DEVELOPMENT AND VALIDATION OF AN INVENTORY TO ASSESS EATING AND MEALTIME BEHAVIOR PROBLEMS IN CHILDREN WITH AUTISM

DISSERTATION

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Despite speculations in the literature regarding the relationship between a diagnosis of autism and abnormalities in eating behavior and atypical nutritional intake, little research has examined the eating patterns of children with autism. Additionally, few measures have been developed to evaluate the mealtime behavior of young children. The current study was conducted to develop a measure of mealtime behavior problems (BAMBI) and to gather information about the eating behavior and nutritional intake of children with autism as compared to that of typically developing children. Additionally, subject recruitment and data collection via the Internet was evaluated to determine if online research can be a valid methodology in conducting psychological research.

Caregivers completed a battery of measures online including a demographic information form, two measures of mealtime behavior problems, the Gilliam Autism Rating Scale, and a food frequency questionnaire. In addition, caregivers responded to a recall interview in which they were asked to list all foods eaten by their child during the previous 24 hours.

Results supported the reliability and validity of the BAMBI in evaluating mealtime behavior problems in children with autism. Additionally, findings indicated that children with autism presented with more mealtime behavior problems than did
typically developing children. In terms of nutritional intake, children with autism
consumed fewer servings of vegetables and smaller percentage of the RDA of nutrients
(e.g., calories, fiber) than did typically developing children. The current study also lends
support to the relationship between characteristics of autism (e.g., communication
difficulties, social interaction difficulties, the frequency of stereotyped behaviors, and
developmental disturbances) and mealtime behavior problems and nutritional intake.
Correlational analyses revealed that characteristics of autism were positively associated
with mealtime behavior problems and negatively correlated with nutritional intake. In
addition, higher levels of mealtime behavior problems were associated with more limited
nutritional intake. Finally, results support the validity of web-based data collection as a
legitimate research tool in psychological studies.
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CHAPTER 1

INTRODUCTION

There has been little research examining the eating patterns and nutritional intake of children with autism, despite the fact that they are often described as having unusual eating habits, ranging from slight abnormalities in eating to clinically significant feeding problems (Cornish, 1998; Whitely, Rodgers, & Shattock, 2000). Feeding problems are not part of the diagnostic criteria for autism according to the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV); however, abnormalities in eating (e.g., consumption limited to a few foods, pica) are listed as associated features of autistic disorder (American Psychiatric Association, [APA], 1994). Additionally, questions about eating behaviors are included in diagnostic instruments (e.g., Gilliam Autism Rating Scale), and in the literature, many studies of the treatment of feeding disorders include children with autism (Babbitt, et al., 1994; Kern & Marder, 1996; Raiten & Massaro, 1986). Most recently, studies have suggested a relationship between the behavioral correlates of autism and dietary insufficiencies or excesses (Raiten, 1988; Whitely, Rodgers, Savery, & Shattock, 1999). Although the literature suggests that the inadequate nutritional intake of children with autism may have important implications
related to etiology and early intervention strategies, few studies have systematically assessed the prevalence and nature of feeding difficulties in this population.

**Typical Feeding Development**

Pediatric feeding problems occur as a result of interruption in the course of normal feeding development. The progression of feeding abilities typically occurs during the first two to three years of life and is dependent upon proper anatomic development (e.g., maturation of oral-motor and gastrointestinal structures), central nervous system development (e.g., gaining volitional control over previously reflexive movements, coordination of respiration and swallowing), and experiential learning (e.g., exposure to foods of a variety of textures, adapting to changing methods of food presentation) (Eicher, 1997; Stevenson & Allaire, 1991). Proper development in these areas results in changes in functional feeding skills and the accompanying changes in foods eaten.

