior was lower when compliance resulted in edible items rather than a break. Treatment gains were achieved without the use of EE. Results of Lalli et al. (1999) and DeLeon et al. (2001) suggested that for some individuals, positive reinforcement may abolish escape as reinforcement within demand contexts resulting in an increase in compliance without the use of EE.

Specific to the feeding demand context, researchers have shown that positive reinforcement for bite acceptance may increase food consumption even when food refusal continues to result in escape (e.g., Cooper et al., 1999; Levin & Carr, 2001; Riordan, Iwata, Wohl, & Finney, 1980; Riordan, Iwata, Finney, Wohl, & Stanley, 1984; Wilder, Normand, & Atwell, 2005). For example, Riordan et al. (1984) examined the effects of positive reinforcement (preferred foods) on acceptance of non-preferred foods in the treatment of the feeding problems of 4 children with developmental disabilities who exhibited either low overall or highly selective food intake. Results showed that delivery of preferred foods contingent on acceptance of non-preferred foods resulted in increased food intake for all 4 children (without the use of EE). Similarly, Cooper et al. (1999) compared the effects of varying the quantity and/or the quality of positive reinforcement (i.e., contingent access to preferred foods/drinks) paired with acceptance of bites of non-preferred foods in the treatment of 4 children who exhibited either low overall or highly selective food intake. Increasing the quantity of reinforcers (i.e., number of sips of Pepsi™ or bites of potato chips) provided contingent on acceptance of bites of non-preferred foods resulted in an overall increase in food acceptance (without the use of EE) for 1 participant. Increased food consumption was achieved in the Riordan et al. (1984) and Cooper et al. (1999) studies without the use of EE, suggesting that positive reinforcement for appropriate behavior (food acceptance) effectively competed with negative reinforcement for problem behavior (food refusal) for those children.

Although some previous studies have suggested that EE may be necessary to increase and maintain food consumption (e.g., Ahearn et al., 1996; Cooper et al., 1995; Hoch et al., 1994; Piazza, Patel et al., 2003), results of other studies provided evidence that positive reinforcement may abolish escape as reinforcement in the feeding context (e.g., Cooper et al., 1999; Levin & Carr, 2001; Riordan et al., 1984; Riordan et al., 1980; Wilder et al., 2005). However, all participants in the studies conducted to date in which EE was not necessary were children who had established eating patterns (i.e., the problem involved an inadequate quantity of foods consumed and/or highly selective intake of the types of food consumed). No studies have demonstrated increases in food acceptance with children displaying total food refusal using only positive reinforcement.

Noncontingent Positive Reinforcement as a Motivating Operation

Studies demonstrating that positive reinforcement may abolish escape as reinforcement within the demand context have largely examined the effects of contingent schedules of positive reinforcement (DRA). Noncontingent schedules of positive reinforcement (NCR) have been examined infrequently. One exception is a study conducted by Harding and colleagues (1999) who examined the influence of NCR on the escape-maintained problem behavior of 2 children. The children were provided a series of concurrent choice options that varied availability of noncontingent access to adult attention, noncontingent access to preferred toys, and presentation of demands. Results showed that both children consistently allocated their time to choice areas that included noncontingent adult attention when no demands were presented. When adult attention choice areas included the presentation of demands, the children displayed differential patterns of behavior that appeared to be influenced by the presence or absence of noncontingent access to highly preferred toys. Thus, Harding and colleagues identified conditions involving noncontingent schedules of positive reinforcement that changed the

MO for escape-maintained behaviors resulting in increased compliance without the use of EE.

Other researchers have examined the effects of NCR on escape-maintained food refusal (Cooper et al., 1995; Reed et al., 2004; Wilder et al., 2005) with mixed findings. Wilder and colleagues examined the use of NCR to decrease self-injurious behavior (SIB) and increase food acceptance in a child who was diagnosed with developmental disabilities and who exhibited inadequate and selective food intake. Treatment involved noncontingent (continuous) access to a video during meals, which resulted in a decrease in SIB and an increase in food acceptance without the use of EE. Cooper et al. (1995) used treatment packages including positive reinforcement (DRA and/or NCR) and EE (NRS) to increase the food acceptance of 4 children exhibiting total food refusal. Subsequent removal of NCR (i.e., noncontingent access to toys and attention) and EE components individually with 1 of the participants was associated with decreases in the number of bites accepted by the participant. Reed et al. (2004) examined the individual and combined effects of NCR and EE in the treatment of total food refusal exhibited by 4 children. Acceptance increased only when EE was implemented independent of whether NCR was present or absent. However, NCR contributed to the effects of EE during treatment in terms of reduced refusal behaviors and negative vocalizations for 2 of the participants.

The results of Wilder et al. (2005), Cooper et al. (1995), and Reed et al. (2004) suggest that NCR may have changed the MO for escape as reinforcement. Wilder et al. (2005) showed that NCR was solely responsible for food acceptance. Cooper et al. (1995) demonstrated that NCR influenced the maintenance of food acceptance. Reed et al. (2004) showed that although NCR did not influence food acceptance, it did influence refusal behaviors (when combined with EE) for some of the participants. Collectively, the results of these studies suggest that NCR may change the MO for escape as reinforcement for at least some children. If an aversive antecedent (e.g., bite offer) becomes less aversive in the presence of preferred stimuli, this should decrease the motivation for feeding behaviors maintained by negative reinforcement. However, no studies have demonstrated increases in acquisition of food acceptance as a result of this change in MO with children displaying total food refusal.

The Effects of Biological Variables in Assessment and Treatment of Escape-Maintained Behaviors

Biological variables such as illness, allergies, and fatigue may serve as MOs by altering the functional relationship between behavior and the environment (Carr & Smith, 1995). An emerging literature has demonstrated the interaction between biological variables and behavior (e.g., Carr & Owen-DeSchryver, 2006; Christensen et al., 2009; Kennedy & Meyer, 1996; O'Reilly, 1995, 1997; Reed, Dolezal, Cooper-Brown, & Wacker, 2005). Kennedy and Meyer, O'Reilly, and Reed et al. (2005) each demonstrated that specific biological conditions (i.e., sleep deprivation, allergy symptoms, and otitis media) increased the likelihood of escape-maintained behavior. In terms of MOs, this means that the biologic variable increased the value of negative reinforcement. For example, O'Reilly (1995) conducted a functional analysis to identify the consequences that maintained aggressive behavior and the relationship between those consequences and sleep deprivation for an individual with developmental disabilities. Results showed that aggression was maintained by negative reinforcement and that aggression was more likely to occur when sleep deprivation was present. Similarly, Kennedy and Meyer (1996) showed that biological events either independently or in combination could affect functional analysis outcomes with 3 participants. Specifically, an escape function was identified only when allergy symptoms were present with 1 participant. An increase in escape-maintained problem behavior was observed when a 2nd participant was sleep deprived. A 3rd participant demonstrated an increase in problem behavior across all conditions of the functional analysis when sleep deprived, with the highest rates occurring in the escape condition. O'Reilly (1995) and Kennedy and Mayer (1996) demonstrated that biological variables may increase the value of negative reinforcement.

Identification of biological variables may lead directly to treatment or influence the effectiveness of treatment. One study in the behavioral feeding literature provides preliminary evidence that biological variables may alter the effectiveness of behavioral treatments (Reed et al., 2005). Reed et al. (2005) evaluated the interactive effects of a biological variable (disrupted sleep) and behavioral treatment components on the bite acceptance of a child who exhibited severe food refusal. Specifically, Reed and colleagues examined the influence of disrupted sleep (i.e., the child had to be awakened prior to the start of the meal) on the effectiveness of DRA with and without EE. Results showed food acceptance was less likely to persist during meals following disrupted sleep when DRA was used. Food acceptance increased to clinically acceptable levels only when EE was added to the intervention, regardless of sleep disruption. Although EE was necessary to achieve clinically acceptable levels of food acceptance, results from the sleep comparison showed that food acceptance varied as a function of whether the participant's sleep had been disrupted. Thus, sleep disruption may have increased the aversiveness of bite offers thereby increasing the value of escape as reinforcement. Results of Reed et al. (2005) provide preliminary evidence that remediation of problem behavior associated with biological variables should plausibly be linked with the specific variable underlying the biological condition (Carr & Smith, 1995).

Food Satiation as a Motivating Operation

A potential biological variable that may influence behavior during treatment of severe or total food refusal is food satiation. Children who exhibit severe or total food refusal often require enteral nutritional support, such as NG- or G-tube feedings, to sustain their growth. As oral feedings are introduced with children who receive nutritional support, it is likely that food satiation-related effects during oral feedings may occur. Thus, food satiation caused by supplemental feedings may increase the aversiveness of food presentation, thereby increasing the value of escape as reinforcement.

Basic and applied studies on satiation and deprivation have shown that food satiation may reduce subsequent caloric intake in humans and other animals (e.g., Gossette, 1971; Johnson, Pesek, & Newland, 2009; Smith & Duffy, 1957; Vollmer & Iwata, 1991). For example, a basic study conducted by Smith and Duffy (1957) examined the effects of deprivation and satiation on the intake of sucrose and saccharine solutions by rats. Results showed consumption of smaller quantities of both substances were associated with the satiation group. In a study conducted by Vollmer and Iwata (1991) examining the influence of MOs on the effectiveness of reinforcers, the researchers assessed the effects of food satiation and deprivation on a simple operant response (i.e., putting a block in a hole), which resulted in contingent access to a food item with 3 individuals with developmental disabilities. Results showed that response rates for all 3 participants were lower during conditions of satiation.

Linscheid (1999, 2006) commented on the lack of studies conducted on food deprivation manipulation procedures in the behavioral feeding literature. Linscheid (2006) described a model of inpatient services for pediatric feeding problems, which included a food deprivation manipulation component. The procedure involved eliminating all supplemental feeding at the onset of behavioral treatments and re-instating supplemental feeding as needed, depending on the child’s weight loss. Byars et al. (2003) described a multicomponent behavioral clinic program for the treatment of pediatric feeding problems. One component involved reducing supplemental feedings by more than 50% of the preadmission levels at the onset of treatment. Although Linscheid (2006) and Byars et al. (2003) recommended that food deprivation manipulation procedures occur during clinical treatment of pediatric feeding problems, no studies have systematically examined their effects.

Purpose of the Current Investigation

The purpose of this three-experiment study was to examine the influence of two potential MOs on refusal of bite presentations. In Experiment 1, I examined the abolishing effects of NCR on negative reinforcement (escape) during bite presentations with a child who was dependent on G-tube feedings. EE was used only to ensure that contact of bite presentations occurred at the child's lips; the child was allowed to refuse (escape) bites from entering his mouth (i.e., just past his lips by his teeth). The presence and absence of NCR (continuous access to positive reinforcement in the form of preferred items/activities) were examined to evaluate whether NCR decreased the aversiveness of the meal, thus decreasing the child's motivation to escape bites from entering his mouth (i.e., functioned as an abolishing operation [AO]).

When a bite of food enters a child's mouth, the child can accept the bite either past the lips (by the teeth), further inside the mouth on the mid-tongue, or on the mid-tongue with mouth closure, allowing the food to be deposited. In Experiment 2, the abolishing effects of NCR on negative reinforcement (escape) during bite presentations were examined across this hierarchy of bite placements with a 2nd child, who was dependent on liquid feedings. Specifically, demand fading combined with EE was used to increase bite acceptance across the hierarchy. Required bite placement was increased within the hierarchy at each consecutive fading step. EE occurred only for acceptance of the required bite placement at each fading step. Escape was permitted for all successive bite placements within the hierarchy. This enabled me to examine the AO effects of NCR on negative reinforcement in the form of escape from bite presentations across a hierarchy of bite placements.

The individual and combined MO effects of NCR and food-related satiation on negative reinforcement (escape) during bite presentations were examined in Experiment 3 with a 3rd child, who was dependent on G-tube feedings. This was the first study to systematically examine the effects of tube-feed manipulations as an MO in the treatment of food refusal. Food-related satiation was examined by (a) manipulating the volume of overnight tube feeds (i.e., tube-feed satiation vs. deprivation) and (b) observing oral feedings within close and distant temporal proximity to overnight tube feeds. EE was used to insure that contact of bite offers occurred at the child's lips, but the child was allowed to refuse (escape) bites from entering her mouth. The presence and absence of NCR and food satiation and deprivation were examined individually and in combination. This enabled me to examine the individual and combined AO effects of NCR and food deprivation on negative reinforcement for food refusal.

CHAPTER II

LITERATURE REVIEW

The purpose of this chapter is to provide a brief review and practical guidelines for the treatment of severe food refusal in children. Feeding difficulties are relatively common among typically developing children, with reported prevalence rates of up to 29%. Feeding difficulties are even more common (between 33% and 80%) among children with developmental disabilities (Babbitt, Hoch, & Coe, 1994; Burklow et al., 1998; Luiselli, 1994; Manikam & Perman (2000); Palmer & Horn, 1978). Although the majority of feeding difficulties are transitory and require little to no treatment, approximately 4% to 10% of these children require intensive assessment and intervention (Christophersen & Hall, 1978; Kessler & Dawson, 1999; Linscheid, 2006). Children exhibiting severe food refusal accept only a highly restricted range and quantity of foods or refuse all food, resulting in dependence on liquid oral feedings (e.g., bottle feeds) or enteral nutritional support (e.g., gastrostomy- [G-] or nasogastrostomy- [NG-] tube feeds). If left untreated, severe food refusal can result in weight loss, malnutrition, lethargy, impaired mental or physical development, and even death (Christopherson & Hall, 1978). These children represent one subgroup that may require intensive intervention to reduce problematic mealtime behaviors and increase oral consumption of food and liquids.

Severe feeding problems are often not the result of a single etiology, but represent a complex interaction between biological factors (e.g., medical conditions, physiological anomalies) and environmental variables (Kedesdy & Budd, 1998). Some children with feeding problems have a history of medical problems (e.g., Gastroesophageal Reflux Disease; GERD) or physiological impairments (e.g., a cleft palate), which resulted in pain and discomfort being associated with oral feedings. Some children are born premature or have significant medical complications as infants, which may preclude or disrupt oral feedings for a period of time and thus interrupt the normal feeding cycle. Children who are dependent on tube feedings may miss oral feeding experiences during the "critical period" for development of oral feeding skills (between 6 and 7 months of age) making later establishment of oral feeding more difficult. Such complications, however, do not solely account for the development and maintenance of food refusal.

Biological and environmental factors likely interact to develop and maintain feeding problems. Environmental factors include behavioral mismanagement during meals (i.e., inadvertent reinforcement of inappropriate eating patterns) and lack of exposure to appropriate food textures (Babbitt, Hoch, & Coe, 1994; Palmer, Thompson, & Linscheid, 1975; Piazza, Fisher et al., 2003). For example, a child with severe GERD may develop an aversion to food because of the pain and discomfort caused by reflux. Pairings of food and pain may lead to problematic mealtime behaviors (e.g., crying, head, turning, batting at the spoon) when a caregiver attempts to feed the child. Faced with problematic mealtime behaviors, caregivers may terminate the meal or wait for the child to "calm down" before continuing. Caregivers also may provide increased attention following problematic mealtime behavior. For example, following problem behaviors, a caregiver may coax the child to eat (e.g., "come on, you like it"), provide reprimands (e.g., "don't throw your food"), attempt to soothe or calm the child, or alter the quantity or quality of attention (e.g., play games with the child such as "here comes the airplane"). Some caregivers also may provide toys following problematic mealtime behavior to calm or distract the child. From a caregiver's perspective, these consequences are logical because they may produce the immediate effect of temporarily stopping the undesirable behavior (i.e., the caregiver's behavior may be maintained by negative reinforcement). However, from a functional perspective, such consequences can worsen mealtime problems over the long term if they function as reinforcement, resulting in continued problematic behaviors long after the biological problem (e.g., GERD) has been treated.

A body of literature exists in applied behavior analysis that establishes some empirically supported treatments for these feeding problems. A review conducted by

Kerwin (1999) evaluated the methodological rigor of studies on the treatment of feeding problems (between 1970 and 1997), based on the proposed criteria of the Task Force on Promotion and Dissemination of Psychological Procedures (1995). Using these guidelines, of the 79 studies identified, only 29 met the methodological criteria. All 29 evaluated behavioral interventions suggesting that behavioral treatments can be methodologically rigorous and represent a valid approach to treating feeding problems for at least some children.

Studies meeting the methodological criteria of Kerwin (1999) that targeted the treatment of severe or total food refusal most often used a multi-component treatment package that included differentially reinforcing appropriate mealtime behaviors (e.g., food acceptance and swallowing) and eliminating escape following problematic mealtime behaviors (e.g., food refusal or crying). Thus, differential reinforcement plus escape extinction (EE) are the most common treatments for childhood feeding problems. During the past decade, the behavioral feeding literature has advanced our understanding of the functional relationship between mealtime behavior and environmental variables by further isolating the treatment effects of these components and via the development of other operant-based assessment and treatment techniques. Bachmeyer (2009) provided a review and offered guidelines for the assessment and treatment of food selectivity and inadequate intake in children. The purpose of this chapter is to provide a current review of procedures that have been utilized in the assessment and treatment of severe food refusal and to provide a practical guide for clinicians who develop behavioral interventions in outpatient settings.

A systematic search of articles published between 1970 and 2009 in peer-reviewed journals targeting the treatment of oral feeding in children was conducted via PsychINFO and ERIC using the keywords “feeding disorders,” “feeding problems,” and “food refusal.” The references within selected articles were searched for additional relevant sources. Finally, each article was reviewed to determine if it met the inclusionary criteria for this review. Studies were included if (a) behavioral procedures were examined in the treatment of childhood feeding problems, (b) single-subject experimental designs were used, and (c) one or more participants exhibited severe or total food refusal. Thirty-five studies met the inclusion criteria (see Table 1, end of Chapter I).

Procedures Shown to be Effective in the Assessment and Treatment of Severe Food Refusal

Thirty-one of the 35 studies assessed the consequences maintaining problematic mealtime behavior or used consequence-based procedures in treatment. Fifteen studies assessed the influence of antecedent variables or used antecedent-based procedures (alone or in combination with consequence-based procedures). A review of these studies indicated that, historically, assessment and treatment of food refusal within the operant literature has focused on the role of consequences in the maintenance of feeding problems and the use of consequence-based interventions. The success of these consequence-based treatments has led to second-generation studies that examined antecedent variables that influence the functional relations between mealtime behavior and environmental consequences.

Consequence-Based Assessments

The behavioral literature has emphasized the identification of environmental variables that maintain problem behaviors and the precise specification of these behaviors. Objective definitions of behavior topography are important for establishing treatment goals and for evaluating treatment outcomes, but do not indicate factors accounting for problematic behaviors that should be addressed in treatment. For this reason, consequences maintaining feeding problems, such as escape or avoidance of bites, increased caregiver attention, or delivery of preferred foods or items, are identified to optimize treatment. Both descriptive (Casey, Cooper-Brown, Wacker, & Rankin, 2006; Piazza, Fisher et al., 2003) and experimental (Bachmeyer et al., 2009; Girolami & Scotti, 2001; Piazza, Fisher et al., 2003) functional assessment methodologies have been used to successfully identify the consequences maintaining feeding problems and prescribe treatment.

Descriptive Analysis

Descriptive analyses have been used most often to develop hypotheses regarding the consequences provided by caregivers for a child's problematic mealtime behavior that may be functionally related to that behavior. Hypotheses based on descriptive analysis results have been used to determine test conditions for subsequent functional analyses or to lead directly to treatment development. For example, Piazza, Fisher, et al. (2003) conducted descriptive assessments of 9 children and parent dyads during meals. Results showed that, following problematic mealtime behaviors, parents provided consequences such as coaxing and reprimanding, allowing the child to periodically take a break from or avoid eating, and giving the child preferred food or toys. Hypotheses about consequences maintaining problematic mealtime behavior were developed based on assessment results and were tested during subsequent functional analyses.

Casey and colleagues (2006) used a descriptive assessment methodology to identify the schedules of reinforcement provided by the caregiver of a child exhibiting severe food refusal. Descriptive analysis results suggested that the parent provided a lean schedule of positive reinforcement (e.g., praise) for the child's appropriate mealtime behaviors (i.e., bite acceptance, self-feeding) and a dense schedule of negative reinforcement (escape/avoidance from bite offers) for problematic mealtime behaviors (i.e., refusal of bites, crying). The schedules of reinforcement provided by the parents were manipulated as an intervention for the child's food refusal. EE (a treatment that eliminated escape/avoidance of bite offers) combined with a dense schedule of positive reinforcement for appropriate mealtime behaviors decreased the child's problematic mealtime behaviors and increased appropriate mealtime behaviors.

Functional Analysis

Experimental functional analysis has been used to quantify precisely the reinforcing functions of problematic mealtime behavior leading to the development of highly specific and effective interventions that directly address the function(s) that maintain problem behavior. For example, Piazza, Fisher and colleagues (2003) applied the functional analysis methodology described by Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1984) to the problematic mealtime behaviors of 15 children. During alternating meals of the functional analysis, consequences such as attention and brief breaks that are typically used by parents were consistently implemented following problematic behavior. Results of the functional analysis indicated that differential responding occurred for 10 of the 15 children (67%). For all participants, treatment involved using at least one of the identified functional reinforcers (escape, attention, tangible items) in a reinforcement-based procedure (i.e., differential positive, differential negative, or noncontingent reinforcement). Treatment also involved an EE procedure for 67% of the participants for whom an escape function was identified and ignoring problem behavior for all participants for whom an attention function was identified. Results suggested that the functional analyses described by Piazza, Fisher et al. (2003) were useful for identifying the environmental events that maintained food refusal and that the results were useful in the development of effective treatments.