Feeding development varies considerably among individual children. Typically, during the first six months of life, a child’s diet is comprised of breast milk or infant formula (Linscheid, Budd, & Rasnake, 2003). As the child’s oral motor skills develop (e.g., refinement of tongue movement), liquid intake is followed by spoon feedings of pureed foods. Small pieces of solid food are often introduced at approximately 6 to 9 months of age, as tongue movements mature and jaw movements become coordinated. By 12 months, tongue lateralization and rotary jaw movements have developed, and larger pieces of food and foods of more fibrous texture are often introduced.

In addition to oral-motor and neurological development, changes in appetite, food preference, and functional feeding skills occur within the first two years (Linscheid, Budd, & Rasnake, 2003). The first year of life is a period of rapid weight gain
accompanied by regular appetite. However, after 12 months of age, the rate of weight
gain decreases significantly, and the child’s appetite becomes less consistent. At the
same time, the child begins to develop preferences for specific tastes and textures of food.
Also at this time (twelve to fifteen months), the child begins self-feeding.

Factors That Interrupt Feeding Development

The development of age-appropriate feeding skills is influenced by a number of
interacting domains; subsequently, difficulties in any one of these areas can result in a
feeding problem. These areas include the growth and development of anatomic
structures used in feeding, the medical status of the child, the child’s social-emotional
development, and environmental factors (Eicher, 1997; Linscheid, et al., 2003; Stevenson

The proper anatomical function of oral structures involved in eating and
swallowing (e.g., palate, tongue, and jaw) is one factor important in feeding development
(Eicher, 1997). If there is disruption or abnormality in the development of these
structures, interruption of typical feeding development is likely to occur. For instance,
clefts in the lip or palate can lead to difficulty in sucking, subsequently having an adverse
effect on the development of bottle feeding as well as the development of oral-motor
skills necessary for later feeding (Stevenson & Allaire, 1991).

The delayed development of oral-motor skills involved in the feeding process can
have an adverse effect on feeding development as well. Necessary oral-motor structures
may develop, however coordination of these structures into efficient oral-motor patterns
may be delayed (Eicher, 1998). For example, a child with cerebral palsy may display an
immature oral-motor pattern which prevents the child from advancing the texture of foods consumed (e.g., from pureed foods to foods of higher texture).

A child’s medical status can also have a significant impact on feeding development. Medical conditions which adversely affect the respiratory, gastrointestinal and central nervous systems can lead to disruptions in normal feeding development and inherently increase the risk of feeding difficulties (Eicher, 1998; Linscheid, et al., 2003; Riordan, Iwata, Finney, Wohl, & Stanley, 1984). Gastroesophageal reflux (GER), the reverse flow of gastric contents from the stomach into the esophagus, can be associated with discomfort during or immediately after eating and subsequently limit a child’s intake (Eicher, 1998). Food allergies can also result in sensitivity and discomfort (e.g., wheezing, rhinitis, eczema, vomiting, constipation), and this association can ultimately limit the type or amount of food consumed (Strobel & Hourihane, 2001).

The development of a child’s functional feeding skills can be affected by their social, cognitive, and emotional development. These developmental changes include the child’s increased desire for autonomy and control, adjustment to limits set by adults, development of general cognitive abilities, and the acquisition of social interaction skills, among others (Budd & Chugh, 1998; Linscheid, et al., 2003). Developmental changes occur simultaneously with changes related to feeding development. Subsequently, their interaction can lead to substantial feeding behavior problems in young children.

For example, by 18 months of age, children are able to feed themselves. Their appetite has decreased significantly and become more variable since infancy, and they have simultaneously developed strong food preferences. These appetite changes, in combination with a child’s desire for independence, can lead to noncompliant behavior
during mealtimes (e.g., refusal to eat what parents have prepared, leaving the table before a meal is complete, tantrums) (Linscheid, et al., 2003). Noncompliance is an expected part of social-emotional development. However, if it interferes with a caregiver’s attempts to provide adequate nutrition for their child, the caregiver may respond in such a way as to reinforce the child’s noncompliant behavior, thereby increasing the likelihood of the behavior occurring in the future (e.g., providing the child with a preferred food when other foods are refused, thereby increasing the likelihood that the child will refuse presented foods in order to obtain preferred foods in the future).