Consequence-Based Treatments

Negative Reinforcement

Negative reinforcement (escape or avoidance from bites of food) has been shown to play a major role in the maintenance of food refusal. For example, Piazza, Fisher, and colleagues (2003) found negative reinforcement to be the most frequently identified maintaining variable (90% of children with differentiated functional analyses) during functional analyses of the mealtime behavior of 10 children. Negative-reinforcement-based interventions (EE and differential negative reinforcement) have been shown to be effective treatments if matched to the function of mealtime behavior. A number of studies have shown that negative reinforcement treatment components (e.g., an EE procedure) may be necessary to increase food acceptance with children exhibiting severe food refusal (e.g., Ahearn et al., 1996; Bachmeyer et al., 2009; Cooper et al., 1995; Kerwin, Ahearn, Eicher, & Burd, 1995; Piazza, Patel et al., 2003; Reed et al., 2004).

Escape Extinction (EE). EE is a term that has been used to describe negative-reinforcement-based procedures that prevent the child from escaping the feeding situation. Extinction results in decreased problematic mealtime behavior by arranging the termination of the ongoing reinforcement contingency (escape). Two EE procedures targeting food/liquid acceptance, nonremoval of the spoon (Ahearn et al., 1996; Ahearn, Kerwin, Eicher, & Lukens, 2001; Babbitt et al., 1994; Bachmeyer et al., 2009; Casey et al., 2006; Coe et al., 1997; Cooper et al., 1995; Dawson et al., 2003; deMoor, Didden, & Korzilius, 2007; Hoch et al., 1994; Hoch et al., 2001; Kerwin et al., 1995; Piazza, Patel, et al., 2003; Patel, Piazza, Kelly, Ochsner, & Santana, 2001; Patel, Piazza, Martinez et al., 2002; Patel et al., 2006; Reed et al., 2004; Reed et al., 2005; Sevin, Gulotta, Sierp, Rosica, & Miller, 2002) and physical guidance (Ahearn et al., 1996; Ahearn et al., 2001; deMoor et al., 2007; Hoch et al., 2001; Kahng, Boscoe, & Byrne, 2003; Kerwin et al., 1995; Piazza, Patel, et al., 2003) have been documented to be effective. Both interventions involve preventing escape from the feeding situation until the presented food has been accepted. *Nonremoval of the spoon (NRS)* involves the food remaining in front of the child until it is accepted. For example, Hoch and colleagues (2001) increased food/liquid acceptance with 2 children exhibiting total food refusal by using a procedure in which the feeding utensil remained at the child's lips until acceptance occurred. Results suggested that increases in food/liquid acceptance only occurred when the NRS procedure was added to the intervention. *Physical guidance (PG)* involves the mouth being guided open with gentle jaw pressure contingent on refusal to accept food. Kerwin and colleagues (1995) used PG to increase food acceptance in the treatment of total food refusal exhibited by 2 children. Specifically, the spoon remained at the lower lip for 5 s or until acceptance occurred, whichever came first. If the bite was not accepted within 5 s of the presentation, the feeder physically guided the mouth open by applying gentle pressure to the mandibular junction of the jaw, and placing the spoon into the open mouth. Ahearn and colleagues (1996) compared the effectiveness of these two EE procedures to increase food acceptance in the treatment of severe food refusal with 3 children. Subsequent to baseline, an alternating treatments comparison was implemented in a multiple baseline design across the participants. Results indicated that both treatments were effective in establishing food acceptance for all participants.

Eating is a complex response consisting of a chain of behaviors that include accepting, chewing, and swallowing the food or drink. Treatment procedures that target food acceptance (e.g., NRS, PG) can be associated with collateral increases in alternative topographies of food refusal, such as food expulsion or packing (holding or pocketing food in the mouth for extended periods of time). Sevin et al. (2002) examined the effects of sequentially introducing extinction procedures across multiple topographies of food refusal. NRS produced an increase in food acceptance and a decrease in disruption (batting at the spoon, head turning), but expulsion of food emerged. When expulsion was treated, packing of food emerged. Finally, when packing was treated, all topographies of food refusal remained low and acceptance remained high. Results suggested that treatments that target one refusal behavior at a time may fail to increase food consumption because other, untreated topographies of refusal may emerge. One potential explanation for this finding is that food expulsion and packing may be a part of a chain of negatively reinforced behaviors that a child exhibits during the treatment of food refusal. This chaining or behavioral hierarchy phenomenon is an important consideration for clinicians because treatments that target one behavior (e.g., expulsion) may fail to increase food consumption if contingencies are not arranged for other possible collateral behavior (e.g., packing of food in the mouth).

Re-presentation (Coe et al., 1997; Hoch et al., 2001; Girolami, Boscoe, & Roscoe, 2007; Kerwin et al., 1995; Sevin et al., 2002) and redistribution (Gulotta, Piazza, Patel, & Layer, 2005; Sevin et al., 2002) of bites procedures have been documented to be effective treatments for food expulsion and packing, respectively. Re-presentation involves repeatedly presenting expelled food until the bite is swallowed. Redistribution involves scooping up pocketed food and placing it back on the mid tongue. One hypothesis for the operant mechanism responsible for treatment effects with these procedures is EE, because it is likely that expulsion of food and packing are part of a chain of negatively reinforced behaviors. Coe and colleagues used re-presentation to treat the feeding problems of 2 children. Positive reinforcement and NRS effectively increased food acceptance but also increased food expulsion. Positive reinforcement for swallowing did not treat expulsion of food. Food consumption increased when re-presentation was added to the intervention. Gulotta and colleagues (2005) evaluated the effects of using food redistribution with a bristled massaging toothbrush to reduce packing and increase consumption in 4 children with feeding problems. Packing was reduced for all participants. In addition, latency to clean mouth (the duration of time from acceptance to food no longer being present in the child's mouth in the absence of expulsion) decreased for 2 children when the food-redistribution procedure was used.

Differential Negative Reinforcement (Escape) of Alternative Behavior (DNRA). Negative-reinforcement-based treatment procedures other than EE have rarely been reported in the behavioral feeding literature. One procedure that has been evaluated is DNRA. DNRA involves delivering a negative reinforcer (escape) contingent on desired behaviors, such as accepting or swallowing bites of food. Kahng et al. (2003) examined the effects of differential positive (social praise) and negative (termination of meal) reinforcement procedures and PG to treat the food refusal exhibited by a child. Differential positive reinforcement of alternative behavior with and without PG did not result in increases in food acceptance. Food acceptance increased only when differential negative reinforcement of alternative behavior (termination of meal) was added to treatment. A token was provided to the child following each bite accepted. The child was able to terminate the meal by turning in a pre-specified number of tokens. The number of tokens required to terminate the meal was gradually increased.

Kelley, Piazza, Fisher, and Oberdorff (2003) evaluated the separate and combined effects of differential negative and positive reinforcement procedures on the acquisition of cup drinking in the absence of EE. A preference assessment was used to identify relatively more- and less-preferred foods. The differential negative reinforcement procedure involved the child being able to avoid presentation of the less preferred food by accepting the drink. The differential positive reinforcement procedure involved contingent access to the more preferred food following acceptance of the drink. Escape from drinking was in direct competition with a different negative reinforcement contingency (i.e., avoidance of eating the less-preferred food) and/or positive reinforcement (i.e., delivery of the more-preferred food). Cup drinking increased with the differential negative and positive reinforcement-based procedures, both alone and in combination, without using EE.

Results of the Kahng et al. (2003) and Kelley et al. (2003) studies suggest that negative reinforcement may be an effective reinforcer to increase food/liquid acceptance for some children. However, the individual contribution of negative reinforcement in both studies is unclear. In the Kahng et al. (2003) study, the negative reinforcement procedure was added to a treatment package that included differential positive reinforcement of alternative behavior with and without PG. In the Kelley et al. (2003) study, cup drinking increased in all conditions after the child was exposed to the condition in which differential negative and positive reinforcement were combined; thus, it is possible that the effects of the combined treatment carried over to the condition in which differential negative reinforcement was implemented alone.

Positive Reinforcement

Positive reinforcement (in the form of access to adult attention, tangible items, or preferred foods) has been shown to play a role in the maintenance of feeding problems for some children. Piazza, Fisher et al. (2003) identified multiple functions (i.e., access to adult attention or tangible items) for a substantial percentage (80%) of the children who showed differential responding during functional analyses of their mealtime behavior. Positive reinforcement-based treatment components (attention extinction, differential or noncontingent positive reinforcement) when combined with EE procedures have been shown to enhance or maintain treatment effects for some children who exhibit severe food refusal.

Attention Extinction (AE). When problematic mealtime behavior is maintained by caregiver attention it may be necessary to terminate the maintaining response-reinforcer contingency in order to achieve optimal treatment effects. AE involves ignoring all problematic mealtime behaviors (e.g., not reprimanding or coaxing the child). Bachmeyer et al. (2009) conducted functional analyses to identify multiply controlled refusal behaviors (maintained by both negative and positive reinforcement in the form of access to adult attention). Extinction procedures matched directly to multiply controlled refusal behaviors were tested individually and in combination with 4 children. AE alone did not result in decreased refusal behaviors or increased bite acceptance. By contrast, EE alone resulted in increased acceptance and decreased refusal behaviors, but not to clinically acceptable levels. Combining the extinction techniques matched both maintaining variables (escape and attention) and produced further reductions in refusal behaviors for all participants. Results suggested that when refusal behavior is multiply controlled, extinction of both classes of reinforcement may be necessary to achieve optimal treatment effects.

Differential (Positive) Reinforcement of Alternative Behaviors (DRA). Differential positive reinforcement involves providing the child with access to preferred stimuli contingent on desired behavior, such as accepting or swallowing bites of food. In the studies on DRA included in this review, preferred items or activities were always used as the positive reinforcers, either alone or in combination with social praise, except in one study (Kelley et al., 2003) in which a food was used as a reinforcer after EE was used to increase acceptance of the food. DRA has been documented to effect behavior idiosyncratically in the treatment of severe food refusal. When added to EE, DRA has been shown to be associated with beneficial effects such as reductions in refusal behaviors and reductions in the side effects of EE (i.e., extinction bursts and emotional responding) for some children (e.g., Piazza, Patel, et al. 2003). For example, Piazza, Patel and colleagues examined the individual and combined effects of DRA (contingent access to preferred toys) and EE in the treatment of food and liquid refusal of 4 children. Consumption increased for all participants only when EE was implemented, independent of the presence or absence of positive reinforcement. However, the addition of DRA to EE appeared to be associated with reductions in extinction bursts, lower levels of refusal behaviors, and reduced crying for 3 participants.

A few researchers (Casey et al., 2006; Hoch et al., 2001) have shown that DRA (in the form of contingent access to preferred toys) may also influence the maintenance of food acceptance for some children. For example, Hoch and colleagues (2001) conducted component analyses of multi-component interventions that combined EE techniques (NRS and re-presentation) and DRA in the treatment of food refusal exhibited by 4 children. Results suggested that EE procedures were necessary to decrease refusal behaviors and increase food acceptance. Positive reinforcement, however, was also necessary to maintain increases in food acceptance and decreases in refusal behaviors for 1 participant. Similarly, Casey et al. (2006) used a treatment package combining DRA and EE to decrease refusal behaviors and increase food acceptance with a child exhibiting severe food refusal. Subsequent manipulation of schedules of reinforcement (contingent escape and praise) suggested that a dense schedule of positive reinforcement was necessary to maintain increases in food acceptance and decreases in refusal behaviors.

The study conducted by Kelley and colleagues (2003) is the only study included in this review that showed that DRA (without EE) may influence the initial acquisition of acceptance with children who exhibit severe food refusal. Kelley and colleagues used EE to increase acceptance of pureed foods with a child who exhibited total food refusal. Subsequent preference assessments identified a preferred food, which was then provided contingent on the child's acceptance of liquids. DRA resulted in acquisition of cup drinking in the absence of EE. As previously noted, cup drinking increased in all conditions after the child was exposed to the condition that combined the DRA and DNRA procedures, thus it is possible that the effects of the combined treatment carried over to the condition in which DRA was implemented alone.

Noncontingent Positive Reinforcement (NCR). An alternative to providing preferred stimuli contingently is to provide them continuously throughout the meal. In the studies on NCR included in this review, preferred toys or activities were always used as positive reinforcers, either alone or in combination with social praise (Cooper et al., 1995; Reed et al., 2004). NCR has also been documented to effect behavior idiosyncratically in the treatment of severe or total food refusal. When added to EE, NCR has also been shown to be associated with beneficial effects such as reductions in refusal behaviors and the side effects of EE (i.e., extinction bursts and emotional responding) for some children (e.g., Reed et al., 2004). For example, Reed and colleagues examined the individual and combined effects of NCR and EE in the treatment of the food and liquid refusal of 4 children. Consumption increased for all participants only when EE was implemented, independent of whether NCR was present or absent. Similar to the results of the Piazza, Patel, et al. (2003) study, however, the addition of positive reinforcement (NCR) to EE appeared to be associated with some beneficial effects (i.e., reductions in extinction bursts and lower levels of refusal behaviors) for 2 participants.

One study (Cooper et al., 1995) showed that NCR (in the form of continuous access to preferred toys) may also influence the maintenance of food acceptance for some children. Cooper and colleagues used treatment packages that combined EE and positive reinforcement procedures (NCR and/or DRA) to increase food acceptance in 4 children who exhibited severe food refusal. The researchers systematically evaluated the individual contributions of treatment components once treatment effects were observed. Similar to the Casey et al. (2006) and Hoch et al. (2001) studies, results of Cooper et al. (1995) suggested that EE procedures were necessary to decrease refusal behaviors and increase food acceptance. Positive reinforcement, however, was also necessary to maintain food acceptance for 1 participant.

Antecedent-Based Assessments

The success of consequence-based treatments has led to research examining antecedent characteristics of the mealtime situation that may influence the functional relationship between the child’s mealtime behavior and environmental consequences. The texture and type of food presented and the method in which it is presented (e.g., bite size, feeding utensil) are examples of antecedent variables that may change the MO for escape as a reinforcer. Altering these variables may influence (increase or decrease) the aversive properties of the food/drink presentation and abolish or establish escape as reinforcement, and thus increase or decrease refusal behaviors. Analysis of MOs leads to specific interventions (e.g., stimulus fading) that are tied to a particular food dimension (e.g., texture).

Food Type and Texture

Munk and Repp (1994) developed an assessment to determine the environmental context in which food refusal behaviors occurred across distinct antecedent variables for 5 children. Four categories of feeding problems were identified: (a) food selectivity by type (accepted certain foods at all textures, but refused other types of food at all textures), (b) food selectivity by texture (accepted all foods at one texture, but refused the same foods at a different texture), (c) combination of both types and texture selectivity, and (d) total food refusal (refused all foods). Munk and Repp (1994) raised the possibility that manipulation of antecedent variables such as type and texture may be effective in treating feeding problems. Patel, Piazza, Santana, and Volkert (2002) conducted an assessment of food type and texture using procedures similar to Munk and Repp with a child displaying food expulsion. A comparison of the presence and absence of meats during the meal suggested that expulsions were more likely in the presence of meat when foods were presented at the same texture. When the texture of meats, but not other foods, was decreased, expulsions decreased. Results indicated selectivity by both type and texture. Results of the evaluation were used to prescribe a treatment (reducing the texture of one food type) that reduced expulsion of food. The finer texture may have functioned as an AO, decreasing the aversive property of the meats, thereby reducing the motivation to avoid (expel) meats. Patel et al. (2005) conducted an assessment of food texture (baby food, pureed table food, wet ground) with 3 children who exhibited severe food refusal and displayed high levels of packing. Results suggested high levels of packing and low gram intake were associated with higher textured foods, and low levels of packing and high gram intake were associated with lower textured foods. Results of the evaluation were used to prescribe the food texture used during treatment. All participants gained weight when the texture of foods was decreased initially and then increased gradually over time.

Food Volume/Bite Size

Kerwin et al. (1995) conducted an assessment of varying amounts of food on a spoon (empty spoon, spoon dipped in food, quarter spoonful of food, half spoonful of food, and level spoonful of food) with 3 children who chronically refused food. When presented with five volumes of food ranging from an empty spoon to a level spoon, each child in the study exhibited differential levels of bite acceptance. Increased food volume was associated with increased levels of refusal behavior and decreased levels of bite acceptance for all participants. Increased food volume may have functioned as an establishing operation (EO) increasing the aversiveness of the bite presentation, thereby increasing the motivation to refuse.

Antecedent-Based Treatments

Several researchers have developed and evaluated methodologies that manipulate antecedent variables (e.g., stimulus fading, demand fading) in the treatment of severe food refusal. Such antecedent-based procedures have been shown to be effective interventions or to enhance treatment effects when added to a treatment package (i.e., positive reinforcement and/or EE).

Stimulus Fading

A few researchers have demonstrated the effectiveness of *fading*, a technique that involves exposing the child to various aspects of the feeding situation in a gradual manner (e.g., Johnson & Babbitt, 1993; Mueller, Piazza, Patel, Kelley, & Pruett, 2004; Patel et al., 2001). *Stimulus fading* consists of gradually and systematically changing the stimulus (in this case, the food/drink and/or utensil) from a form that is readily accepted by the child to one that is refused. For example, Johnson and Babbitt used stimulus fading of utensil type and food consistency combined with DRA to treat the food refusal exhibited by a child. During the first treatment phase, diluted pureed foods were introduced using a stimulus the child accepted (a regular baby bottle). In the second treatment phase, undiluted pureed foods were presented in the bottle. Finally, the undiluted pureed foods were presented on a spoon. Accepted presentations were contingently reinforced across all phases. High levels of acceptance were maintained throughout the stimulus fading. Results suggested that gradually altering the food consistency and utensil type from stimuli the child already accepted (liquids via a bottle) to those previously refused (purees via a spoon) was effective in treating the child’s food refusal. Patel and colleagues (2001) used stimulus fading of liquid concentration in combination with DRA and EE to increase intake of a calorie-dense fluid by a child after a treatment combining DRA and EE had failed to increase acceptance of the target liquid. The fading procedure consisted of adding Carnation Instant Breakfast (CIB) and then milk to water (a fluid the child would drink). Results suggested that gradually altering the liquid concentration from a liquid the child would drink to the target calorie-dense fluid was effective in increasing the child’s intake of the target liquid. Similarly, Mueller and colleagues (2004) blended preferred and nonpreferred foods and gradually altered their concentrations to treat the severe food refusal of 2 children after a treatment combining EE with NCR or DRA was effective in increasing the acceptance of one or two foods (labeled preferred) and ineffective in increasing the acceptance of 14 to 15 foods (labeled nonpreferred). The fading procedure involved blending the foods the child accepted (preferred) with foods the child refused (nonpreferred) and gradually altering the ratio of preferred and nonpreferred foods (e.g., 10% nonpreferred/90%preferred, 20% nonpreferred/80% preferred). Results suggested that acceptance increased for nonpreferred foods that had been blended and remained low for nonpreferred foods that had not been exposed to the stimulus fading procedure.

Demand Fading

Demand fading has involved gradually increasing the quantity and variety of foods that the child is required to consume or gradually increasing the response requirements during meals (Hagopian, Farrell, & Amari, 1996; Luiselli, 1994; Luiselli, 2000). For example, Luiselli (2000) used demand fading combined with DRA to establish food acceptance and self-feeding with a child who exhibited chronic food refusal. The antecedent manipulations included visual cueing of a criterion number of self-fed bites that were required during meals to receive positive reinforcement (preferred toys) and gradually increasing the criterion (demand fading). Results suggested that bite acceptance and self-feeding increased within a changing criterion design as the response criterion for reinforcement was gradually increased from 1 to 10 self-fed bites during the course of treatment.

High-Probability (High-P) Instructional Sequence

The *high-p instructional sequence* (a procedure based on the theory of behavioral momentum) involves the presentation of high-probability (high-p) requests (e.g., presentations of an empty spoon) prior to a low-probability (low-p) request (e.g., presentation of a previously refused food), and is based on the premise that given a chain of demands, a low-p demand will be more readily followed when preceded by a high-p demand (Mace et al., 1988). A few studies have evaluated the effectiveness of the high-p sequence to increase mealtime compliance resulting in mixed findings (Dawson et al., 2003; McComas et al., 2000; Patel et al., 2006). Three patterns of results have been found using the high-p instructional sequence: (a) the high-p instructional sequence did not influence food acceptance or refusal behavior, (b) food acceptance increased with EE in the presence and absence of the high-p sequence but it increased more rapidly when the high-p sequence was added to EE, and (c) food acceptance increased only when the high-p sequence was added to EE. Dawson and colleagues (2003) examined the individual and combined effects of the high-p instructional sequence and EE in the treatment of severe food refusal for 1 participant. The high-p sequence consisted of three one-step instructions (e.g., “touch red,” “give me five”) followed by the low-p response (i.e., bite presentation). Acceptance increased and refusal behaviors decreased only with the introduction of EE, independent of the presence or absence of the high-p sequence. McComas and colleagues (2000) examined the effects of EE with and without a high-p sequence in the treatment of a child’s severe food refusal. Results suggested that food acceptance increased more rapidly when the high-p sequence was added to EE. However, acceptance also increased in the absence of the high-p procedure after only five sessions. Similarly, Patel and colleagues examined the effects of EE with and without a high-p instructional sequence with 2 children exhibiting severe food refusal. The high-p sequence consisted of three presentations of a response that was similar topographically (i.e., presentations of an empty Nuk®, liquid on a spoon, and a preferred liquid on a spoon) to the low-p response (i.e., presentation of a Nuk® with food, liquid from a cup, and presentation of a nonpreferred food). Acceptance of food increased in the presence but not the absence of the high-p sequence for 2 of 3 children. In addition, the high-p sequence combined with EE was associated with reduced levels of refusal behavior relative to EE alone for 2 participants.

Biological Variables

Biological conditions can serve as antecedent variables that change the MO for escape as reinforcement. Reed et al. (2005) evaluated the effects of a biological variable (disrupted sleep) on bite acceptance during treatment of a child's severe food refusal. Specifically, Reed and colleagues (2005) examined the influence of disrupted sleep (i.e., the child had to be awakened prior to the start of the meal) on bite acceptance when DRA was implemented with and without EE. Results showed food acceptance was less likely to occur during meals following disrupted sleep when only DRA was used. Food acceptance increased to clinically acceptable levels only when EE was added to the intervention. Results from the sleep comparison showed that food acceptance varied as a function of whether the participant's sleep had been disrupted. Thus, sleep disruption may have increased the aversiveness of bite offers, increasing the value of escape as a reinforcer. Results suggest that biological conditions can serve as MOs (specifically, establishing operations) for escape-maintained food refusal.

Recommendations for Practice

Because severe feeding problems are the result of a complex interaction between biological factors (e.g., medical conditions, physiological anomalies) and environmental variables (Kedesdy & Budd, 1998), intervention needs to be individualized and ideally developed using an interdisciplinary approach that focuses on all of the components contributing to the feeding problem (i.e., medical conditions, oral-motor functioning, and environmental variables). A thorough medical work-up is essential prior to initiating treatment. Initiation of treatment prior to resolution of medical problems may be countertherapeutic, particularly if treatment results in the ongoing pairing of oral intake with pain. In addition, some medical conditions require that the child follow a carefully regimented diet, and failure to do so may have serious consequences. Involvement of a speech and language and/or occupational therapist may be indicated to ensure that it is safe to feed the child orally. Some children aspirate solids or liquids; thus, for these children, eating may be life threatening. In addition, a speech and language and/or occupational therapist can determine appropriate food textures, feeding utensils, and volume of solid or liquid presentation for the child based on the child's current level of oral motor functioning. Involvement of a nutritionist may be important to determine the guidelines for the quality and quantity of foods that should comprise the child's diet. The role of the behavior analyst is to evaluate environmental variables contributing to the feeding problem and the following general guidelines, based on the empirical evidence reviewed, are important in assessment and treatment of severe food refusal.

Functional Assessment and Analysis

Children who exhibit severe food refusal may display refusal behaviors for a variety of consequences: to escape or avoid bite/drink offers, to gain access to caregiver attention, or to gain access to preferred stimuli (e.g., preferred toys or foods). Assessment of mealtime behaviors via descriptive and/or experimental functional analyses may improve understanding of why problematic mealtime behaviors occur on a case-by-case basis, allowing practitioners to select individualized treatments directly related to the functional relationship of problematic mealtime behavior. Conducting a descriptive analysis in which the clinician observes the caregiver feeding the child as he or she would at home allows the clinician to operationally define parent and child behavior and develop hypotheses about consequences that may be maintaining food refusal (e.g., escape or increased attention). These hypotheses can then either be tested in an analogue functional analysis, such as in the Piazza, Fisher et al. (2003) study, or lead directly to treatment, such as in the Casey et al. (2006) study.

Additional analyses of MOs may provide useful information about specific stimuli that alter the efficacy of the reinforcers identified during the functional analysis. The caregiver-fed meals during the descriptive analysis may also be helpful in the identification of stimuli that may be appropriate for this type of evaluation. A variety of food-related stimuli may be appropriate for evaluation such as feeding utensils (e.g., spoon vs. cup or bottle), food volume/bite size, and food type or texture. One method for evaluating the effects of MOs is to alter the antecedent conditions while maintaining constant reinforcement conditions (Smith & Iwata, 1997). For example, evaluations of food type or texture (Munk & Repp, 1994) with constant consequent conditions (i.e., escape during all conditions) may aid in the identification of specific types of foods or textures that change the MO for escape from bite presentations thus influencing levels of bite acceptance or food refusal (Patel, Piazza, Santana, et al., 2002).

Function-Based Interventions

Negative Reinforcement-Based Treatments

When negative reinforcement (escape) is hypothesized or experimentally demonstrated to maintain food refusal, practitioners may want to consider using differential negative reinforcement to increase food/liquid acceptance by either providing a break from the meal contingent on acceptance (Kahng et al., 2003) or programming a different negative reinforcement contingency (i.e., avoidance of less preferred food/drink contingent on acceptance of the target food/drink; Kelley et al., 2003).

If reinforcement-based procedures alone are not effective, EE (NRS or PG) may be necessary (e.g., Ahearn et al., 1996; Hoch et al., 2001; Kerwin et al., 1995). The literature suggests that EE procedures are effective treatments for severe food refusal. When using EE, it may also be necessary to program contingencies for all topographies of food refusal (e.g., expulsion of food and packing; Sevin et al., 2002). Therefore, practitioners may want to consider adding re-presentation (e.g., Coe et al., 1997; Girolami et al., 2007) and redistribution (e.g., Gulotta et al., 2005) to the intervention to prevent operant conditioning of other topographies of refusal behaviors (e.g., expulsions and packing) as food acceptance is established.

EE procedures should be used cautiously, however, for several reasons. First, as indicated previously, a child's safety for oral feeding should be determined prior to treatment initiation. Second, consultation with a speech and language and/or occupational therapist to determine the appropriate food/liquid consistencies and seating arrangements is essential as aspiration risk may increase if the child is distressed during the meal. Consideration should be given to conducting initial extinction sessions in a therapeutic environment to observe the child's response to the procedure prior to having a caregiver implement the procedure without professional supervision. Lastly, caregivers should be informed fully about the effects and potential side effects of extinction-based treatments such as extinction bursts and increases in emotional behavior (Lerman & Iwata, 1995; Lerman et al., 1999).

Positive Reinforcement-Based Treatments

When EE procedures are needed, practitioners should consider the potential benefits of positive reinforcement components (i.e., DRA and/or NCR), such as decreased extinction bursts, lower levels of refusal behaviors, decreased emotional responding (e.g., crying), and maintenance of treatment effects (e.g., Cooper et al., 1995; Piazza, Patel, et al., 2003; Reed et al., 2004). In addition, if positive reinforcement is hypothesized or demonstrated to maintain food refusal, it may also be necessary to terminate this maintaining response-reinforcer contingency (e.g., ignore problem behavior) in order to achieve optimal treatment effects (Bachmeyer et al., 2009).

The influence of positive reinforcement (DRA and NCR) on the acquisition of food/liquid acceptance has not been widely demonstrated in the treatment of severe food refusal, but these procedures are the simplest approach to the treatment of a feeding problem. Thus, practitioners may want to consider implementing positive reinforcement-based procedures, either alone or in combination with differential negative reinforcement procedures or antecedent-based treatments, as the first step to treatment (Kelley et al., 2003). One possible reason that positive reinforcement has not been widely shown to result in the acquisition of food/liquid acceptance with children who exhibit severe food refusal is that few opportunities to contact the reinforcement contingencies occur as compared to children who have established patterns of eating.

Antecedent-Based Treatments

A number of antecedent-based procedures have shown promise either alone or as adjuncts to positive reinforcement or EE procedures. For example, initiating treatment with decreased demands such as decreased food texture (Patel, Piazza, Layer, Coleman, & Swartzwelder, 2005), spoon volumes/bite sizes (Kerwin et al., 1995), or bite requirements Hagopian et al., 1996; Luiselli, 1994, 2000), or with stimuli (food/liquid consistencies or concentrations or utensils) that the child readily accepts (e.g., Johnson & Babbitt, 1993; Mueller et al., 2004; Patel et al., 2001) may enhance treatment effects. Such arrangements may enhance treatment effects by decreasing the aversiveness of the meal situation thereby abolishing escape as a reinforcer. These conditions may also increase the probability that the child contacts reinforcement (e.g., contingent access to toys or adult attention [differential positive reinforcement] or termination of the meal [differential negative reinforcement]) more quickly. When treatment effects are established with minimal requests or preexisting stimuli, fading techniques (stimulus or demand fading) can be used to reach target expectations (e.g., age appropriate food textures and volumes). One limitation of fading strategies is that they may be time consuming; however, probes of target stimuli or demands can be conducted throughout the fading treatment to determine whether continued fading is necessary.

An additional strategy that may augment EE is a high-p instructional sequence (McComas et al., 2000; Patel et al., 2006). One possible explanation for the mixed findings with the high-p instructional sequence is that utilizing a high-p response that is similar topographically (e.g., acceptance of an empty spoon) to the low-p response (e.g., acceptance of a spoon with a bite of food) may influence the effectiveness of the instructional sequence. Thus, practitioners may want to consider this strategy only if the child demonstrates high levels of compliance with a request that is similar to food consumption (e.g., acceptance of an empty spoon).

Biological conditions can serve as antecedent variables that change the MO for escape as reinforcement (Carr & Smith, 1995). Only one study to date (Reed et al., 2005), however, has evaluated the effects of a biological variable (disrupted sleep) on behavioral treatments of food refusal. Practitioners should consider the effects of disrupted sleep as well as other biological conditions such as food-satiation due to enteral nutritional support and gastrointestinal disturbances or other illnesses that may increase the aversiveness of eating when treating food refusal.

Summary

Children have feeding problems for a variety of reasons; therefore, assessment and treatment should focus on all components (i.e., biological, oral-motor, and environmental) that may contribute to the feeding problem. Currently, treatment strategies with the most scientific support are based on applied behavior analysis (Kerwin, 1999). Specifically, procedures based on EE (e.g., NRS and PG) have the most empirical support in the literature as effective treatments for food refusal. The effectiveness of reinforcement-based procedures alone has not been widely demonstrated with children who exhibit severe food refusal. However, a number of researchers have demonstrated that positive and negative reinforcement procedures may add to the treatment effects of EE procedures. In addition, a growing body of literature on antecedent variables that alter the MO for negative reinforcement (escape) of food refusal is showing good promise for the individual effectiveness of reinforcement-based procedures.

The opportunities for additional investigations in the area of assessment and treatment of severe food refusal are vast given the dearth of the literature in this area. A few areas for future researchers to consider include the following. First, functional analysis and evaluation of function-based treatments for other problem behaviors associated with severe food refusal, such as expulsions, packing, gagging, and vomiting, are needed. Second, it remains unclear under what conditions positive reinforcement may have treatment effects. One possible reason that positive reinforcement has been shown to contribute to effective treatment for some children but not for others may be that some children's food refusal is maintained by both positive and negative reinforcement, but some children's food refusal is maintained only by negative reinforcement. Thus, examining the effectiveness of positive reinforcement procedures following a functional analysis of food refusal behaviors is another area for future research. Third, demonstration of the treatment effects of the antecedent strategies discussed in this review (i.e., stimulus fading, demand fading, the high-probability instructional sequence) are limited to a few participants; thus, further replication of these strategies is warranted. Finally, research examining the effects of manipulating multiple variables that may interact to change the MO for negative reinforcement of food refusal is needed.

Table 1. Summary of Studies Included in Review

Study	Target Behaviors	Procedures	Results
Linscheid et al. (1987)	ACC	DRA, shaping	Combined treatment package resulted in increases in food/liquid ACC.
Johnson & Babbitt (1993)	ACC, Refusals	DRA, EE, Stimulus fading	ACC increased and refusals decreased as a result of DRA and EE combined with stimulus fading (i.e., gradually altering the food consistency and feeding utensil).
Hoch et al. (1994)	ACC, Intake	EE (NRS), DRA, NCR	DRA resulted in increases in ACC for one participant. Food ACC increased and refusals decreased to clinically acceptable levels for all participants when EE was added to treatment.
Luiselli (1994)	ACC	DRA, Demand fading	Combined treatment package resulted in increases in ACC.
Munk & Repp (1994)	ACC, Refusals, Expulsions,	Food type and texture manipulation	Assessment results suggested that each participants' feeding problem fit into one of four categories: (a) total food refusal, (b) type selectivity, (c) texture selectivity, or (d) type and texture selectivity.
Cooper et al. (1995)	ACC, Intake	EE (NRS), NCR, DRA; component analysis	Food ACC increased using treatment package. Component analysis indicated EE was always an active variable and DRA/NCR was an active variable for 2 of the participants.
Kerwin et al. (1995)	ACC, Refusals, Expulsions, MC	Spoon volume manipulation, DRA w/ & w/o EE (NRS or PG, REP)	Assessment data suggested participants showed differential levels of ACC across spoon volumes. Treatments were effective in increasing targeted spoon volumes. Generalization of acceptance to untreated, larger spoon volumes occurred for all 3 participants.
Ahearn et al. (1996)	ACC	EE (NRS vs. PG)	Both treatments were effective in establishing food ACC. PG was associated with fewer corollary behaviors, shorter meal durations, and parental preference.
Hagopian et al. (1996)	ACC, Refusals	Backward chaining, Demand fading	Backward chaining resulted in acquisition of cup drinking. The quantity of liquid consumed was increased using demand fading.

Table 1 (continued)

Study	Target Behaviors	Procedures	Results
Coe et al. (1997)	ACC, Expulsions	EE (NRS, REP), DRA	NRS and DRA for ACC were effective in increasing food ACC. DRA for swallowing alone was not effective in treating expulsions. REP was necessary to decrease expulsions.
Luiselli (2000)	ACC, Self-feeding	DRA, Demand fading	Combined treatment package resulted in increases in independent food ACC.
Ahearn et al. (2001)	ACC, Refusals	EE (NRS vs. PG)	Both treatments were effective in decreasing refusals and establishing ACC.
Girolami & Scotti (2001)	Refusals	Functional analysis	Food refusal was maintained by escape for 2 of the participants and positive reinforcement (in the form of attention and toys) for the 3rd participant.
Hoch et al. (2001)	ACC Expulsions, MC, Intake	DRA (ACC or MC) EE (NRS and/or REP) individually and in combination	Extinction procedures were needed to treat ACC, MC, and expulsions for all 4 participants. Positive reinforcement (for either ACC or MC) influenced the maintenance of treatment effects for 1 participant.
Kahng et al. (2001)	ACC, Refusals,	DRA, Response cost	Multicomponent intervention led to an increase in food ACC and a decrease in problem behavior.
Patel et al. (2001)	MC	EE, DRA, Stimulus fading	EE combined with DRA did not result in increased intake of a calorically dense (target) liquid. MC increased with the addition of stimulus fading (i.e., gradually altering the concentration of the target liquid with a liquid consistently consumed).
Patel, Piazza, Martinez et al. (2002)	ACC, MC	DRA (ACC or MC) w/ & w/o EE (NRS)	ACC and MC increased for all 3 participants only when EE was added to the DRA procedures, independent of whether positive reinforcement was provided for ACC or MC.
Patel, Piazza, Santana et al. (2002)	Expulsions, Intake	Food type and texture manipulation	Assessment results suggested both food type and texture influenced food expulsions. Assessment results were used to prescribe treatment that reduced expulsion.

Table 1 (continued)

Study	Target Behaviors	Procedures	Results
Sevin et al. (2002)	ACC, Refusals, Expulsions, Packing	EE (NRS, REP, redistribution)	NRS resulted in increased food ACC and decreased refusal behaviors, but expulsion of food increased. When food expulsion was treated (using REP) packing increased. Packing was treated using redistribution and all topographies of refusal behaviors remained low.
Dawson et al. (2003)	ACC, Refusals	High-P with and without EE	ACC increased and refusals decreased only when EE was added independent of the use of the high-p instructional sequence.
Kahng et al. (2003)	ACC, Refusals	DRA with and without EE (PG), DNRA w/ EE (PG)	ACC did not increase with DRA even when EE was added. DNRA combined with EE resulted in increases in ACC.
Kelley et al. (2003)	ACC	DRA, DNRA, individually and in combination	Liquid consumption increased with both positive and negative reinforcement, both alone and in combination (without EE).
Piazza, Fisher et al. (2003)	Refusals	Descriptive analysis, Functional analysis	Descriptive analyses suggested that caregivers provided ESC, ATTN, and preferred foods/toys contingent on refusals. FA results suggested 67% of participants showed differential responding. Of the participants who showed differential responding, 90% showed sensitivity to ESC and 80% of participants' behavior was multiply maintained.
Piazza, Patel et al. (2003)	ACC, Refusals, Negative vocalizations	DRA and EE individually and in combination	ACC increased only when EE was added, independent of the presence or absence of DRA. The addition of DRA was associated with decreased refusals and negative vocalizations for some participants.
Mueller et al. (2004)	ACC, MC	Stimulus fading + EE	Nonpreferred foods that had been exposed to a blending treatment (i.e., mixing nonpreferred foods into preferred foods in various ratios) were consumed at higher levels compared to nonpreferred foods that had not been blended. Consumption of all 16 target foods increased after 7 or 8 foods had been exposed to the blending treatment.

Table 1 (continued)

Study	Target Behaviors	Procedures	Results
Reed et al. (2004)	ACC, Refusals, negative vocalizations	NCR, EE individually and in combination	ACC increased only when EE was implemented, independent of whether NCR was present or absent. NCR was associated with lower refusals and negative vocalizations when combined with EE.
Gulotta et al. (2005)	Packing, Latency to MC	Redistribution	Redistribution reduced packing for all participants and reduced latency to MC for 2 participants.
Patel, Piazza, Layer et al. (2005)	Packing, Intake	Food texture manipulation	Packing and intake were higher when lower textured foods were presented than when higher textured foods were presented.
Patel, Piazza, Martinez et al. (2005)	ACC, MC	DRA (ACC) vs. DRA (MC) with and without EE	ACC and MC increased for all 3 participants once EE was added, independent of whether reinforcement was provided for ACC or MC. Maintenance was observed in 2 participants when EE was removed.
Reed et al. (2005)	ACC	DRA w/ & w/o EE, sleep disruption analysis	ACC was less likely to persist during meals following disrupted sleep, but only when EE was not implemented. EE was needed for ACC to increase to clinically acceptable levels.
Casey et al. (2006)	ACC, Refusals	Descriptive analysis; DRA with and without EE	Descriptive analysis identified refusals on rich schedule of negative reinforcement and appropriate behavior on lean schedule of positive reinforcement. Combined treatment package resulted in increased food ACC and decreased refusals. DRA appeared to be most responsible for maintenance of food consumption.
Patel, Reed et al. (2006)	ACC, Refusals	High-P, EE with and without High-P	ACC increased in the presence and not the absence of the High-P sequence for 2 of the 3 participants. High-P combined with EE was associated with reduced levels of refusals relative to EE alone for 2 participants.
deMoor et al. (2007)	ACC	EE (NRS, PG), DRA, Fading	Combined treatment package resulted in increases in food ACC.

Table 1 (continued)

Study	Target Behaviors	Procedures	Results
Girolami et al. (2007)	Expulsions	Presentation w/ Spoon vs. NUK®, EE (REP) w/ Spoon vs. NUK®,	Fewer expulsions were observed when using the NUK® for representation as compared to the spoon, and further reductions were observed when the brush was also used for initial presentations.
Bachmeyer et al. (2009)	ACC, Refusals	Functional analysis, EE (NRS) and AE individually and in combination	EE alone resulted in decreases in refusals and increases in ACC. EE combined with AE resulted in decreases in refusal behaviors to clinically acceptable levels and high and stable ACC.

Note. ACC = acceptance; AE = attention extinction; ATTN = attention; DNRA = differential negative reinforcement; DRA = differential positive reinforcement for an alternative behavior; EE = escape extinction; ESC = escape; FA = functional analysis; High-P = high-probability instructional sequence; MC = mouth clean; NRS = nonremoval of the spoon; PG = physical guidance; REP = representation of bites

CHAPTER III

METHODOLOGY

Experiment 1

Participant

Experiment 1 had 1 participant. Adam was an 18-month-old boy who was receiving intensive outpatient services in the behavioral feeding clinic at the University of Iowa Children's Hospital. He had been diagnosed with Diamond-Blackfan anemia and Pierre Robin syndrome. His medical history was significant for hypertension and hypoplastic/dysplastic left kidney. He also had a history of cleft palate and had undergone correction of tongue/lip adhesion and cleft palate. Oral examinations by a speech and language pathologist indicated delayed tongue movement and a small mandible. His growth was poor in comparison to norms on standard growth charts. However, characteristic of Diamond-Blackfan anemia, he was short in stature, and his weight compared to his height was normal on standard growth charts. He received enteral nutritional support since birth due to his feeding difficulties. At the time of intensive outpatient feeding therapy, he was receiving 100% of his nutritional needs via gastrostomy- (G-) tube feedings. In response to his caregivers' attempts to feed him orally, Adam consistently displayed disruptive behaviors such as pushing the food or utensil away, turning his head away, and crying, resulting in total food refusal.