Environmental factors that may contribute to feeding difficulty include lack of exposure to developmentally appropriate food textures and behavior mismanagement (Babbitt, et al., 1994). If a child is presented with food textures too advanced for his/her developmental level, he/she is likely to have difficulty chewing and swallowing that food, resulting in coughing or gagging. Such an aversive event may have a punishing effect on the child’s eating behavior, resulting in refusal of food in the future. Behavior mismanagement refers to caregiver actions which lead to or maintain noncompliant mealtime behaviors (e.g., providing an irregular feeding environment, providing inconsistent consequences for appropriate and inappropriate behaviors during mealtime) (Budd & Chugh, 1998).

**Pediatric Feeding Disorders**

Feeding behavior lies on a continuum from normal eating behavior (i.e., that which allows caloric intake adequate for weight gain and linear growth as well as satisfactory nutritional content) to maladaptive eating behavior (i.e., that which may interfere with adequate nutritional intake such that weight gain, health, and development
are compromised). Along the continuum, feeding problems can range in severity from subclinical levels (e.g., picky eating, undereating, overeating) to clinical extremes (e.g., chronic food refusal, failure to thrive, obesity) that can lead to severe medical conditions (Budd & Chugh, 1998). Pediatric feeding problems are indicated if a child’s eating behavior results in insufficient weight gain, significant nutritional deficits, or severely maladaptive mealtime behaviors. It has been reported that clinically significant feeding disorders occur in young children at a 25% - 45% incidence rate (Linscheid, et al., 2003; Turner, Sanders, & Wall, 1994; Werle, Murphy, & Budd, 1998).

Feeding disorders have been conceptualized in a number of ways, most commonly by their outcome, cause, and topography (Linscheid, et al., 2003; Luiselli, 1989). It is outcome that unifies the class of feeding problems; regardless of cause or manifestation, clinically significant eating and mealtime problems are associated with the threat of malnutrition and its implications for health and development. Among the immediate consequences of deficient nutrition are skin rashes, hair loss and compromised immune system functioning (Eicher, 1998). If left untreated for an extended length of time, a child who presents with nutritional deficits is at risk for delayed physical and cognitive development and in some cases, life threatening malnutrition (Clark, Rhoden, & Turner, 1993; Liebowitz, 1991). Behavioral changes such as irritability, fatigue, and sleep difficulties may result as well (Eicher, 1998). An additional outcome of consistently poor nutrition is failure to thrive, which refers to growth that is below what is expected given a child’s age and gender (Black, 2003).

As previously described, the causes of feeding problems include medical conditions, oral-motor dysfunction, and behavioral mismanagement. Although feeding
problems may be classified by their etiology, most commonly there is no single cause of feeding problems, rather causal factors interact and result in the manifestation and maintenance of a feeding problem. For example the oral-motor pattern of a child with cerebral palsy may not be sufficiently developed to manage foods of advanced textures. A caregiver may present these foods to the child because they are age-appropriate. If the child experiences an adverse reaction to these foods (e.g., coughing, gagging) he/she may subsequently refuse them in the future. If the parent responds in such a way as to reinforce the refusal of food, (e.g., attention, cajoling) it is likely that the child will continue to refuse those foods.

Finally, feeding problems can be categorized by their behavioral presentation. Children with feeding problems often present with one or more of the following mealtime behavior problems: self-feeding deficit, rumination and vomiting, improper pacing, limited intake, food refusal or over-selectivity, and disruptive mealtime behavior problems.

**Delay in self-feeding skill.** By 18 months of age, children typically demonstrate adequately independent feeding skills. Luiselli (1989) describes a self-feeding deficit as one in which the child is unable to “locate, transport, and or insert food into the mouth independently, using an appropriate utensil or hands.” Such a deficit may result in increased demands on the caregiver and decreased social interaction around mealtime (Luiselli, 1989).