Setting and Materials

Sessions occurred during 12 days of intensive outpatient services and were conducted in a clinic room of a pediatrics outpatient clinic at the University of Iowa Children's Hospital. The clinic room was equipped with a medical examination table and chairs. Materials included a high chair, a video camera and tripod, feeding utensils (i.e., rubber-coated infant spoons), bibs, timers, non-latex surgical gloves, various age-appropriate toys (when applicable), towels, washcloths, and observation recording forms (see Appendix A). Based on recommendations from the feeding team's speech and language pathologist, Adam was fed a pureed diet. He was offered two Stage 2 baby foods (peaches and peas), selected by his caregivers as initial foods to target during treatment.

Dependent Variables

Target Clinical Outcomes

Target clinical outcomes were determined based on (a) presenting concerns and (b) an assessment of oral motor skills. Reports by Adam's caregivers, review of his medical records, and observations of meals conducted by his caregivers indicated that he consistently exhibited refusal behaviors, which prevented his caregivers from contacting bite offers with his mouth and resulted in his dependency on tube feedings. Oral examinations conducted by the feeding team's speech and language pathologist indicated impaired oral structural development (i.e., history of cleft palate and abnormal mandible size) and delayed oral motor skills (i.e., delayed tongue movement). Adam's refusal behaviors during oral feedings precluded comprehensive evaluation of his oral motor skills and swallowing, which was necessary to further determine a progression of treatment. Thus, target clinical outcomes for Adam were to decrease his refusal behaviors during oral feedings and increase his acceptance of small tastes of food past his lips in order for the speech and language pathologist to conduct further evaluation of Adam's oral motor skill development and functioning.

Response Definitions and Dependent Variables

There were two dependent variables: (a) bites accepted Past Lips and (b) refusal behaviors for Past Lips. Both were evaluated to examine the abolishing effects of noncontingent positive reinforcement on negative reinforcement for food refusal. The dependent variables were scored on a trial-by-trial (bite-by-bite) basis. Data were collected on bite acceptance within a hierarchy of bite placement (i.e., At Lips or Past Lips) as defined in Table 2 (end of Chapter III). EE occurred for bite placement At Lips. This was conducted to ensure that Adam came into contact with the food during bite offers. Escape was permitted for bites Past Lips. This enabled me to examine the abolishing effects of noncontingent positive reinforcement on escape from bite presentations. Thus, *the percentage of bites accepted Past Lips* was the first dependent variable, which was calculated by summing data for bites accepted Past Lips, divided by the total number of bites and multiplying by 100. *Refusal behaviors* associated with bites Past Lips, as defined in Table 2, was the second dependent variable. The number of bites in which refusal behaviors occurred was summed, divided by the total number of bites, and multiplied by 100.

Measurement

Observation System

All sessions were videotaped. Data were collected in vivo and via videotapes using a trial-by-trial (bite-by-bite) recording system (see Appendix A for recording form). Trained observers recorded the dependent variables for each bite presentation.

Procedural Fidelity

Procedural fidelity was evaluated by collecting data on the feeder's correct implementation of the procedures (i.e., bite placement, removal of the bite presentation, and provision of positive reinforcement) on a bite-by-bite basis. *Correct bite placement*, based on Figure 1, was defined as the feeder placing the bite At Lips if refusal behaviors associated with bite acceptance Past Lips occurred, or placing the bite Past Lips if refusal behaviors did not occur. *Correct provision of positive reinforcement* was defined as the feeder providing continuous access to toys and adult attention only during the noncontingent reinforcement sessions. The percentage of bites with correct implementation of the procedures was calculated by summing the number of bites in which both correct bite placement and correct provision of positive reinforcement occurred, dividing that number by the total number of bites and multiplying by 100. Procedural fidelity data were collected for 31% of sessions and was 100%.

Inter-observer Agreement (IOA)

Two observers independently recorded the occurrence and nonoccurrence of the dependent variables on a bite-by-bite basis during 37.5% of sessions. Agreement coefficients were calculated by dividing the total number of agreements (occurrence and nonoccurrence) by the total number of agreements (occurrence and nonoccurrence) plus disagreements and multiplying by 100%. An occurrence agreement was defined as a bite in which both observers scored the occurrence of the target behavior. A nonoccurrence agreement was defined as a bite in which the observers did not score the occurrence of the target behavior. A disagreement was defined as a bite in which one observer scored the occurrence of the target behavior and the other observer did not score the occurrence of the target behavior. Mean agreements were 99.8% (range, 90% to 100 %) for bite acceptance and refusal behaviors.

Design

To examine the abolishing effects of noncontingent positive reinforcement (NCR) on negative reinforcement (escape) during bite presentations, the effect of the presence and absence of NCR was examined within a reversal (ABAB) design in which NCR was absent during Phase A and present during Phase B.

Procedures

Phase A (Absence of NCR)

Sessions were 5 min in duration. Four sessions blocks were conducted daily at the same scheduled time each day (9 a.m., 10 a.m., and 11 a.m.). Each session block was comprised of four 5-min sessions for a total of 16 sessions per day. Adam received his g-tube feedings at home, 2 hours prior to and following behavior therapy. A caregiver was present in the room during all sessions. Adam was seated in a high chair during sessions. He was offered two Stage 2 baby foods. One food, randomly selected, was offered in each session. Bite presentations consisted of a level (1.5 cc) rubber-coated infant spoon of baby food. A timer was set for 5 min at the beginning of the session. Bites were presented by a therapist approximately every 30 s or immediately following placement of the previous bite, if the previous bite presentation exceeded 30 s due to the occurrence of refusal behaviors. Praise was provided following each bite acceptance. The session was terminated when the timer sounded, or if a bite had been presented but not completed before the timer sounded, the session was terminated immediately after that bite presentation was completed.

EE was used for bite placement At Lips (see Figure 1). That is, refusal behaviors that occurred before the bite was placed At Lips were blocked and the bite was presented until the food was swiped on the outside of his lips. Escape was available for bite placement Past Lips (see Figure 1). That is, if refusal behaviors for Past Lips occurred when the bite was placed At Lips, the bite presentation was immediately removed.

Phase B (*Presence of NCR)*

All procedures were the same as for Phase A except that continuous access to preferred toys and adult attention was provided throughout the session. Adult attention consisted of the therapist or caregiver talking, singing, and/or playing with Adam. Toys were selected based on a brief free-operant preference assessment conducted prior to each session similar to procedures described by Roane, Vollmer, Ringdahl, and Marcus (1998). A variety of 8 to 10 toys were placed either on the floor or on a table in front of Adam where he was able to access all items. He was free to manipulate the items of his choice for approximately 1 min. The item manipulated for the greatest duration was used during the subsequent session and was placed on the highchair tray. The remaining toys were left in his sight throughout the session. The toy on the highchair was replaced if he pointed to or verbally requested a different toy during the session. If Adam did not request a change, between bite presentations, the therapist offered to change the preferred toy intermittently during the session.

Experiment 2

Participant

Experiment 2 had 1 participant. Lexie was a 3-year-old girl who was receiving intensive outpatient services in the behavioral feeding outpatient clinic at the University of Iowa Children's Hospital. She had been diagnosed with developmental delays and septo-optic dysplasia. She had a history of gastroesophageal reflux disease (GERD) and was prescribed Prevacid®. Oral examinations conducted by the feeding team's speech and language pathologist indicated normal oral structural development and functioning, and prior swallowing assessments showed no structural evidence of swallowing difficulties (e.g., aspiration). At the time of intensive outpatient feeding therapy, her weight was at the 69th percentile on standard growth charts. However, she received 100% of her caloric intake via bottle feeds of PediaSure®. In response to her caregivers' attempts to feed her solid foods, Lexie consistently displayed disruptive behaviors such as pushing the food or utensil away, turning her head away, and crying, resulting in severe food refusal and dependence on liquids.

Setting and Materials

Sessions occurred during 13 days of intensive outpatient services. The setting and materials were identical to Experiment 1 with the exception of the use of a booster seat instead of a highchair. Based on recommendations from the feeding team's speech and language pathologist, Lexie was fed a pureed diet. She was offered pudding, yogurt, and applesauce, which were selected by her caregiver as initial foods to target during treatment.

Dependent Variables

Target Clinical Outcomes

Target clinical outcomes were determined based on (a) presenting concerns and (b) an assessment of oral motor skills. Reports by Lexie's caregiver, review of her medical records, and observations of meals conducted by her caregiver indicated that she consistently exhibited refusal behaviors during attempts to feed her solid foods resulting in severe food refusal and liquid dependence. Results from oral motor and swallowing assessments conducted by the feeding team's speech and language pathologist showed no evidence of impaired oral structural development or functioning and suggested that it was safe for her to ingest solid foods. Because of her lack of experience with solid foods, however, it was recommended that oral feedings first involve pureed foods rather than age-appropriate textures. Thus, the target clinical outcomes for Lexie were to decrease her refusal behaviors during mealtimes and increase her acceptance of smooth/pureed foods.

Response Definitions and Dependent Variables

There were two dependent variables: (a) bite acceptance within a hierarchy of bite placement (At Lips, Past Lips, On Tongue, and On Tongue with Mouth Closure), and (b) refusal behavior. Both were evaluated to examine the abolishing effects of noncontingent positive reinforcement on negative reinforcement for refusal of bite presentations. The dependent variables were scored on a trial-by-trial (bite-by-bite) basis. Data were collected on bite acceptance within the hierarchy of bite placement as defined in Table 2. Demand fading combined with EE was used to increase bite acceptance across the hierarchy. Required bite placement was increased within the hierarchy at each consecutive fading step. EE occurred only for the required bite placement at each fading step. Escape was permitted for all successive bite placements within the hierarchy at each fading step. This enabled me to examine the abolishing effects of noncontingent positive reinforcement on negative reinforcement for food refusal across a hierarchy of bite placement. Thus, the first dependent variable was the *percentage of bites accepted* at a bite placement within the hierarchy that exceeded the required demand for that fading step. The percentage of bites accepted at each bite placement was calculated by summing data for bites accepted at that particular bite placement, dividing by the total number of bites and multiplying by 100.

The second dependent variable was *refusal behaviors* associated with bite acceptance at any placement within the hierarchy that exceeded the required bite placement for that fading step as described in Table 2. The number of bites in which refusal behaviors occurred was summed, divided by the total number of bites, and multiplied by 100.

Measurement

Observation System, Procedural Fidelity, and IOA

The observation system was identical to the one used in Experiment 1. Procedural fidelity for bite placement and provision of positive reinforcement was evaluated as in Experiment 1. Procedural fidelity data were collected for 31% of sessions and was 100%.

IOA was assessed for 34% of sessions and was collected and calculated as in Experiment 1. Mean agreements were 99% (range, 90% to 100 %) for bite acceptance and refusal behaviors.

Design

To examine the abolishing effects of NCR on negative reinforcement (escape) during bite presentations across a hierarchy of bite placements, the effects of the presence and absence of NCR were examined within a reversal (ABACDCEF) design. Phase A was the presence of NCR and Phase B was the absence of NCR when the required demand was At Lips. Phase C was the presence of NCR and Phase D was the absence of NCR when the demand was Past Lips. Phase E was the presence of NCR and Phase F was the absence of NCR when the demand was On Tongue.

Procedures

During all phases, sessions were 5 min in duration. Four session blocks were conducted daily at the same scheduled time each day (8:30 a.m., 10:00 a.m., 11:30 p.m., and 3:00 p.m.). Each session block was comprised of four 5-min sessions for a total of 16 sessions per day. Lexie was offered pudding, yogurt, or applesauce and was seated in a booster seat during sessions. She was offered PediaSure® via a bottle at 6 a.m. (120 cc), 12:30 p.m. (240 cc), 4 p.m. (240 cc), and 8 p.m. (240 cc). A caregiver was present in the room during all sessions. Lexie was seated in a high chair during sessions. A timer was set for 5 min at the beginning of the session. Bites were presented by a therapist approximately every 30 s or immediately following placement of the previous bite, if the previous bite presentation exceeded 30 s due to the occurrence of refusal behaviors. Praise was provided following each bite acceptance. The session was terminated when the timer sounded, or if a bite had been presented but not completed before the timer sounded, the session was terminated immediately after that bite presentation was completed.

Phase A: At Lips (Presence of NCR)

Preferred toys were selected and provided continuously with adult attention as in Experiment 1. EE occurred only for acceptance of the bite At Lips. Refusal behaviors that occurred before the bite was placed At Lips were blocked and the bite was presented until it was placed as required. Escape was permitted for bite acceptance Past Lips, On Tongue, and On Tongue with Mouth Closure. The bite presentation was immediately removed if refusal behaviors associated with each of these placements occurred (see Figure 2).

Phase B: At Lips (Absence of NCR)

All procedures were the same as for Phase A except that toys were not present in the room and adult attention was only provided (in the form of praise) contingent on bite acceptance.

Phase C: Past Lips (Presence of NCR)

Preferred toys were selected and provided continuously with adult attention as in Experiment 1. EE occurred only for acceptance of the bite Past Lips. Refusal behaviors that occurred before the bite was placed at the required demand were blocked and the bite was presented until it was placed as required. Escape was permitted for bite acceptance On Tongue and On Tongue with Mouth Closure. The bite presentation was immediately removed if refusal behaviors associated with both of these placements occurred (see Figure 3).

Phase D: Past Lips (Absence of NCR)

All procedures were the same as for Phase C except that toys were not present in the room and adult attention was only provided (in the form of praise) contingent on bite acceptance.

Phase E: On Tongue (Presence of NCR)

Preferred toys were selected and provided continuously with adult attention as in Experiment 1. EE occurred only for acceptance of the bite On Tongue. Refusal behaviors that occurred before the bite was placed at the required demand were blocked and the bite was presented until it was placed as required. Escape was permitted for bite acceptance On Tongue with Mouth Closure. The bite presentation was immediately removed if refusal behaviors associated with this placement occurred (see Figure 4).

Phase F: On Tongue (Absence of NCR)

All procedures were the same as for Phase E except that toys were not present in the room and adult attention was only provided (in the form of praise) contingent on bite acceptance.

Experiment 3

Participant

Experiment 3 had 1 participant. Abigail was a 2 ½-year-old girl diagnosed with developmental delays who received intensive outpatient services in the behavioral feeding outpatient clinic at the University of Iowa Children’s Hospital. Oral examinations conducted by the feeding team’s speech and language pathologist indicated normal oral structural development and functioning, and prior swallowing assessments showed no structural evidence of swallowing difficulties (e.g., aspiration). She independently fed herself limited quantities of a few select foods, and attempts made by her caregivers to feed her resulted in refusal behaviors such as pushing the food or utensil away, turning her head away, and crying. Approximately 1 year prior to receiving intensive outpatient therapy services, she underwent surgery for a G-tube placement due to concerns regarding inadequate weight gain (i.e., her weight was below the 3rd percentile on standard growth charts). Within the year prior to receiving intensive outpatient therapy services, her weight fluctuated between the 3rd and 7th percentiles. At the time of intensive outpatient therapy, she was receiving 100% of her caloric needs via G-tube feedings.

Setting and Materials

Sessions occurred during 15 days of intensive outpatient services. The setting and materials were identical to Experiment 2. Based on recommendations from the feeding team's speech and language pathologist, Abigail was served a diet of bite-sized (approximately 2.54 cm x 2.54 cm) pieces of table food. She was offered a variety of eight foods (two from each of the four food groups), which were selected by her caregiver as initial foods to target during treatment.

Dependent Variables

Target Clinical Outcomes

Target outcomes were determined based on (a) presenting concerns and (b) an oral motor skill assessment. Reports by Abigail's caregivers, review of her medical records, and observations of meals conducted by her caregiver indicated that she consistently consumed extremely limited quantities of food (5 bites or less per meal on average) when she fed herself and exhibited refusal behaviors when her caregiver attempted to feed her resulting in severe food refusal and percutaneous endoscopic gastrostomy- (PEG-) tube dependence. Results from oral motor and swallowing assessments showed no evidence of impaired oral structural development or functioning suggesting that it was safe for her to ingest regular table-textured foods. Thus, the target clinical outcomes for Abigail were to decrease her refusal behaviors during mealtimes, increase her oral consumption of table-textured foods, and decrease her dependence on G-tube feedings.

Response Definitions and Dependent Variables

Response definitions were the same as in Experiment 2. Bite acceptance At Lips was the only required demand throughout the study. Escape was available for all successive bite placements within the hierarchy across all phases. Thus, the first dependent variable was *the percentage of bites accepted* at a bite placement that exceeded At Lips (see Table 2). The percentage of bites accepted at each bite placement was calculated by summing data for bites accepted at that particular bite placement, dividing by the total number of bites, and multiplying by 100. The second dependent variable was *refusal behaviors* associated with bite acceptance at any placement within the hierarchy that exceeded At Lips (see Table 2). The number of bites in which refusal behaviors occurred was summed, divided by the total number of bites, and multiplied by 100.

Abigail was weighed on the same scale by hospital staff on a weekly basis and weights were recorded in her medical record and reported to her pediatric gastroenterologist in order to closely monitor her nutritional status throughout the study and evaluate treatment outcomes.

Measurement

Observation System, Procedural Fidelity, and IOA

The observation system was identical to the one used in Experiment 1. Procedural fidelity for bite placement and provision of positive reinforcement was evaluated as in Experiment 1. Procedural fidelity data for bite placement and provision of positive reinforcement were collected for 29% of sessions and was 100%. The fidelity of administration of the correct volume of overnight tube feedings was also evaluated by reviewing logs of overnight tube feedings completed by Abigail's caregiver for each day within the study. The volume of overnight tube feeds were administered correctly during all days of the study according to caregiver logs. IOA was assessed for 34% of sessions and was collected and calculated as in Experiment 1. Mean agreements were 100% for bite acceptance, refusal behaviors, and weight.

Design

To examine the interactive effects of NCR and food-related satiation on MOs for negative reinforcement (escape) during bite placement, the effects of the presence and absence of NCR and food-related satiation and deprivation were examined using a combined multi-element and reversal design. A reversal (ABCBCD) design was used to examine the effects of NCR and tube-feed satiation. Phase A was the absence of NCR and tube-feed satiation, Phase B was the presence of NCR and tube-feed satiation, Phase C was the presence of NCR and tube-feed deprivation, and Phase D was tube-feed deprivation. Within Phase D, a comparison of the presence and absence of NCR was conducted within a multi-element design. A multi-element design was also used to evaluate the effects of relative states of food-related satiation, based on the temporal proximity to overnight tube feeds in the absence (Phase A) and presence (Phase B) of NCR.

Procedures

During all phases, sessions were 10 min in duration. Five to seven sessions were conducted daily within a 4- to 5-hr period with 30- to 40-min breaks in between sessions. The number of sessions conducted daily varied as a result of the family's arrival times for their scheduled clinic appointment. Abigail was offered a variety of eight foods (two foods from each of the four food groups). One food from each of the four food groups was offered during each session, which was randomly chosen before each session. Bites were pieces of table food approximately 2.54 cm x 2.54 cm. A caregiver was present in the room during all sessions. Abigail was seated in a high chair during sessions. A timer was set for 5 min at the beginning of the session. Bites were presented by a therapist approximately every 30 s or immediately following placement of the previous bite, if the previous bite presentation exceeded 30 s due to the occurrence of refusal behaviors. Praise was provided following each bite acceptance. The session was terminated when the timer sounded, or if a bite had been presented but not completed before the timer sounded, the session was terminated immediately after that bite presentation was completed. EE occurred only for acceptance of the bite At Lips. Refusal behaviors that occurred before the bite was placed At Lips were blocked and the bite was presented until it was placed as required. Escape was permitted for bite acceptance Past Lips, On Tongue, and On Tongue with Mouth Closure. The bite presentation was immediately removed if refusal behaviors associated with each of these placements occurred (see Figure 2).

Phase A (Tube-Feed Satiation + Absence of NCR)

Ten-minute oral feeding sessions were conducted between 10 a.m. and 3 p.m. with 30- to 40-min breaks in between sessions. The number of sessions conducted daily varied as a result of the family's arrival times for their scheduled clinic appointment. The proximity to overnight tube feeds was defined by AM and PM oral feeding sessions. This allowed me to examine the abolishing effects of relative levels of food-related satiation on negative reinforcement associated with escaping bite acceptance as a result of temporal distance from overnight tube feedings. *AM oral feedings* were defined as sessions that occurred between 10:00 a.m. and 12:00 p.m. *PM oral feedings* were defined as sessions that occurred between 1:00 p.m. and 3:00 p.m.

Supplemental feedings of PediaSure® were administered at home overnight via a PEG-tube. Feedings were comprised of continuous infusion of 50 cc/hr for the first hour, which began at 10 p.m. and was followed by 70 cc/hr for 11 hours, totaling 820 cc (829 kcal). This was Abigail's overnight tube feed schedule and volume prior to receiving outpatient services, as prescribed by her pediatric gastroenterologist, to ensure that she received her daily caloric needs.

Phase B (Tube-Feed Satiation + Presence of NCR)

All procedures were the same as for Phase A except that preferred toys were selected and provided continuously with adult attention as in Experiment 1.