**Rumination.** Rumination is the volitional return of previously consumed food into the mouth and is seen in approximately 6 - 10% of individuals with developmental disabilities (Fredericks, Carr, & Williams, 1998). Individuals who engage in rumination
are at risk for aspiration, dehydration, malnutrition, and social isolation (Luiselli, 1989; Matson & Kuhn, 2001).

**Improper pacing.** Improper pacing involves engaging in behavior resulting in either rapid eating or long latency between bites of food (Luiselli, 1989). Rapid pacing may result in gagging or vomiting, while slower pacing may lead to limited caloric intake or long meal duration with short latency between meals (Luiselli, 1989).

**Limited intake.** Some individuals with feeding difficulties may consume food using adequate self-feeding skills but in insufficient amounts (Riordan, Iwata, Wohl, & Finney, 1980). As with rumination and improper pacing, individuals who limit their nutrition consumption are at risk for malnutrition and its ill effects.

**Food refusal and over-selectivity.** Feeding disorders can manifest as food refusal or food over-selectivity. Food refusal is defined as an individual consuming fewer than the number of calories necessary for weight gain and linear growth or the rejection of food (Luiselli, 1989; Riordan, et al., 1980). Food over-selectivity is defined as choosing only a limited number of foods to be consumed or consuming an inadequate variety of foods (Luiselli, 1989; Munk & Repp, 1994). Persistent food refusal and over-selectivity can lead to inadequate nutritional intake.

**Disruptive behavior.** This category of feeding problems includes problematic behaviors that occur during mealtimes and interfere with food consumption. Such behaviors include crying, screaming, or otherwise agitated behavior, aggressive and self-injurious behavior, and disruptive behavior (e.g., spitting out food, leaving the table, knocking food off of the table) (Ahearn, 2001; Luiselli, 1989). Such behaviors may impede the consumption of adequate nutrition.
Assessment of Feeding Disorders

To determine if a significant feeding problem is present, a comprehensive feeding assessment is conducted. The purpose of a feeding assessment is to identify the presenting problems and possible contributing factors. Most assessments include a medical component (e.g., history and exam to rule out organic factors, neurodevelopmental assessment, assessment of oral-motor skills), a nutritional component (e.g., current weight, height, and growth trends, caloric intake, nutritional deficiencies), and a behavioral component (e.g., food preferences, mealtime behaviors, feeder-child interactions, adaptive feeding skills) (Eicher, 1998; Linscheid, 1992; Linscheid, et al., 2003; Luiselli, 1989; O’Brien, Repp, Williams, & Christophersen, 1991).

Assessment methods include medical history and exam, clinical interviews with caregivers, records of a child’s food consumption, direct observation of meals, and standardized assessment tools (e.g., behavior checklists) (Linscheid, et al., 2003). However, there are few such assessment tools specific to the evaluation of feeding problems. In addition, behavioral assessment and functional analytic procedures have been utilized to identify antecedent conditions and consequences that may contribute to and maintain feeding behavior problems (Ahearn, Castine, Nault, & Green, 2001; Girolami & Scotti, 2001; Munk & Repp, 1994).

Feeding Disorders and Co-occurring Conditions

Feeding problems are commonly observed in children with medical conditions and children with developmental disabilities (Babbitt, et al., 1994; Eicher, 1997; Munk & Repp, 1994; Riordan, et al., 1984). Medical conditions such as gastroesophageal reflux,
bronchopulmonary dysplasia, and cystic fibrosis (CF) are among those that inherently increase the risk of developing feeding problems (Eicher, 1997; Linscheid, et al., 2003). Children with cerebral palsy, post-natal brain injury, mental retardation, and other developmental disabilities also demonstrate significant rates of feeding difficulty (Prontnicki, 1995).