Phase C (Tube-Feed Deprivation + Presence of NCR)

All procedures were the same as for Phase A except that preferred toys were selected and provided continuously with adult attention in Experiment 1 and overnight tube feed volumes were reduced. Overnight tube feed volumes were altered based on consultation with Abigail's pediatric gastroenterologist. Feedings were comprised of continuous infusion of 50 cc/hr for the first hour, which began at 10 p.m. and was followed by 70 cc/hr for 6 hours, totaling 473 cc (474 kcal). The tube feeding was initiated at the same time using the same rate as during the tube-feed satiation phase; thus, the tube feeding was terminated earlier in the night creating food deprivation prior to the daytime oral feedings. This particular volume was selected by her pediatric gastroenterologist in order to balance setting up food deprivation and continuing to maintain her nutritional status.

Phase D (Tube-Feed Deprivation + Presence of NCR
vs. Tube-Feed Deprivation + Absence of NCR)

Overnight tube feedings were comprised of the reduced volume and schedule as in Phase C. Sessions were counterbalanced between the presence (preferred toys were selected and provided continuously with adult attention as in Experiment 1) and absence (toys were not present in the room and adult attention was only provided contingent on bite acceptance) of NCR.

Table 2. Operational Definitions of Bite Placement Hierarchy

Bite Placement	Bite Acceptance	Refusal Behaviors
At Lips	Child allowed food to be swiped on the outside of the lips.	N/A
Past Lips	Child allowed food to be swiped just inside the lips by the teeth.	Child pursed the lips, preventing the bite from being swiped just inside the lips by the teeth. After the bite was swiped on the outside of the lips, the child turned his/her head 45 degrees or greater away from the bite, pushed the bite/feeder's arm away, or blocked the bite using a hand, bib or toy.
On Tongue	Child allowed food to be swiped on mid-tongue.	Child clenched teeth, preventing the bite from being swiped on mid-tongue. After the bite was swiped past the lips, the child turned his/her head 45 degrees or greater away from the bite, pushed the bite/feeder's arm away, or blocked the bite using a hand, bib or toy.
On Tongue with Mouth Closure	Child allowed bite to be placed on mid-tongue and closed lips around spoon, resulting in the food being deposited within child's mouth.	Child's lips remained open after bite was placed on mid-tongue, preventing the food from being deposited within the child's mouth. After the bite was swiped on the mid-tongue, child turned head 45 degrees or greater away from the bite, pushed the bite/feeder's arm away, or blocked the bite using a hand, bib or toy.

Figure 1. Required Bite Placement: At Lips (Adam Only)

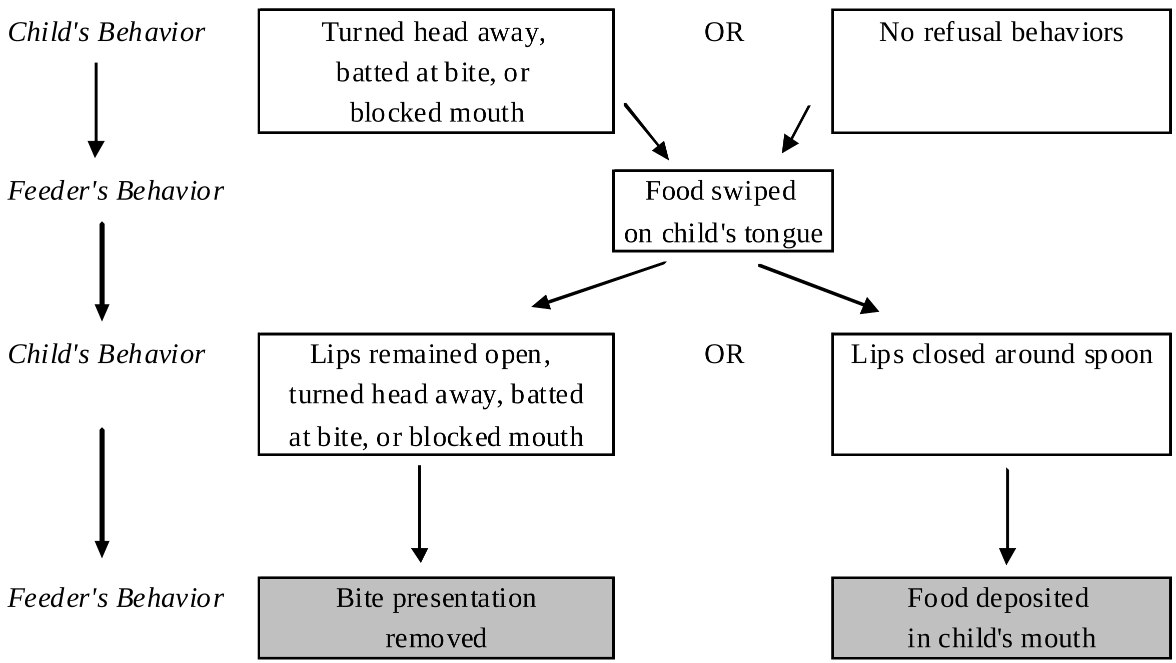


Figure 2. Required Bite Placement: At Lips (Lexie and Abigail Only)

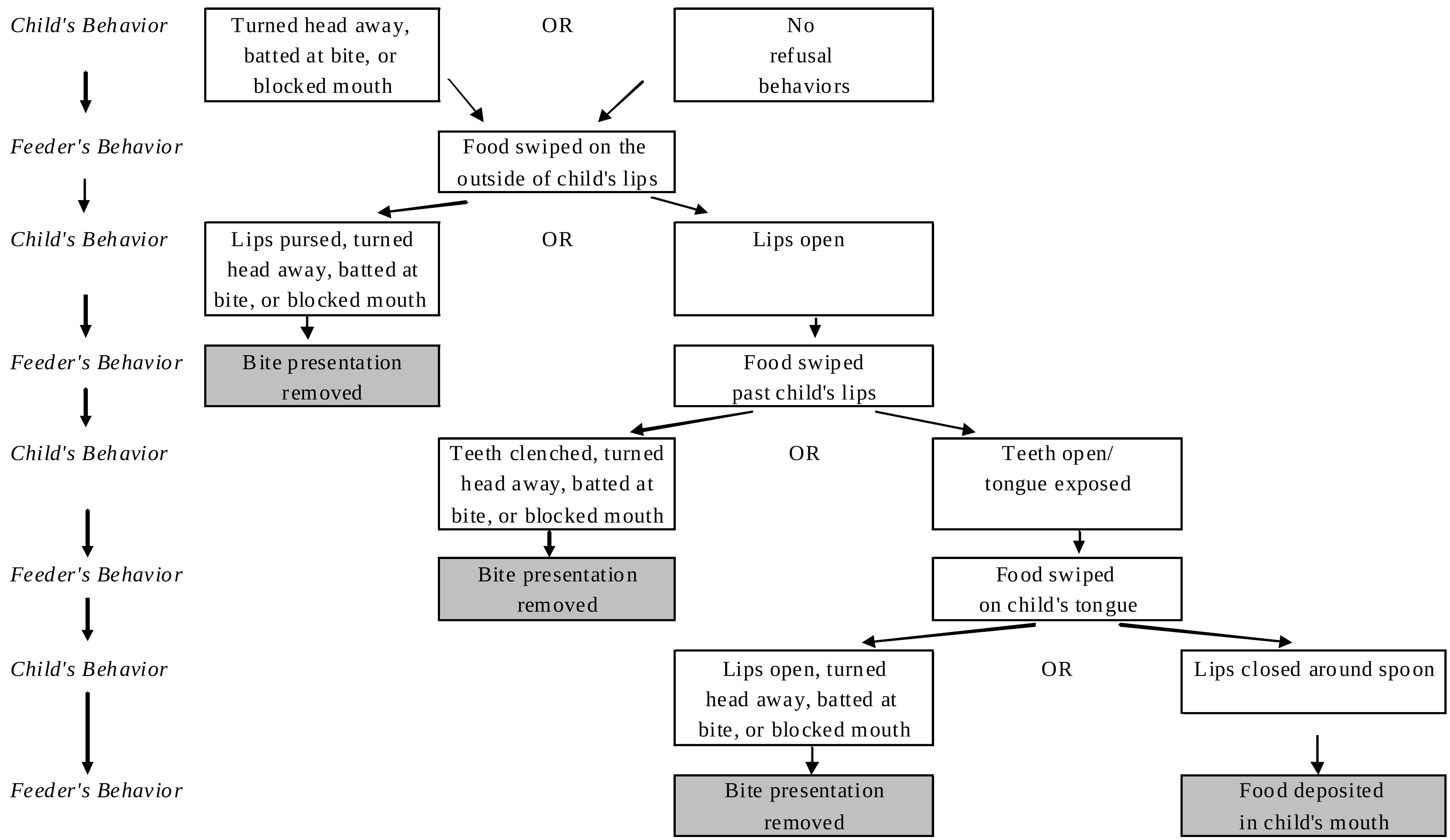


Figure 3. Required Bite Placement: Past Lips (Lexie Only)

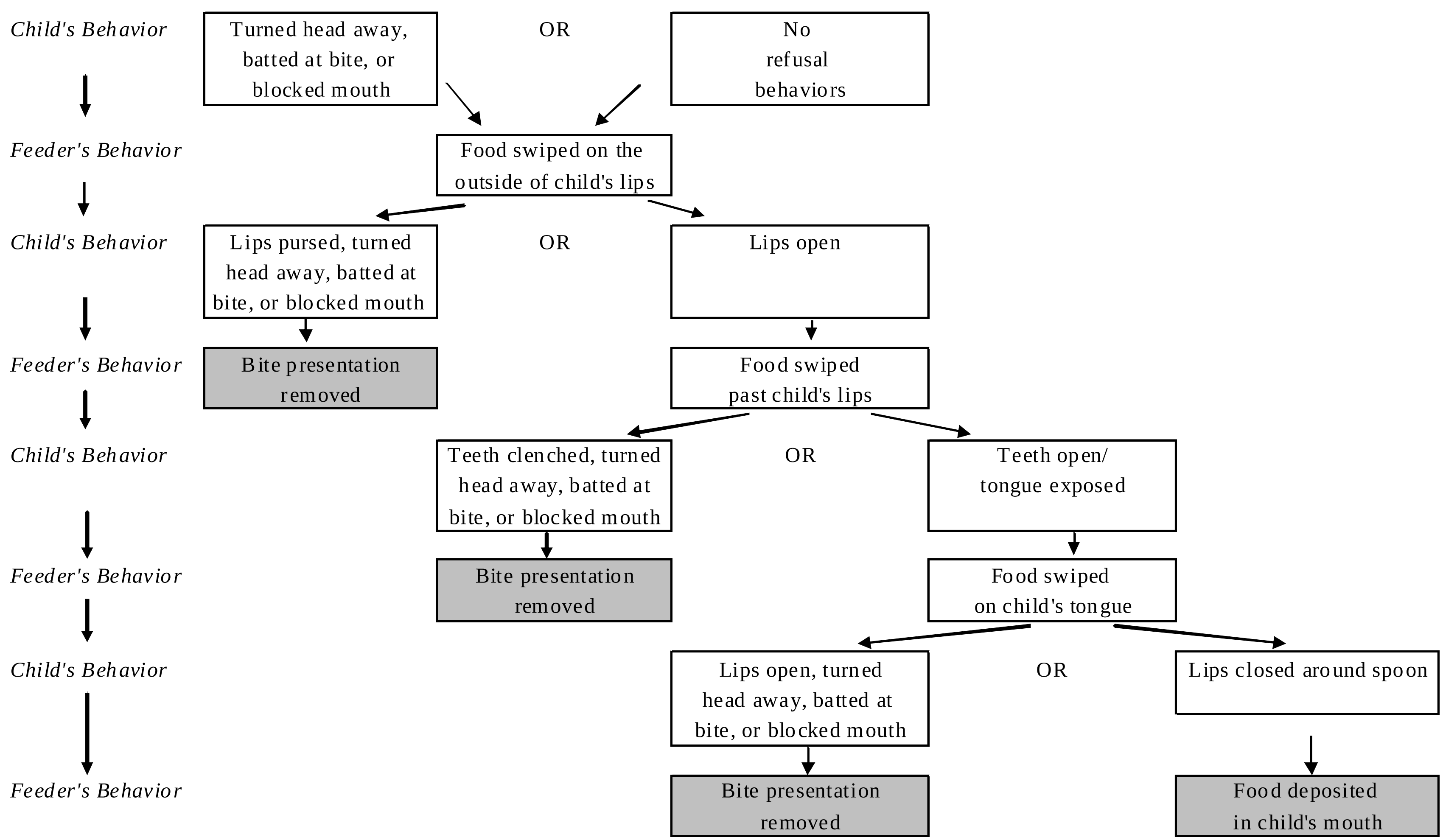
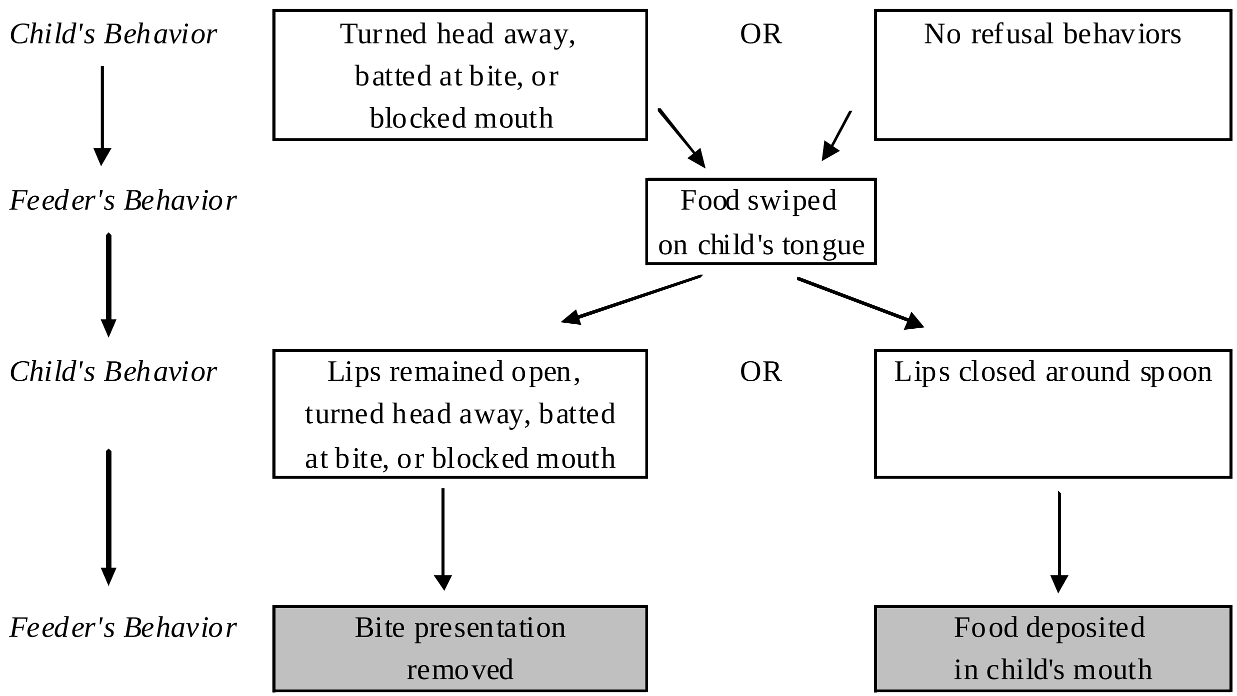


Figure 4. Required Bite Placement: On Tongue (Lexie Only)



CHAPTER IV

RESULTS

Experiment 1

The effects of NCR on negative reinforcement for escaping bite presentations were evaluated within an ABAB reversal design. The mean percentage of Adam's refusal behaviors associated with Past Lips and acceptance Past Lips per session are presented in Table 3. Figure 5 depicts the session-by-session percentage of bites in which Adam engaged in refusal behaviors associated with acceptance Past Lips (top) and the percentage of bites accepted Past Lips (bottom). During the initial A phase (absence of NCR), refusal behaviors associated with acceptance Past Lips increased and remained at 100% for three consecutive sessions and acceptance Past Lips decreased and remained at 0% for three consecutive sessions. During the initial B phase (presence of NCR), refusal behaviors remained at 100% and acceptance Past Lips remained at 0% for two sessions and then an overall decreasing trend in refusal behaviors (range, 100% to 17%) and an overall increasing trend in acceptance (range, 0% to 83%) were observed across the next 20 sessions. A return to the absence of NCR resulted in an immediate increase in refusal behaviors, which maintained at high levels (range, 89% to 100%) across nine sessions, and an immediate decrease in acceptance, which maintained at low levels (range, 11% to 0%) across nine sessions. A decreasing trend in refusal behaviors (range, 100% to 30%) and an increasing trend in acceptance (range, 0% to 70%) were replicated when NCR was re-implemented.

Results of Table 3 and Figure 5 suggest that when escape was allowed for acceptance Past Lips, refusal behaviors decreased and acceptance Past Lips increased when NCR was used. These results support the supposition that NCR may abolish escape from bite presentations as a reinforcer (i.e., function as an AO).

Experiment 2

The effects of NCR on negative reinforcement for escaping bite presentations across a hierarchy of bite placements were examined during demand fading using a BABCDCEF reversal design. The average results across phases are summarized in Table 4. Figure 6 depicts the session-by- session percentage of bites in which Lexie engaged in refusal behaviors for bite placements with escape permitted during each fading step. Acceptance of bites within the hierarchy of bite placement for each session is depicted in Figure 7.

Phases A and B: At Lips (Presence vs. Absence of NCR)

The effects of NCR on bite acceptance when escape was permitted were examined when the required demand was At Lips and escape was permitted for all subsequent bite placements within the hierarchy. During the initial B phase (presence of NCR), refusal behaviors for Past Lips (Figure 6, top panel) was observed at 100% and acceptance Past Lips (Figure 7, top panel) occurred at 0% during the first session. An overall decreasing trend in refusal behaviors for Past Lips (range, 80% to 0%) and an overall increasing trend in acceptance Past Lips (range, 30% to 100%) were observed across the subsequent 25 sessions, with refusal behaviors remaining at or below 20% and acceptance remaining at or above 80% during the final five sessions. During the initial A phase (absence of NCR), refusal behaviors for Past Lips remained below 10% and acceptance Past Lips remained above 90% for two sessions. During the subsequent three sessions, refusal behaviors increased to between 50% and 80% and acceptance decreased to between 20% and 50%. Refusal behaviors remained at or near 100% and acceptance remained at or near 0% during the final three sessions. A return to the presence of NCR (phase B) resulted in an immediate decrease in refusal behaviors (10%), which maintained at low levels (range, 0% to 28%) across seven sessions, and an immediate increase (90%) in acceptance, which maintained at high levels (range, 72% to 100%) across seven sessions. Refusal behaviors for On Tongue and On Tongue with Mouth

Closure (Figure 6, middle and bottom panels, respectively) remained at or near 100% across all phases, and acceptance On Tongue and On Tongue with Mouth Closure (Figure 7, middle and bottom panels, respectively) remained at or near 0% across all phases. Thus, although escape was permitted for acceptance Past Lips, On Tongue, and On Tongue with Mouth Closure, refusal behaviors for Past Lips decreased and acceptance Past Lips increased only when NCR was provided.

Phases C and D: Past Lips (Presence vs. Absence of NCR)

The effects of NCR on bite acceptance when escape was permitted were examined when the required demand was increased to Past Lips and escape was permitted for acceptance On Tongue and On Tongue with Mouth Closure. During the initial C phase (presence of NCR), refusal behaviors for On Tongue (Figure 6, middle panel) and acceptance On Tongue (Figure 7, middle panel) remained variable (range, 70% to 100% and 0% to 30%, respectively) across 23 sessions. During the D phase (absence of NCR), refusal behaviors remained at 100% and acceptance remained at 0% across 6 consecutive sessions. Variable levels of refusal behaviors (range, 80% to 100%) and acceptance On Tongue (range, 0% to 20%) were replicated with a return to the presence of NCR (Phase C). Refusal behaviors for On Tongue with Mouth Closure (Figure 6, bottom panel) remained at or near 100% across all phases, and acceptance On Tongue with Mouth Closure (Figure 7, bottom panel) remained at or near 0% across all phases. Thus, although escape was permitted for acceptance On Tongue and On Tongue with Mouth Closure, refusal behaviors for On Tongue decreased and acceptance On Tongue increased only when NCR was provided.

Phases E and F: On Tongue (Presence vs. Absence of NCR)

The effects of NCR on bite acceptance when escape was permitted were examined when the required demand was increased to On Tongue and escape was permitted for acceptance On Tongue with Mouth Closure during the E and F phases. During the E phase (presence of NCR), refusal behaviors for On Tongue with Mouth

Closure (Figure 6, bottom panel) remained at 100% and acceptance On Tongue (Figure 7, bottom panel) remained at 0% for five sessions. An overall decreasing trend in refusal behaviors (range, 80% to 10%) and an overall increasing trend in acceptance (range, 20% to 90%) were observed across the subsequent 18 sessions with refusal behaviors remaining at or below 10% and acceptance remaining at or above 90% during the final nine sessions. Refusal behaviors for On Tongue with Mouth Closure remained at or below 10% and acceptance On Tongue with Mouth Closure remained at or above 90% during the four sessions in Phase F (absence of NCR). Thus, although escape was permitted for acceptance On Tongue with Mouth Closure, refusal behaviors decreased and acceptance On Tongue with Mouth Closure increased when NCR was used. When NCR was removed refusal behaviors maintained at low levels and acceptance On Tongue with Mouth Closure maintained at high levels.