**Cystic fibrosis.** Research has been conducted regarding the prevalence, assessment, and treatment of feeding problems in children with CF (Sanders, Turner, Wall, Waugh, & Tully, 1997; Singer, Nofer, Benson-Szekely, & Brooks, 1991; Stark, et al., 1993; Stark, Powers, Jelalian, Rape, & Miller, 1994). Due to gastrointestinal and respiratory system abnormalities, children with CF require between 125% and 150% of the recommended daily allowance of calories for healthy children, however studies suggest that most children with CF are not meeting these increased caloric requirements (Singer, et al., 1991; Stark, et al., 1993; Stark, Jelalian, & Miller, 1995). In addition, children with CF present with clinically significant mealtime behavior problems. For example, Sanders and colleagues (1997) found that during difficult meals, children with CF displayed significantly more disruptive behaviors than non-clinic controls. In addition, parents of children with CF reported that these behaviors were more problematic than did parents of non-clinic controls.

One reason that children with CF are not meeting increased caloric recommendations and present with feeding problems is the increased emphasis placed on food consumption and the associated attention focused on mealtimes. The need for high caloric intake results in increased pressure for caregivers to maintain adequate oral intake for their children (Stark, et al., 1994). Attempts to increase caloric intake during meals
have been found to be positively correlated with maladaptive mealtime behaviors (Singer, et al., 1991; Stark, et al., 1993). Maladaptive mealtime behaviors then interfere with increased caloric intake, resulting in a feeding problem (e.g., food refusal).

**Developmental disabilities.** It is estimated that 30% of children with developmental disabilities present with significant feeding difficulties (Babbitt, et al., 1994; Eicher, 1997; Munk & Repp, 1994; Riordan, et al., 1984). One suggested explanation is that the feeding process is comprised of both physical and social components. Often, children with developmental disabilities experience difficulties in each of these realms, and subsequently, children with disabilities may be at greater risk for developing a feeding problem than typically developing children (Prontnicki, 1995). In addition, some developmental disabilities have specific eating patterns related directly to the disorder. For example, Prader-Willi syndrome is characterized by mental retardation, obesity, and hyperphagia with associated stealing of food and binge eating (Prontnicki, 1995; Sarimski, 1996).

Feeding problems in children presenting with neuromuscular dysfunction are highly prevalent and are often severe (Sullivan, et al., 2000). Children with neuromuscular dysfunction or delayed fine and gross motor coordination may have difficulty swallowing, holding utensils, or feeding themselves (Luiselli, 1989; Prontnicki, 1995). In addition, communication difficulties may impair a child’s ability to express food preferences or discomfort related to eating (Prontnicki, 1995).

Finally, children with Down syndrome have significant delays in oral-motor functioning and often demonstrate abnormal development of anatomical structures involved in feeding (Spender, et al., 1996). These impairments can have a significant and
adverse effect on children’s food intake and may subsequently affect parent-child interactions around mealtimes. Few studies have explored the specific nature of feeding problems in this population.

Feeding Problems in Children with Autism

Although prevalence rates indicate that significant feeding problems are common among young children with developmental disabilities, few studies have focused on the prevalence and characteristics of feeding problems within specific diagnostic categories of developmental disabilities. Autism is one area where little research has been conducted regarding feeding problems, despite the fact that many of its inherent characteristics suggest that children with autism are at risk for feeding problems.

For example, some research suggests that children with autism present with multiple medical factors found to be associated with the development of feeding problems. Additionally, some etiological theories of autism are related to nutrient intake and food sensitivities. Sensory issues are prevalent in children with autism and may adversely affect feeding development as well. Finally, behavioral difficulties associated with autism may interfere with food consumption.

Medical factors. Mason-Brothers and colleagues (1993) found that children with autism presented significantly more often with gastrointestinal difficulties (e.g., diarrhea, recurrent vomiting), poor suck as infants, food allergies, hypotonia, and a history of tonsillectomy/adenoidectomy than did their siblings. These factors have been demonstrated to be associated with the onset of childhood feeding problems, suggesting that a subgroup of children with autism presenting with these factors may be at risk for the development of feeding difficulty.
Biochemical and nutritional theories of autism. Theories have recently been developed and research has ensued regarding the biochemical and nutritional factors related to autistic disorder (Shattock, Kennedy, Rowell, & Berney, 1990; Shattock & Lowdon, 1991; Whitely, et al., 1999). This research has revealed correlations between particular enzyme deficiencies and the behavioral features of autistic disorder (Shattock, et al., 1990).

Gluten and casein are two proteins that have been implicated in biochemical theories of autism. Gluten is a protein found in wheat, oats, barley, and rye, while casein is a dairy protein similar in structure to gluten. It has been suggested that individuals with autism lack enzymes necessary to break down casein and gluten proteins. Peptides formed by this incomplete breakdown act as opioids, which could permeate intestinal walls and move into the bloodstream. Subsequently, these peptides could cross the blood-brain barrier, disrupting central nervous system function (Whitely, et al., 1999). The behavioral and neurological correlates of autism, such as self-injurious behavior, cognitive deficits, and social-emotional difficulties, may be a consequence of this central nervous system breakdown (Whitely, et al., 1999). Some research has revealed high levels of these peptides in the urine of individuals with autism (Reichelt & Knivsberg, 2003), while others have found no difference in the urine concentration of individuals with autism as compared with controls (Whitely, et al., 1999; Williams, Shattock, & Berney, 1991).

Whitely and colleagues (2000) suggest that the addictive qualities of the opioid peptides may lead to increased appetite for foods high in gluten and casein proteins. This craving may eventually lead to increased selectivity and limitations in the type of foods
consumed. In contrast, the inability to break down specific nutrients may lead to food sensitivities and limited preferences. As in the case of individuals with food allergies, the negative sensations associated with foods not tolerated may lead to avoidance of those particular foods (Strobel & Hourihane, 2001). These limitations can result in the development of clinically significant feeding difficulties (e.g., food over-selectivity).

**Sensory issues.** Twenty-seven percent of children with feeding problems refuse to eat food of developmentally appropriate texture (O’Brien, et al., 1991). For example, a child may consume only pureed food, rather than advancing to foods of higher textures. This inability to advance to higher textures of foods can be a result of oral-motor difficulties and delays or sensory deficits (O’Brien, et al., 1991). Children with autism often manifest sensory hypersensitivity and poor motor control, and these sensitivities may lead them to restrict their intake to food of tolerable textures (Ahearn, 2001; Prontnicki, 1995; Williams, Dalrymple, & Neal, 2000). Extreme over-selectivity may then lead to inadequate nutritional intake.

**Behavioral deficits.** Behavioral difficulties associated with autistic disorder may disrupt typical feeding development as well. For example, children with autism often present with communication delays or deficits and may be unable to communicate their nutritional wants and needs, such as hunger, fullness, food likes and dislikes, or discomfort around eating (Prontnicki, 1995; Raiten & Massaro, 1986). Additionally, children with communication difficulties may not be influenced by their caregivers' attitudes toward healthy eating in the same way as children without such deficits (Raiten & Massaro, 1986). Thus, communication barriers may prevent children from adequately meeting their nutritional needs.
In addition, rigid and repetitive behavior patterns are characteristic of autistic disorder. This preference for sameness could lead to extreme restrictions in the types of food consumed (Cornish, 1998; Raiten & Massaro, 1986; Whitely, et al., 2000; Williams, et al., 2000). For example, a child with autism may insist on eating the same food with the same utensils at each meal or only foods of a particular brand.

Difficulties with social interactions are also characteristic of children with autism. Lack of age-appropriate social exchanges and opportunities to model appropriate mealtime behavior may make it difficult for a child with autism to learn behaviors such as the proper use of utensils and self-feeding skills. The combination of these factors and communication deficits can make it difficult for a child to maintain a nutritionally adequate diet.

**Empirical Study of Eating Behavior and Autism**

Most reports of the nature and prevalence of feeding problems in children with autism are anecdotal; few studies have systematically explored the nature of feeding problems and nutrition consumption in this population (Ahearn, et al., 2001; Schreck, Williams, & Smith, 2004; Williams, et al., 2000).