Results of Figures 6 and 7 and Table 4 suggest that refusal behaviors decreased and acceptance increased for the first bite placement in the hierarchy only when NCR was used, during the first two fading steps, and was maintained in the absence of NCR during the final fading step, even though escape was permitted. Results of the first two fading steps provide additional support for the supposition that NCR may abolish escape from bite presentations as a reinforcer (i.e., function as an AO). The AO effects, however, were limited to the first bite placement in the hierarchy with escape allowed. Thus, when escape was allowed across multiple bite placements in the hierarchy (i.e., when At Lips and Past Lips were the required demand), the AO effects did not extend to the terminal bite placement within the hierarchy (i.e., On Tongue with Mouth Closure).

Experiment 3

The effects of two potential MOs (i.e., NCR and food-related satiation) on negative reinforcement for escaping bite presentations were evaluated in Experiment 3. The mean percentage of Abigail's refusal behaviors and acceptance of bite placements (with escape allowed) per session are presented in Table 5. The percentage of bites in which Abigail engaged in refusal behaviors for bite placements with escape permitted is depicted in Figure 8. Acceptance within the hierarchy of bite placement is depicted in Figure 9.

Phase A: Tube-Feed Satiation + Absence of NCR

The effects of relative levels of food-related satiation (as a result of temporal relation to overnight tube feedings) on negative reinforcement for escaping bite presentations were examined in the absence of NCR during AM and PM feeding sessions. Refusal behaviors for all bite placements with escape permitted remained high (range, 75% to 100% for Past Lips [Figure 8, top panel] and range from 85% and 100% for On Tongue and On Tongue with Mouth Closure [Figure 8, middle and bottom panels, respectively]) during all seven sessions conducted in the AM. Refusal behaviors for all bite placements with escape allowed increased (from 10% to 75% for Past Lips and from 15% to 85% for On Tongue and On Tongue with Mouth Closure) across the two sessions conducted in the PM. Acceptance of all bite placements with escape allowed remained low (range, 0% to 25% for Past Lips [Figure 9, top panel] and range, 0% to 15% for On Tongue and On Tongue with Mouth Closure [Figure 9, middle and bottom panels, respectively) during all AM sessions. Acceptance of all bite placements with escape permitted decreased (from 90% to 15% for Past Lips and from 85% to 15% for On Tongue and On Tongue with Mouth Closure) across the two sessions conducted in the PM.

Phases B and C: Tube-Feed Satiation + Presence of NCR
vs. Tube-Feed Deprivation + Presence of NCR

The effects of relative levels of food-related satiation on negative reinforcement for escaping bite presentations were examined in the presence of NCR during AM and PM feeding sessions and with and without tube-feed deprivation. During the initial B phase (tube-feed satiation + presence of NCR), refusal behaviors for all bite placements with escape allowed remained high (range, 65% to 90% for Past Lips, range, 95% to

100% for On Tongue, and 100% for On Tongue with Mouth Closure), during the six sessions conducted in the AM, but decreased (range, 0% and 42% for Past Lips and range, 0% and 68%% for On Tongue and On Tongue with Mouth Closure) during the eight sessions conducted in the PM. Acceptance of all bite placements remained low (range, 10% to 35% for Past Lips and range, 0% to 5% for On Tongue and On Tongue with Mouth Closure), during the AM sessions, but increased (range, 50% to 100% for Past Lips and range, 30% to 100% for On Tongue and On Tongue with Mouth Closure) during the PM sessions.

During the initial C phase (tube-feed deprivation + presence of NCR), refusal behaviors for all bite placements with escape allowed remained low (below 10% for all bite placements) during the eight sessions conducted in the PM, with the exception of two sessions (at 35% for Past Lips and above 70% for On Tongue and On Tongue with Mouth Closure). During the 11 sessions conducted in the AM, refusal behaviors for bite placements with escape allowed decreased to below 20% for all bite placements, with the exception of one session (at 75% for Past Lips and 85% for On Tongue and On Tongue with Mouth Closure). Acceptance of all bite placements remained high (above 80% for all bite placements) during the PM sessions, with the exception of two sessions (below 60% for Past Lips and below 30% for On Tongue and On Tongue with Mouth Closure).

Refusal behaviors for all bite placements with escape allowed remained low (below 10%), during the initial three sessions conducted in both the AM and PM, with a return to tube-feed satiation in the presence of NCR (Phase B), but increased (above 90%) during the subsequent three sessions conducted in the AM and two sessions in the PM. Acceptance of all bite placements remained high (above 90%) during the initial three sessions conducted in both the AM and PM, but decreased (below 10%) during the subsequent three sessions conducted in the AM and 2 sessions in the PM.

With the re-introduction of tube-feed deprivation combined with NCR (Phase C) refusal behaviors for all bite placements with escape allowed were high (range, 55% to

85%) during the initial three sessions conducted in the AM but decreased (below 15%) during the subsequent five sessions conducted in the AM. Refusal behaviors for all bite placements with escape permitted decreased (below 20%) during all seven sessions conducted in the PM. Acceptance of all bite placements remained low (range, 15% to 40%) during the initial three sessions conducted in the AM but increased (range, 80% to 100%) during the subsequent five sessions conducted in the AM. Acceptance of all bites placements increased (range, 80% to 100) during all seven7 sessions conducted in the PM.

Phase D: Tube-Feed Deprivation + Presence of NCR vs.
Tube-Feed Deprivation + Absence of NCR

The effects of NCR on negative reinforcement for escaping bite presentations with tube-feed deprivation were examined within a multi-element design (presence vs. absence of NCR). Refusal behaviors for all bite placements with escape permitted remained low (range, 0% to 18%) during all six sessions using NCR. Without NCR, refusal behaviors for all bite placements with escape permitted remained low (5%) during the first session but increased (range, 35% to 60%) during the subsequent four sessions. Acceptance of all bite placements with escape allowed remained high (range, 80% to 100%) during all six sessions with NCR. Without NCR, acceptance of all bite placements with escape allowed remained high (92%) during the first session but decreased (range, 20% to 58%) during the subsequent four sessions.

Results of Table 5 and Figures 8 and 9 suggest that refusal behaviors for bite placements with escape allowed were influenced by an interaction of two variables (NCR and food satiation) that appeared to function as MOs. The addition of NCR decreased refusal behaviors during sessions conducted temporally distant from overnight tube feedings (PM sessions; i.e., a relative state of food deprivation) but remained high during sessions following overnight tube feedings (AM sessions; i.e., a relative state of food satiation). Refusal behaviors decreased during AM sessions when the volume of overnight tube feedings was decreased (i.e., a relative state of food deprivation) but only when NCR was used. These results support the supposition that NCR and relative levels of food-related satiation and deprivation interacted to change the MO for escaping bite presentations. NCR appeared to abolish escape from bite presentations (AO) and food-related satiation (i.e., overnight tube feeds and sessions following overnight tube feeds) appeared to establish escape from bite presentations (EO). The combined AO effects of NCR and tube-feed deprivation resulted in decreased refusal behaviors and increased acceptance across all bite placements, even with escape allowed (including the terminal bite placement) as a reinforcer.

Clinical Results

The immediate clinical goals for Adam (Experiment 1) were to decrease food refusal behaviors and increase acceptance of small tastes of food inside his mouth in order to conduct further oral motor evaluation. Adam's refusal behaviors decreased to an average of 40% during the final five sessions conducted (compared to an average of 92% during the initial A phase) and acceptance of bites past his lips increased to an average of 60% (compared to an average of 8% during the initial A phase). Following the completion of Experiment 1, the speech and language pathologist successfully completed an oral motor evaluation when NCR and EE for bite placement At Lips were used.

Clinical goals for Lexie (Experiment 2) were to decrease refusal behaviors and increase acceptance of pureed/smooth foods. Refusal behaviors for bite placement On Tongue with Mouth Closure (the terminal bite placement) decreased to below 10% and acceptance On Tongue with Mouth Closure increased to above 90% during the four sessions conducted in the final phase (compared to 100% and 0%, respectively, during Phase A). Lexie was accepting three smooth foods at the conclusion of intensive outpatient therapy. Lexie's caregiver was trained to use NCR and EE procedures for bite placement On Tongue. Lexie's refusal behaviors remained below 10% and acceptance remained above 90% during caregiver training sessions.

Clinical goals for Abigail (Experiment 3) were to decrease food refusal behaviors, increase acceptance of table-texture foods, and decrease g-tube feedings. Refusal behaviors decreased to below 20% and acceptance On Tongue with Mouth Closure increased to above 80% during the six sessions that used NCR in the final phase (with tube-feed deprivation). Abigail's caregiver was trained to implement NCR and EE procedures for bite placement At Lips. Refusal behaviors remained below 20% and acceptance remained above 80% during caregiver training sessions at the completion of the experiment. Abigail was accepting a variety of eight table-texture foods (two from each of the four food groups), and Abigail's overnight tube feeds were reduced by 43%. On average, Abigail's total per oral caloric intake was equivalent to the reduction in tube feeds during each tube-feed deprivation phase. Weight gain was achieved by the conclusion of Experiment 3 and during 3- and 5-month follow-up (Table 6).

Table 3. Mean Percentage of Refusal Behaviors and Bite Acceptance (per Session) for Bite Placements with Escape Allowed for Adam (Experiment 1)

	Phase A Absence of NCR	Phase B Presence of NCR	Phase A Absence of NCR	Phase B Presence of NCR
Past Lips				
Refusal Behaviors	91.67	71.56	94.67	54.94
Bite Acceptance	8.33	28.44	5.33	45.06

Figure 5. Percentage of trials with refusal behaviors for Past Lips (top panel) and percentage of bites accepted Past Lips (bottom panel) for Adam (Experiment 1)

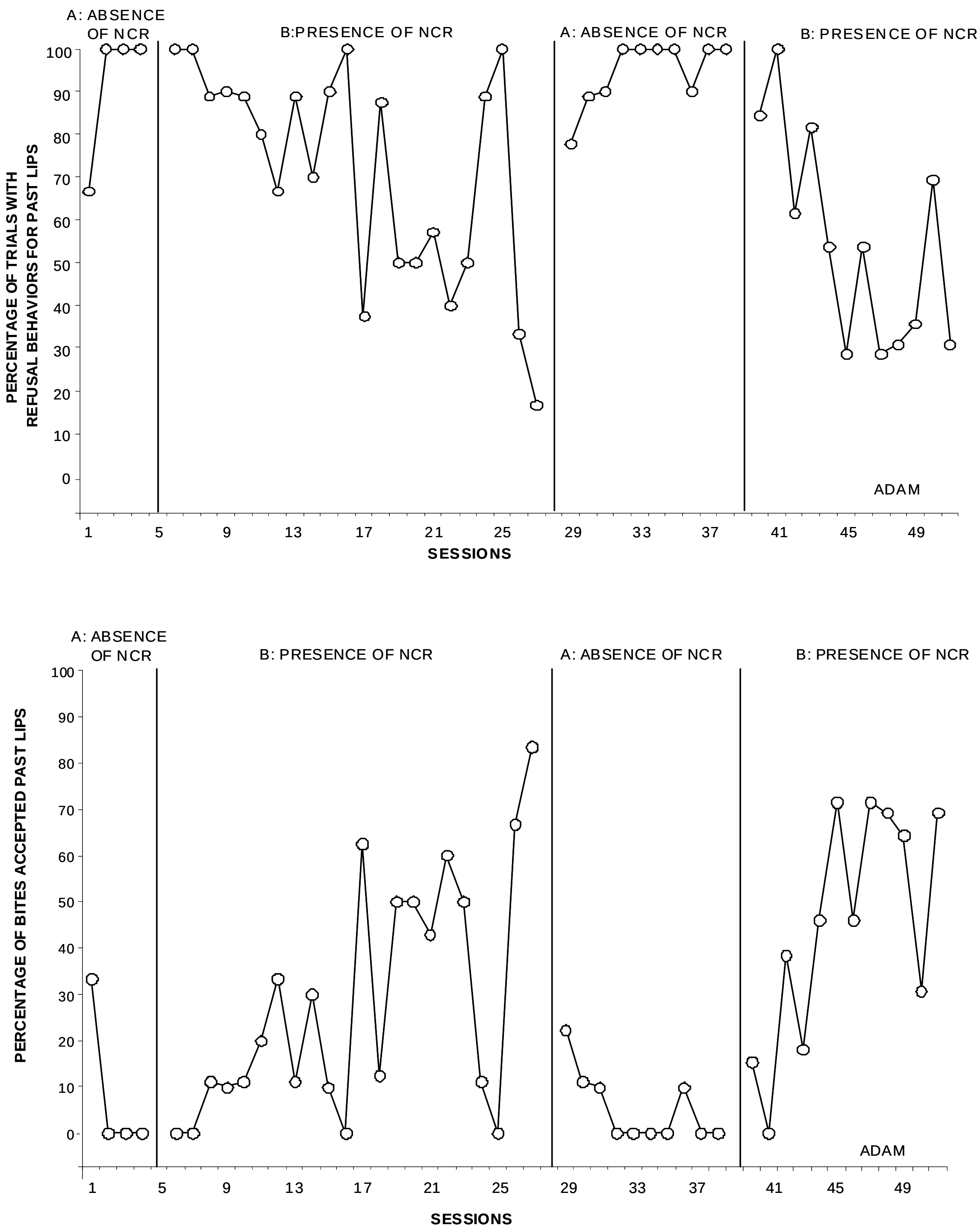


Table 4. Mean Percentage of Refusal Behaviors and Bite Acceptance (per Session) for Bite Placements with Escape Allowed for Lexie (Experiment 2)

	Required Demand: At Lips			Required Demand: Past Lips			Required Demand: On Tongue	
	Phase B Presence of NCR	Phase A Absence of NCR	Phase B Presence of NCR	Phase C Presence of NCR	Phase D Absence of NCR	Phase C Presence of NCR	Phase E Presence of NCR	Phase F Absence of NCR
Past Lips								
Refusal Behaviors	41.37	62	10.68	N/A	N/A	N/A	N/A	N/A
Bite Acceptance	58.63	37.80	89.32	N/A	N/A	N/A	N/A	N/A
On Tongue								
Refusal Behaviors	99.62	100	97.73	90.78	100	95.76	N/A	N/A
Bite Acceptance	0.38	0	2.27	9.22	0	4.24	N/A	N/A
Mouth Closure								
Refusal Behaviors	100	100	100	99.60	100	100	44.95	2.77
Bite Acceptance	0	0	0	0.40	0	0	55.05	97.22

Figure 6. Percentage of trials with refusal behaviors for Past Lips (top panel), On Tongue (middle panel), and On Tongue with Mouth Closure (bottom panel) for Lexie (Experiment 2)

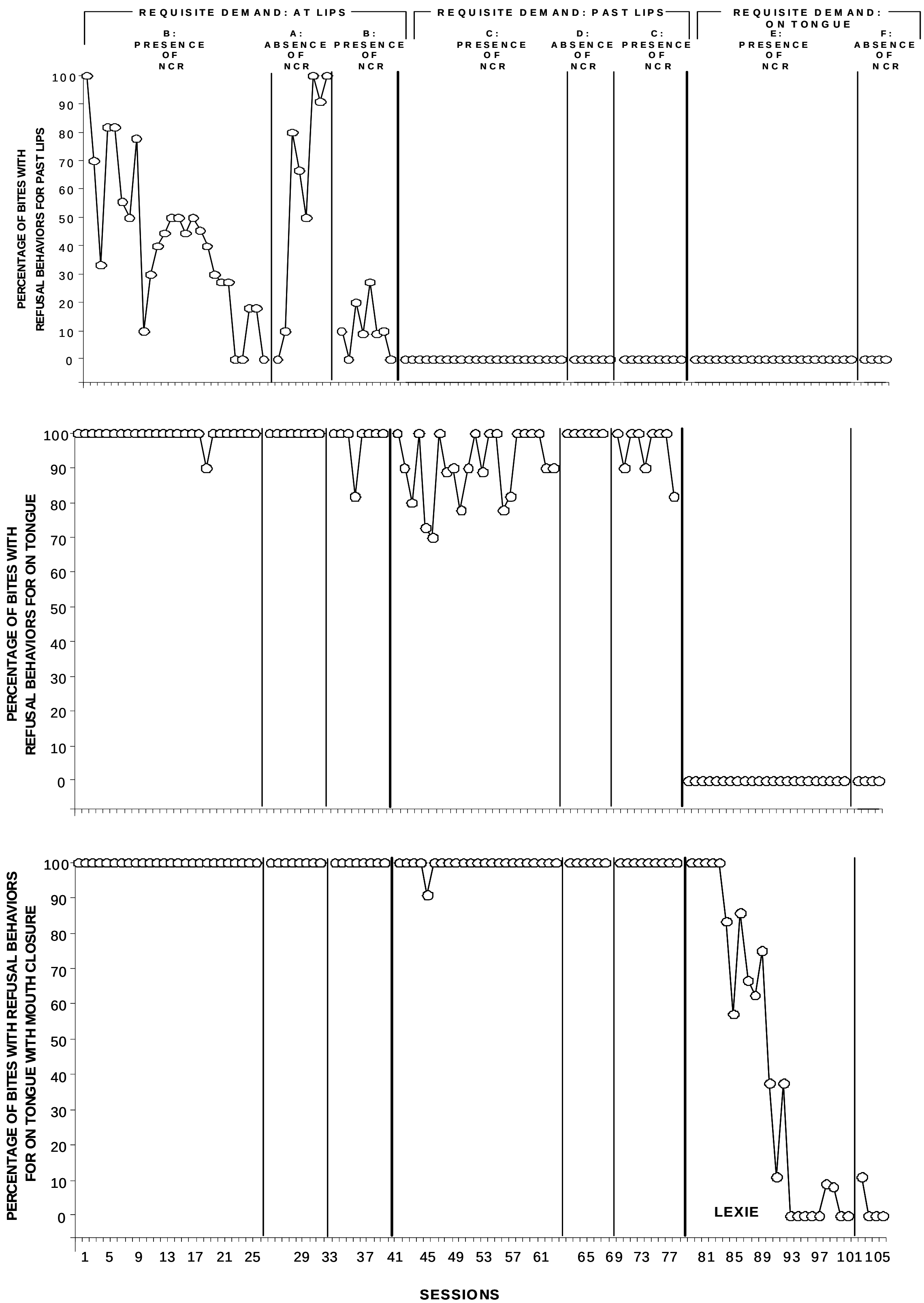


Figure 7. Percentage of trials accepted Past Lips (top panel), On Tongue (middle panel), and On Tongue with Mouth Closure (bottom panel) for Lexie (Experiment 2)

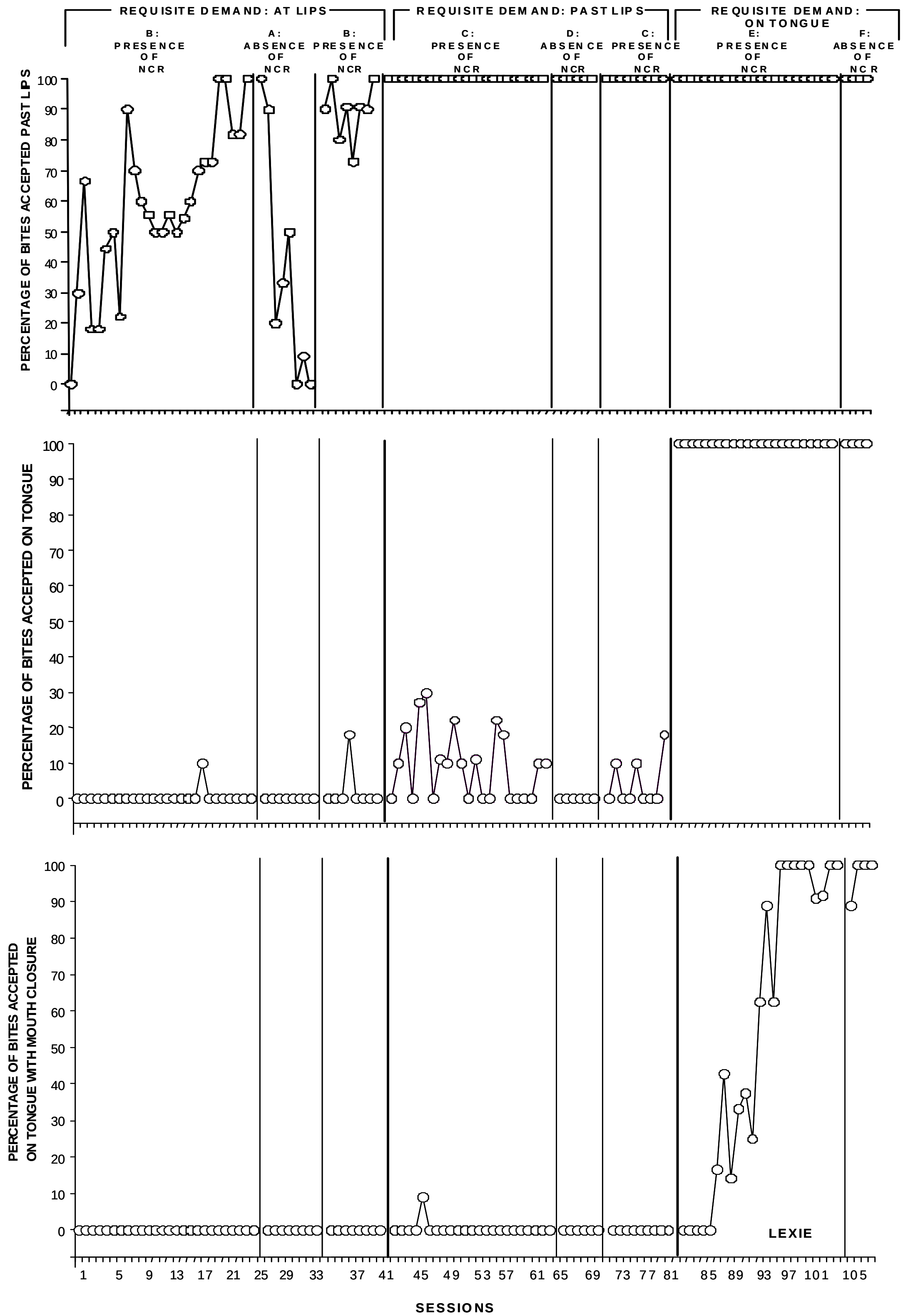


Table 5. Mean Percentage of Refusal Behaviors and Bite Acceptance (per Session) for Bite Placements with Escape Allowed for Abigail (Experiment 3)

	Phase A Tube-Feed Satiation + Absence of NCR		Phase B Tube-Feed Satiation + Presence of NCR		Phase C Tube-Feed Deprivation + Presence of NCR		Phase B Tube-Feed Satiation + Presence of NCR		Phase C Tube-Feed Deprivation + Presence of NCR		Phase D Tube-Feed Deprivation	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	Absence of NCR	Presence of NCR
Past Lips												
Refusal Behaviors	93.37	42.50	79.31	9.57	9.52	11.31	49.07	38.87	27.08	5.40	38.77	4.56
Bite Acceptance	6.63	52.50	20.69	90.43	90.48	88.69	50.93	42.30	72.92	94.60	61.22	95.43
On Tongue												
Refusal Behaviors	97.02	50	98.24	15.52	10.78	17.14	50.83	60.87	28.40	6.08	43.11	4.56
Bite Acceptance	2.98	50	1.76	84.48	89.22	82.85	49.17	39.13	71.60	93.92	56.89	95.43
Mouth Closure												
Refusal Behaviors	97.02	50	100	15.52	11.24	19.87	50.83	60.87	29.96	6.08	43.11	4.56
Bite Acceptance	2.98	50	0	84.48	88.76	79.13	49.17	39.13	70.04	93.92	56.89	95.43

Figure 8. Percentage of trials with refusal behaviors for Past Lips (top panel), On Tongue (middle panel), and On Tongue with Mouth Closure (bottom panel) for Abigail (Experiment 3)

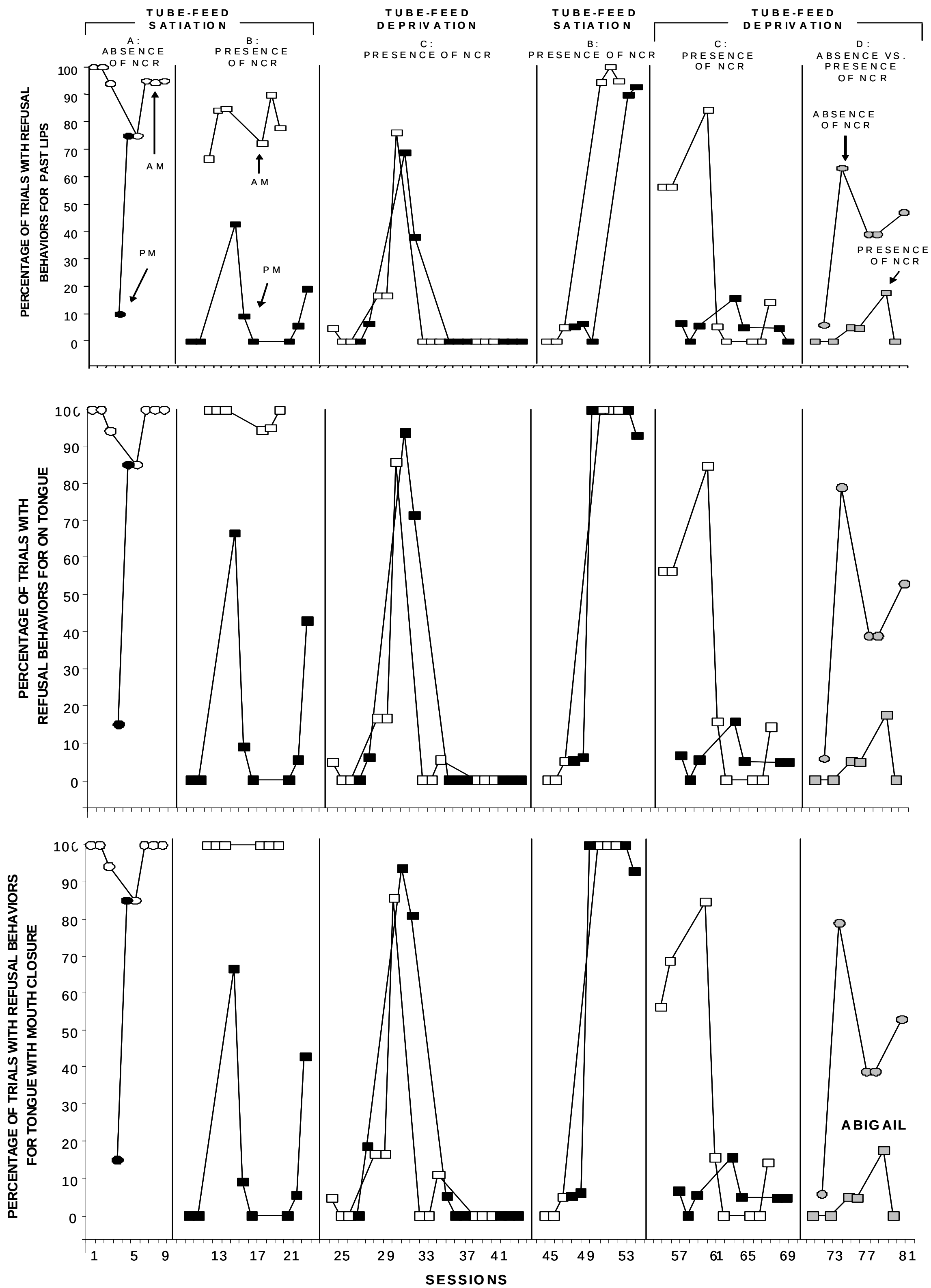


Figure 9. Percentage of trials accepted Past Lips (top panel), On Tongue (middle panel), and On Tongue with Mouth Closure (bottom panel) for Abigail (Experiment 3)

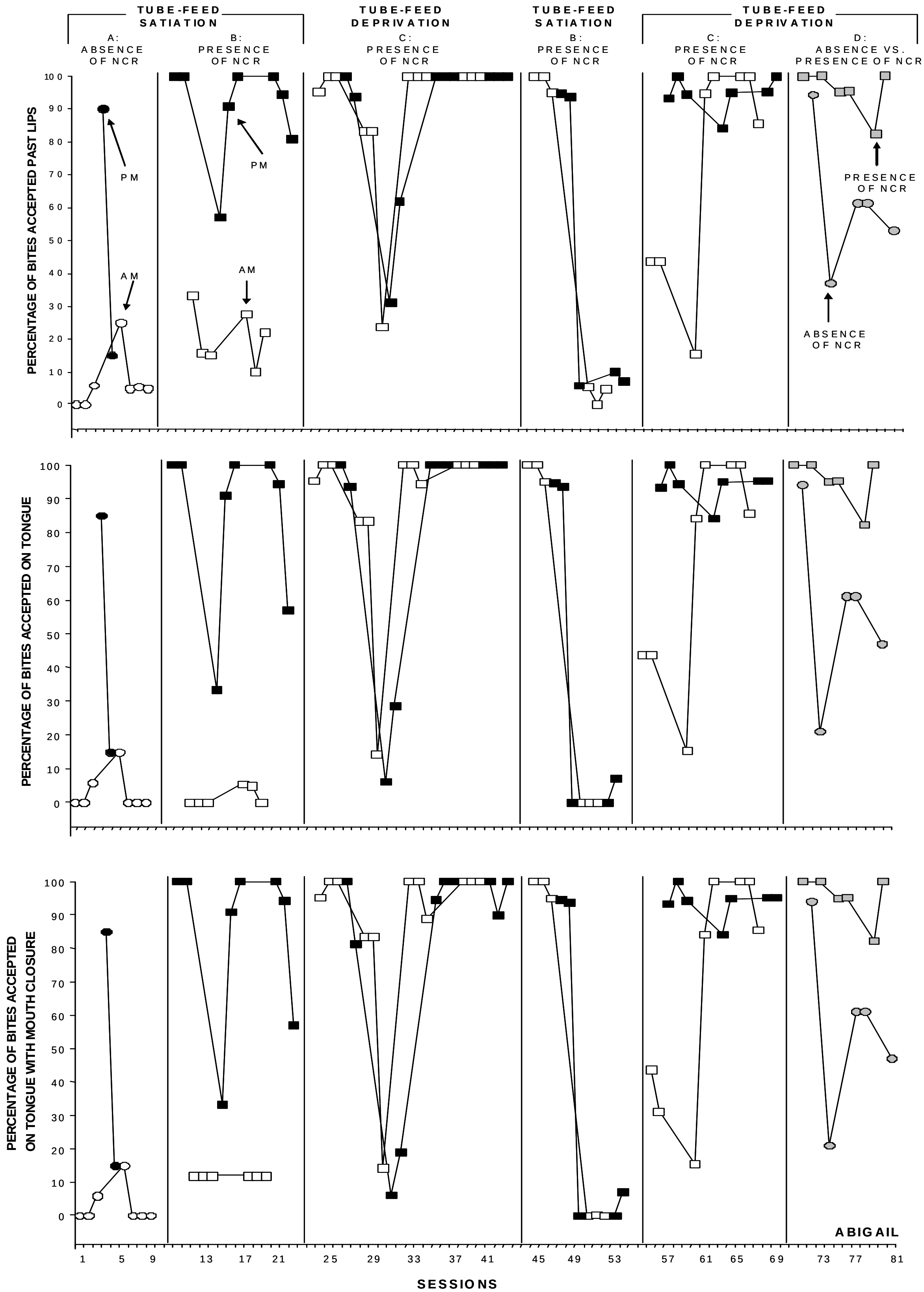


Table 6. Weight and Tube-Feed Volumes for Abigail (Experiment 3)

	Weight (kg)	Weight (percentile)*	Tube Feeds (% of daily caloric needs)
12 months prior to evaluation	10.0	3%	N/A
6 months prior to evaluation	10.6	3%	100%
1 week prior to evaluation	11.7	7%	100%
Following evaluation (15 days)	12.0	7%	57 – 100%
3-month follow-up	13.2	21%	57%
5-month follow-up	14.2	36%	57%

* Percentile developed by the National Center for Health and Statistics in collaboration with the National Center for Chronic Disease and Prevention and Health Promotion (2000).

CHAPTER V

DISCUSSION

Overview

The current study examined the influence of two potential MOs on bite acceptance for children exhibiting severe food refusal: (a) NCR (continuous access to positive reinforcement in the form of preferred items/activities), a variable that may abolish escape as a reinforcer (AO) for food refusal by decreasing the aversiveness of meals, and (b) food satiation, a variable that may increase the aversiveness of the meal and establish escape as a reinforcer (EO). The AO effects of NCR on negative reinforcement (escape) for refusal behaviors were demonstrated in Experiment 1 even when escape was allowed for food refusal and in Experiment 2 during demand fading across a hierarchy of bite placements. The interactive effects of NCR and food satiation on negative reinforcement for escaping bite presentations (within a hierarchy of bite placements) were demonstrated in Experiment 3. The following sections provide a brief summary and discussion related to the results of each experiment.

Summary of Conceptual Findings

In Experiment 1, I examined the abolishing effects of NCR on negative reinforcement (escape) during bite presentations. EE was used only to ensure that contact of bite offers occurred at the child’s lips; the child was allowed to escape bites from entering his mouth (i.e., acceptance Past Lips) by engaging in refusal behaviors. Refusal behaviors for Past Lips increased and acceptance Past Lips decreased in the absence of NCR. When NCR was used, refusal behaviors for Past Lips decreased and acceptance Past Lips increased. Thus, although escape was permitted for Past Lips, refusal behaviors decreased and acceptance increased when NCR was used. These results suggested that NCR decreased the child’s motivation to escape bites from entering his mouth and, thus, NCR appeared to function as an AO for negative reinforcement (escape).

When a bite of food enters a child’s mouth, it can be accepted at increasing levels of placement. Therefore, in Experiment 2, I examined the abolishing effects of NCR on escape from bite presentations across a hierarchy of bite placements: past the lips, further inside the mouth on the mid-tongue, or on the mid-tongue with mouth closure. Demand fading combined with EE was used to increase bite acceptance across the hierarchy. EE was used only for acceptance of the required bite placement at each fading step; escape was permitted for all successive bite placements within the hierarchy. During each fading step, refusal behaviors for the first bite placement in the hierarchy with escape allowed decreased and acceptance increased when NCR was used. These results suggested that NCR decreased the child’s motivation to escape bite placements at each fading step and thus, NCR appeared to function as an AO for escape across a hierarchy of bite placements.

Taken together, results of Experiments 1 and 2 demonstrated that NCR may decrease the aversiveness of the mealtime situation for some children, thereby decreasing the motivation for refusal behaviors maintained by negative reinforcement. Previous researchers (e.g., Cooper et al. 1995, Wilder et al., 2005) have demonstrated the potential AO effects of NCR on food refusal maintained by negative reinforcement, but only with children who already had established patterns of eating (i.e., selective or overall low intake). Treatment studies for severe food refusal have primarily examined the effects of NCR in combination with EE. Reed and colleagues (2004) examined the individual and combined effects of NCR and EE with children exhibiting severe food refusal. The results suggested that the MO for negative reinforcement (escape) for refusal behaviors did not change when NCR was implemented without EE. The current study is the first to examine the MO effects of NCR with children who display severe food refusal.

Although no change in bite acceptance was observed in the Reed et al. (2004) study, probably because of the use of EE, the change in the MO via NCR was associated with reductions in refusal behaviors for some of the participants. The beneficial effects suggest that there are conditions under which NCR will change the MO for escape from bite presentations for children who exhibit severe food refusal. In the current study, the AO effects of NCR on negative reinforcement from bite acceptance were observed within a hierarchy of bite placements. However, the AO effects were only observed for the first bite placement in the hierarchy when escape was allowed. When escape was allowed across multiple bite placements in the hierarchy (i.e., when the required demand was At Lips and Past Lips), the AO effects did not extend to the terminal bite placement within the hierarchy (i.e., On Tongue with Mouth Closure). Thus, examining the effects of NCR on escape from bite acceptance within a hierarchy of bite placements allowed me to observe the AO effects.

The individual and combined effects of the two potential MOs (NCR and food-related satiation) on escape from bite presentations were examined in Experiment 3. Food-related satiation was examined by (a) manipulating the volume of overnight tube feeds (i.e., tube-feed satiation vs. deprivation) and (b) observing oral feedings within close and distant temporal proximity to overnight tube feeds. EE was used to insure that contact of bite offers occurred at the child's lips, but the child was allowed to refuse (escape) bites from entering her mouth. The presence and absence of NCR and food satiation and deprivation were examined individually and in combination. When NCR was used, refusal behaviors for all bite placements when escape was allowed decreased during sessions conducted temporally distant from overnight tube feedings but remained high during sessions immediately following overnight tube feedings. Refusal behaviors also decreased during AM sessions when the volume of overnight tube feedings was decreased (a relative state of food deprivation) but only when NCR was used. These results suggest that NCR and relative levels of food-related satiation and deprivation interacted to change the MO for negative reinforcement for food refusal for this participant. NCR abolished escape as a reinforcer (AO) and food-related satiation (i.e., overnight tube feeds and sessions following overnight tube feeds) established escape as a reinforcer (EO). The combined MO effects of NCR and deprivation resulted in decreased refusal behaviors and increased acceptance across all bite placements, even when escape was allowed.

Results of Experiment 3 are consistent with previous studies examining the effects of specific biological conditions on escape-maintained behavior. These studies have shown that specific biological variables often increase the value of negative reinforcement, and thus increase the likelihood of escape-maintained behavior (e.g., Carr & Owen-DeSchryver, 2006; Kennedy & Meyer, 1996; O'Reilly, 1995; 1997; Reed et al., 2005). Results of the current study are also consistent with results of basic and applied studies on satiation and deprivation with humans and other animals in showing that food satiation may reduce subsequent caloric intake (e.g., Gossette, 1971; Johnson et al., 2009; Smith & Duffy, 1957; Vollmer & Iwata, 1991). Although food satiation, as a result of enteral nutritional support, has been discussed in the behavioral feeding literature as a potential biological variable that may influence behavior during treatment of severe food refusal (Byars et al., 2003; Linscheid, 1999, 2006), the current study is the first study to systematically examine the effects of food satiation during behavioral treatments of severe food refusal.

The current findings extend the literature in three ways. First, the results of the three experiments extend the findings of the existing literature examining the effects of the competition between positive and negative reinforcement in the treatment of escape-maintained problem behavior. Within this area of the literature, some researchers have shown that contingent schedules of positive reinforcement can increase compliance and decrease escape-maintained problem behavior across a variety of demand contexts even when problem behavior continues to result in escape, precluding the need for EE (e.g., DeLeon et al., 2001; Lalli et al., 1999; Piazza et al., 1997). Contingent access to positive reinforcement has also been shown to increase bite acceptance and decrease food refusal even when problem behavior continues to result in escape (e.g., Cooper et al., 1999;

Riordan et al., 1980; Riordan et al., 1984). Studies demonstrating that positive reinforcement may abolish escape as reinforcement within the demand context, however, have largely examined the effects of contingent schedules of positive reinforcement (DRA). Noncontingent schedules of positive reinforcement (NCR) have been examined infrequently in the extant literature. The current study is the first study to demonstrate increases in acquisition of bite acceptance (compliance) using NCR (without EE) with children displaying severe food refusal.

Second, the current findings extend the literature examining the effects of biological variables on escape-maintained problem behavior. Previous research has shown that specific biological variables (i.e., sleep deprivation, otitis media, and allergy symptoms) may increase the value of negative reinforcement, and, therefore increase the likelihood of escape-maintained behavior (e.g., Kennedy & Meyer, 1996; O'Reilly, 1995, 1997). However, these findings have only been applied to the treatment of feeding problems in one previous study (Reed et al., 2005). The current study is the first study to systematically examine the relative effects of food satiation on the effects of behavioral treatments for pediatric feeding problems.

Finally, the current findings extend the existing literature in the treatment of pediatric feeding problems by examining the interaction of multiple MOs on negative reinforcement (escape) for bite presentations. The systematic examination of antecedent variables that may alter the MO for escape-maintained feeding behaviors has recently received considerable attention in the behavioral feeding literature (e.g., Dawson et al., 2003; Hagopian et al., 1996; Johnson & Babbitt, 1993; Kerwin et al., 1995; Luiselli, 1994, 2000; McComas et al., 2000; Mueller et al., 2004; Munk & Repp, 1994; Patel et al. 2001; Patel, Piazza, Santana, et al., 2002; Patel et al., 2005; Patel et al., 2006; Reed et al., 2005). However, few studies to date have examined the interactive effects of multiple potential MOs on escape-maintained feeding behaviors.

Implications

The findings of the current study provide three major implications for the treatment of severe food refusal. First, previous research on the assessment of pediatric feeding disorders has shown that negative reinforcement (escape or avoidance from bites of food) plays a major role in the maintenance of food refusal and that EE may be necessary to increase food acceptance for some children (e.g., Ahearn et al., 1996; Cooper et al., 1995; Hoch et al., 1994; Piazza, Patel, et al., 2003; Reed et al., 2004), particularly those exhibiting severe food refusal. Although EE has been shown to be effective, it has been associated with a number of side effects, such as extinction-induced collateral behaviors (i.e., extinction bursts, extinction-induced aggression, and emotional responding; Lerman et al., 1999). Moreover, treatment fidelity may be compromised as a result of the child's size or strength when rates and intensity of problem behaviors increase resulting in decreased treatment effects. When increases in desired behaviors (e.g., bite acceptance) do not occur immediately, and problem behaviors increase or emotional responding (e.g., crying) emerges, the situation may become unacceptable to some caregivers. The current findings suggest that under some conditions, NCR may abolish escape from bite acceptance for some children with severe food refusal precluding the need for EE.

Second, Experiment 3 demonstrated that food-related satiation may establish negative reinforcement (escape) from bite presentations for some children. This effect may potentially decrease the effectiveness of behavioral treatments based on positive reinforcement, which otherwise would have been effective. In addition, satiation may also decrease the immediacy of treatment effects for more intensive behavioral treatments such as EE. Children who exhibit severe food refusal often require enteral nutritional support, such as NG- or G- tube feedings to sustain their growth, and oral feedings are often introduced to these children while they are continuing to receive nutritional support.

The current study provides a methodology for examining the effects of food satiation (as a result of enteral nutritional support) on behavioral treatments of severe food refusal.

Finally, Experiment 3 demonstrated that multiple variables may concurrently interact as MOs for negative reinforcement from bite presentations. The current study provides a methodology to examine the interactive effects of multiple potential MOs on escape from bites, which may lead to eliminating EE as a treatment component for some children who exhibit severe food refusal.

Study Limitations

There are at least two limitations of the current study requiring that the results be interpreted with caution. First, EE was used in all three experiments to ensure that contact of bite offers occurred at the child's lips. The participants in the current study each had a history of escaping/avoiding contact with all bite offers. It is unclear whether the same results would have been achieved if the participants would not have been required to come into contact with bite offers at their lips. Second, because the current study was conducted in an outpatient setting, treatment integrity for the overnight tube-feed manipulations in Experiment 3 was limited to caregiver report. Tube feed administration logs were used, however, to increase the accuracy of caregiver report. An additional procedure that could be used to ensure the accuracy of these data would be to videotape tube feeds that occur outside of the controlled clinical setting.

Areas for Future Research

Given the preliminary nature of these findings, several avenues of future research appear warranted. Future research should examine the interaction of other schedules of positive reinforcement (e.g., differential reinforcement) with food-related satiation as a result of overnight tube feeds and close temporal proximity to overnight tube feeds in the treatment of severe food refusal. Additional research examining the relative effects of varying levels of food-related satiation (e.g., manipulating different levels of tube-feed reductions) on behavioral treatments should also be conducted. There are a number of other biological variables (e.g., gastrointestinal disturbances such as chronic constipation or acute recurrences of GERD-related symptoms) that may influence the effectiveness of behavioral treatments, and examination of the influence of these variables on escape-maintained feeding behaviors is warranted.

APPENDIX

OBSERVATION RECORDING FORM

Start Time: ____________________ Name/ID: ____________________
Stop Time: ____________________ Date: ____________________
Feeder: ____________________ Meal: ____________________
Phase/Condition: ____________________

BITE	FOOD/DRINK	CHILD						DEMAND			
1		IND	FED	—	N	G	S	L	P	T	MC
2		IND	FED	—	N	G	S	L	P	T	MC
3		IND	FED	—	N	G	S	L	P	T	MC
4		IND	FED	—	N	G	S	L	P	T	MC
5		IND	FED	—	N	G	S	L	P	T	MC
6		IND	FED	—	N	G	S	L	P	T	MC
7		IND	FED	—	N	G	S	L	P	T	MC
8		IND	FED	—	N	G	S	L	P	T	MC
9		IND	FED	—	N	G	S	L	P	T	MC
10		IND	FED	—	N	G	S	L	P	T	MC
11		IND	FED	—	N	G	S	L	P	T	MC
12		IND	FED	—	N	G	S	L	P	T	MC
13		IND	FED	—	N	G	S	L	P	T	MC
14		IND	FED	—	N	G	S	L	P	T	MC
15		IND	FED	—	N	G	S	L	P	T	MC
16		IND	FED	—	N	G	S	L	P	T	MC
17		IND	FED	—	N	G	S	L	P	T	MC
18		IND	FED	—	N	G	S	L	P	T	MC
19		IND	FED	—	N	G	S	L	P	T	MC
20		IND	FED	—	N	G	S	L	P	T	MC
21		IND	FED	—	N	G	S	L	P	T	MC
22		IND	FED	—	N	G	S	L	P	T	MC
23		IND	FED	—	N	G	S	L	P	T	MC
24		IND	FED	—	N	G	S	L	P	T	MC
25		IND	FED	—	N	G	S	L	P	T	MC

REFERENCES

Ahearn, W. H., Kerwin, M. E., Eicher, P. S., & Lukens, C. T. (2001). An ABAC comparison of two intensive interventions for food refusal. *Behavior Modification, 25*, 385–405.

Ahearn, W. H., Kerwin, M. E., Eicher, P. S., Shantz, J., & Swearingin, W. (1996). An alternating treatments comparison of two intensive interventions for food refusal. *Journal of Applied Behavior Analysis, 29*, 321–332.

Babbitt, R. L., Hoch, T. A., & Coe, D. A. (1994). Behavioral feeding disorders. In D. N. Tuchman. & R. S. Walter (Ed.), *Disorders of feeding and swallowing in infants and children: Physiology, diagnosis, and treatment* (pp. 77–79). San Diego, CA: Cingular.

Babbitt, R. L., Hoch, T. A., Coe, D. A., Cataldo, M. F., Kelly, K. J., Stackhouse, C., et al. (1994). Behavioral assessment and treatment of pediatric feeding disorders. *Developmental and Behavioral Pediatrics, 15*, 278–291.

Bachmeyer, M. H. (2009). Treatment of selective and inadequate intake food intake in children: A review and practical guide. *Behavior Analysis in Practice, 2*, 43–50.

Bachmeyer, M. H., Piazza, C. C., Fredrick, L. D., Reed, G. K., Rivas, K. D., & Kadey, H. J. (2009). Functional analysis and treatment of multiply controlled inappropriate mealtime behavior. *Journal of Applied Behavior Analysis, 42*, 641–658.

Budd, K. S., McGraw, T. E., Farbisz, R., Murphy, T. B. Hawkins, D., Heilman, N., & Werle, M. (1992). Psychosocial concomitants of children's feeding disorders. *Journal of Pediatric Psychology, 17*, 81–94.

Burklow, K. A., Phelps, A. N., Schultz, J. R., McConnell, K., & Rudolph, C. (1998). Classifying complex pediatric feeding disorders. *Journal of Pediatric Gastroenterology and Nutrition, 27*(2), 143–147.

Byars, K. C., Burklow, K. A., Ferguson, K., O'Flaherty, Santoro, K., & Kaul, A. (2003). A multicomponent behavioral program for oral aversion in children dependent on gastrostomy feedings. *Journal of Pediatric Gastroenterology and Nutrition, 37*, 473–480.

Carr, E. G., & Owen-DeSchryver, J. S. (2006). Physical illness, pain, and problem behavior in minimally verbal people with developmental disabilities. *Journal of Autism and Developmental Disorders, 37*, 413–424.

Carr, E. G., & Smith, C. E. (1995). Biological setting events for self-injury. *Mental Retardation and Developmental Disabilities, 1*, 94–98.

Casey, S. D., Cooper-Brown, L. J., Wacker, D. P., & Rankin, B. E. (2006). The use of descriptive analysis to identify and manipulate schedules of reinforcement in the treatment of food refusal. *Journal of Behavioral Education, 15*, 41–52.

Christensen, T. J., Ringdahl, J. E., Bosch, J. J., Falcomata, T. S., Luke, J. R., & Andelman, M. S. (2009). Constipation associated with self-injurious and aggressive behavior exhibited by a child diagnosed with autism. *Education & Treatment of Children, 32*, 89-103.

Christophersen, E. R., & Hall, C. L. (1978). Eating patterns and associated problems encountered in normal children. *Issues in Comprehensive Pediatric Nursing, 3,* 1–16.

Coe, D. A., Babbitt, R. L., Williams, K. E., Hajimihalis, C., Snyder, A. M., Ballard, C., et al. (1997). Use of extinction and reinforcement to increase food consumption and reduce expulsion. *Journal of Applied Behavior Analysis, 30,* 581–583.

Cooper, L. J., Wacker, D. P., Brown, K., McComas, J. J., Peck, S. M., Drew, J., et al. (1999). Use of a concurrent operants paradigm to evaluate positive reinforcers during treatment of food refusal. *Behavior Modification, 23,* 3–40.

Cooper, L. J., Wacker, D.P., McComas, J. J., Brown, K., Peck, S. M., Richman, D., et al. (1995). Use of component analyses to identify active variables in treatment packages for children with feeding disorders. *Journal of Applied Behavior Analysis, 28,* 139–153.

Dawson, J. E., Piazza, C. C., Sevin, B. M., Gulotta, C. S., Lerman, D., & Kelley, M. (2003). Use of a high-probability instructional sequence and escape extinction in a child with food refusal. *Journal of Applied Behavior Analysis, 36,* 105–108.

DeLeon, I. G., Neidert, P. L., Anders, B. M., & Rodriguez-Catter, V. (2001). Choices between positive and negative reinforcement during treatment for escape-maintained behavior. *Journal of Applied Behavior Analysis, 34,* 512–525.

deMoor, J., Didden, R., & Korzilius, H. (2007). Behavioural treatment of severe food refusal in five toddlers with developmental disabilities. *Child: care, health and development, 33,* 6, 670–676.

Fischer, S. M., Iwata, B. A., Mazaleski, J. L. (1997). Noncontingent delivery of arbitrary reinforcers as treatment for self-injurious behavior. *Journal of Applied Behavior Analysis, 30,* 239–249.

Girolami, P. A., Boscoe, J. H., & Roscoe, N. (2007). Decreasing expulsions by a child with a feeding disorder: Using a brush to present and re-present food. *Journal of Applied Behavior Analysis, 40,* 749–753.

Girolami, P. A., & Scotti, J. R. (2001). Use of analog functional analysis in assessing the function of mealtime behavior problems. *Education and Training in Mental Retardation and Developmental Disabilities, 36,* 207–223.

Goh, H. L., & Iwata, B. A. (1994). Behavioral persistence and variability during extinction of self-injury maintained by escape. *Journal of Applied Behavior Analysis, 27,* 173–174.

Gossette, R. L. (1971). Food-satiation response functions of albino rats, obtained on a three-valued randomized deprivation schedule. *Psychonomic Science, 24,* 23–24.

Gulotta, C. S., Piazza, C. C., Patel, M. R., & Layer, S. A. (2005). Using food redistribution to reduce packing in children with severe food refusal. *Journal of Applied Behavior Analysis, 38,* 39–50.

Hagopian, L. P., Farrell, D. A., & Amari, A. (1996). Treating total liquid refusal with backward chaining and fading. *Journal of Applied Behavior Analysis, 29,* 573–575.

Harding, J. W., Wacker, D. P., Berg, W. K., Cooper, L. J., Asmus, J., Mlela, K., & Muller, J. (1999). An analysis of choice making in the assessment of young children with severe behavior problems. *Journal of Applied Behavior Analysis, 32*, 63–82.

Hoch, T. A., Babbitt, R. L., Coe, D. A., Krell, D. M., & Hackbert, L. (1994). Contingency contacting: Combining positive reinforcement and escape extinction procedures to treat persistent food refusal. *Behavior Modification, 18*, 106-128.

Hoch, T. A., Babbitt, R. L., Farrar-Schneider, D., Berkowitz, M. J., Owens, J. C., Knight, T. L., et al. (2001). Empirical examination of a multicomponent treatment for pediatric food refusal. *Education and Treatment of Children, 24*, 176–198.

Iwata, B. A., Dorsey, M. F., Slifer, K. J., Bauman, K. E., & Richman, G. S. (1994). Toward a functional analysis of self-injury. Journal of Applied Behavior Analysis, 27, 197–209. (Reprinted from *Analysis and Intervention in Developmental Disabilities, 2*, 3–20, 1982)

Johnson, C. R., & Babbitt, R. L. (1993). Antecedent manipulation in the treatment of primary solid food refusal. *Behavior Modification, 17*, 510–521.

Johnson, J. E., Pesek, E. F., & Newland, M. C. (2009). High-rate operant behavior in two mouse strains: A response-bout analysis. *Behavioural Processes, 81*, 309–315.

Kahng, S., Boscoe, J. H., & Byrne, S. (2003). The use of an escape contingency and a token economy to increase food acceptance. *Journal of Applied Behavior Analysis, 36*, 349–353.

Kedesdy, J. H., & Budd, K. S. (1998). *Childhood feeding disorders: Biobehavioral assessment and intervention.* Baltimore, MD: Paul H. Brookes.

Kelley, M. E., Piazza, C. C., Fisher, W. W., & Oberdorff, A. J. (2003). Acquisition of cup drinking using previously refused foods as positive and negative reinforcement. *Journal of Applied Behavior Analysis, 36*, 89–93.

Kennedy, C. H., & Meyer, K. A. (1996). Sleep deprivation, allergy symptoms, and negatively reinforced problem behavior. *Journal of Applied Behavior Analysis, 29*, 133–135.

Kerwin, M. E. (1999). Empirically supported treatments in pediatric psychology: Severe feeding problems. *Journal of Pediatric Psychology, 24*, 193–214.

Kerwin, M. E., Ahearn, W. H., Eicher, P. S., & Burd, D. M. (1995). The costs of eating: A behavioral economic food analysis of food refusal. *Journal of Applied Behavior Analysis, 28*, 245–260.

Kessler, D. B., & Dawson, P. (1999). Failure to thrive and pediatric undernutrition: Historical and theoretical context. In D.B. Kessler & P. Dawson (Eds.), *Failure to thrive and pediatric undernutrition* (pp. 3–18). Baltimore, MD: Paul H. Brookes.

Lalli, J. S., Vollmer, T. R., Progar, P. R., Wright, C., Borrero, J., Daniel, D., et al. (1999). Competition between positive and negative reinforcement in the treatment of escape behavior. *Journal of Applied Behavior Analysis*, *32*, 285–296.

Lerman, D. C., & Iwata, B. A. (1995). Prevalence of the extinction burst and its attenuation during treatment. *Journal of Applied Behavior Analysis, 28*, 93–94.

Lerman, D. C., & Iwata, B. A. (1996). Developing a technology for the use of operant extinction in clinical settings: An examination of basic and applied research. *Journal of Applied Behavior Analysis, 29*, 345–382.

Lerman, D. C., Iwata, B. A., & Wallace, M. D. (1999). Side effects of extinction: Prevalence of bursting and aggression during the treatment of self-injurious behavior. *Journal of Applied Behavior Analysis, 32,* 1–8.

Levin, L., & Carr, E. G. (2001). Food selectivity and problem behavior in children with developmental disabilities: Analysis and intervention. *Behavior Modification, 25*, 443–470.

Linscheid, T. R. (1999). Commentary: Response to empirically supported treatments for feeding problems. *Journal of Pediatric Psychology, 24*, 215–216.

Linscheid, T. R. (2006). Behavioral treatments for pediatric feeding disorders. *Behavior Modification*, *30*, 6–23.

Linscheid, T. R., Tarnowski, K. J., Rasnake, L. K., & Brams, J. S. (1987). Behavioral treatment of food refusal in a child with short-gut syndrome. *Journal of Pediatric Psychology, 12*, 451–459.

Luiselli, J. K. (1994). Oral feeding treatment of children with chronic food refusal and multiple developmental disabilities. *American Journal of Mental Retardation, 98*(5), 646–655.

Luiselli, J. K. (2000). Cueing, demand fading, and positive reinforcement to establish self-feeding and oral consumption in a child with chronic food refusal. *Behavior Modification*, *24*, 348–358.

Mace, C. F., Hock, M. L., Lalli, J. S. West, B. J., Belfiore, P., Pinter, E., et al. (1988). Behavioral momentum in the treatment of noncompliance. *Journal of Applied Behavior Analysis, 21*, 123-141.

Manikam, R., & Perman, J. (2000). Pediatric feeding disorders. *Journal of Clinical Gastroenterology, 30*(1), 34–46.

McComas, J. J., Wacker, D. P., Cooper, L. J., Peck, S., Golonka, Z., T. Millard, et al. (2000). Effects of the high-probability request procedure: Patterns of responding to low-probability requests, *Journal of Developmental and Physical Disabilities 12*, 157–171.

Michael, J. (1982). Distinguishing between discriminative and motivational functions of stimuli. *Journal of the Experimental Analysis of Behavior, 37*, 149–155.

Michael, J. (1993). Establishing operations. *The Behavior Analyst, 16*, 191–206.

Mueller, M. M., Piazza, C. C., Patel, M. R., Kelley, M. E., & Pruett, A. (2004). Increasing variety of foods consumed by blending nonpreferred foods into preferred foods. *Journal of Applied Behavior Analysis, 37*, 159–170.

Munk, D. D., & Repp, A. C. (1994). Behavioral assessment of feeding problems of individuals with severe disabilities. *Journal of Applied Behavior Analysis, 27,* 241–250.

O'Brien, S., Repp, A. C., Williams, G. E., & Christophersen, E. R. (1991). *Pediatric feeding disorders. Behavior Modification, 15,* 394–418.

O'Reilly, M. F. (1995). Functional analysis and treatment of escape-maintained aggression correlated with sleep deprivation. *Journal of Applied Behavior Analysis, 28*, 225–226.

O'Reilly, M. F. (1997). Functional analysis of episodic self-injury correlated with recurrent otitis media. *Journal of Applied Behavior Analysis, 30,* 165–167.

Palmer, S., & Horn, S. (1978). Feeding problems in children. In S. Palmer & S. Ekvall (Eds.), *Pediatric nutrition in developmental disorders* (pp. 107–129). Springfield, IL: Thomas.

Palmer, S., Thompson, R. J., & Linscheid, T. R. (1975). Applied behavior analysis in the treatment of childhood feeding problems. *Developmental, Medical, and Child Neurology, 17*, 333–339.

Patel, M. R., Piazza, C. C., Layer, S. A., Coleman, R., & Swartzwelder, D. M. (2005). A systematic evaluation of food textures to decrease packing and increase oral intake in children with pediatric feeding disorders. *Journal of Applied Behavior Analysis, 38*, 89–100.

Patel, M. R., Piazza, C. C., Martinez, C. J., Volkert, V. M., & Santana, C. M. (2002). An evaluation of two differential reinforcement procedures with escape extinction to treat food refusal. *Journal of Applied Behavior Analysis, 35*, 363–374.

Patel, M. R., Piazza, C. C., Kelly, M. L., Ochsner, C. A., & Santana, C. M. (2001). Using a fading procedure to increase fluid consumption in a child with feeding problems. *Journal of Applied Behavior Analysis, 34,* 357–360.

Patel, M. R., Piazza, C. C., Santana, C. M., & Volkert, V. M. (2002). An evaluation of food type and texture in the treatment of a feeding problem. *Journal of Applied Behavior Analysis, 35,* 183–186.

Patel, M. R., Reed, G. K., Piazza, C. C., Bachmeyer, M. H., Layer, S. A., & Pabico, R. S. (2006). An evaluation of a high-probability instructional sequence to increase acceptance of food and decrease inappropriate behavior in children with pediatric feeding disorders. *Research in Developmental Disabilities, 27,* 430–442.

Piazza, C. C., Contrucci, S. A., Hanley, G. P., & Fisher, W. W. (1997). Nondirective prompting and noncontingent reinforcement in the treatment of destructive behavior during hygiene routines. *Journal of Applied Behavior Analysis, 30,* 705–708.

Piazza, C. C., Fisher, W. W., Brown, K. A., Shore, B. A., Patel, M. R., Katz, R. M., et al. (2003). Functional analysis of inappropriate mealtime behaviors. *Journal of Applied Behavior Analysis, 36*, 187–204.

Piazza, C. C., Patel, M. R., Gulotta, C. S., Sevin, B. M., & Layer, S. A. (2003). On the relative contributions of positive reinforcement and escape extinction in the treatment of food refusal. *Journal of Applied Behavior Analysis, 36*, 309–324.

Reed, G. K., Dolezal, D. N., Cooper-Brown, L. J., & Wacker, D. P. (2005). The effects of sleep disruption on the treatment of a feeding disorder. *Journal of Applied Behavior Analysis, 38*, 243–245.

Reed, G. K., Piazza, C. C., Patel, M. R., Layer, S. A., Bachmeyer, M. H., Bethke, S. D., & Gutshall, K. A. (2004). On the relative contributions of noncontingent reinforcement and escape extinction in the treatment of food refusal. *Journal of Applied Behavior Analysis, 37*, 27–42.

Riordan, M. M., Iwata, B. A., Finney, J. W., Wohl, M. K., & Stanley, A. E. (1984). Behavioral assessment and treatment of chronic food refusal in handicapped children. *Journal of Applied Behavior Analysis, 17,* 327-341.

Riordan, M. M., Iwata, B. A., Wohl, M. K., & Finney, J. W. (1980). Behavioral treatment of food refusal and selectivity in developmentally disabled children. *Applied Research in Mental Retardation, 1,* 95-112.

Roane, H. S., Vollmer, T. R., Ringdahl, J. E., Marcus, B. A. (1998). Evaluation of a brief stimulus preference assessment. *Journal of Applied Behavior Analysis, 31*, 605-620.

Sevin, B. M., Gulotta, C. S., Sierp, B. J., Rosica, L. A., & Miller, L. J. (2002). Analysis of response covariation among multiple topographies of food refusal. *Journal of Applied Behavior Analysis, 35*, 65–68.

Smith, M., & Duffy, M. (1957). Consumption of sucrose and saccharine by hungry and satiated rats. *Journal of Comparative and Physiological Psychology, 50,* 65–69.

Smith, R. G., & Iwata, B. A. (1997). Antecedent influences on behavior disorders. *Journal of Applied Behavior Analysis, 30*, 343–375.

Task Force on Promotion and Dissemination of Psychological Procedures. (1995). Training in and dissemination of empirically validated psychological treatments: Report and recommendations. *Clinical Psychologist, 48*, 3–23.

Vollmer, T. R., & Iwata, B. A. (1991). Establishing operations and reinforcement effects. *Journal of Applied Behavior Analysis, 24*, 279–291.

Wilder, D. A., Normand, M., & Atwell, J. (2005). Noncontingent reinforcement as treatment for food refusal and associated self-injury. *Journal of Applied Behavior Analysis,* 38, 549–553.