With regard to behavioral difficulties displayed by children with autism, the outcome of a study conducted by Mason-Brothers and colleagues (1993) indicated that children with autism presented with significantly more feeding problems than did their typically developing siblings, but the authors did not specify the nature of those feeding problems. In examining specific mealtime behavior problems, Raiten and Massaro (1986) found that caregivers of children with autistic disorder reported more food cravings, pica, and perceived eating problems in their children than did caregivers of
typically developing children. Similarly, Schreck and colleagues (2004) found that children with autism presented with more feeding problems related to food refusal, limited variety, and specificity in food presentation than did a group of typically developing children. In another study evaluating parent-reported mealtime behaviors, researchers found that behaviors of children with autism included grazing, getting up from their seat during the meal, preference for brands and packaging, preference for food preparation, refusal of new foods, and large consumption of liquids (Cornish, 1998). Similarly, Whitely et al. (2000) reported that children with autism preferred foods packaged in particular ways, as well as foods high in gluten and casein proteins and foods of specific textures. Ahearn, Castine, Nault, and Green, (2001) found that half of the children they sampled demonstrated selective eating habits. Finally, Williams et al. (2000) surveyed caregivers of children with autism and found that more than 60% of their sample indicated that their children were picky eaters, had problems when trying new foods, and consumed a small number of foods. Despite reporting that their children displayed disordered feeding behavior, 62% of the sample believed their children were receiving adequate nutrition.

In terms of nutrition differences, Raiten and Massaro (1986) found that once nutrients were converted to percentages of recommended daily allowances (RDA), no differences in the number of servings eaten from four food groups or in the consumption of a variety of nutrients were found between a sample of children with autism and a sample of typically developing children. Alternatively, Ho and Eaves (1997) found limited variety in a sample of children with autism. Results of their study indicated that only 7% of the children met the recommended number of daily servings from four food
groups. That sample also presented with higher carbohydrate intake and lower fat intake than the RDA. Schreck et al. (2004) found similar food restrictions across five food groups. Cornish (1998) found that half of the children with autism evaluated for a nutrition study consumed less than the recommended daily level of a variety of nutrients. Cornish also found that as food variety decreased the number of nutrients below recommended levels increased and that 71% of the children included in the study consumed two or fewer portions of fruits and vegetables per day. Conversely, Bowers (2002), in examining seven day diet records of children with autism referred for nutrition assistance, found that 92% of the children met or exceeded recommended amounts of calories and protein.

Although the findings of the majority of these studies are consistent with descriptive reports of limited nutrition and high levels of behavioral feeding problems in children with autism, conclusions drawn from these studies are limited by their methodology. For example, Ahearn and colleagues (2001) employed the direct observation procedures initially used by Munk and Repp (1994) to assess the mealtime behaviors of children with autism. Three foods from each of four food groups were presented to children across six individual sessions, and acceptance and expulsion of food and disruptive behaviors were recorded. Although they reported that many of the children manifested food selectivity, the researchers utilized a definition of food selectivity designed for their study, such that children were classified as overly selective if they only accepted food from one food group, as moderately selective if acceptance was high for one food group and low for at least one other, and as mildly selective if acceptance was high for one food group and low for all other food groups. Additionally,
the researchers indicated that the study was limited in that there was no comparison group of typically developing children or children with other disabilities (Ahearn, et al., 2001).

The studies reported above utilized diet records, medical records, and caregiver questionnaires designed for their studies; however, few of these studies utilized standardized assessment tools to assess mealtime behavior problems. Additionally, most of the studies, with the exception of Raiten and Massaro (1986), Schreck et al. (2004), and Mason-Brothers et al. (1993), did not utilize a comparison group to determine if the nutritional intake and mealtime behavior of children with autism differed from that of typically developing children.

Alternatively, Archer, Rosenbaum, and Streiner (1991) evaluated eating and mealtime behavior problems in both children referred to a pediatric clinic for feeding problems and non-clinic referred children using the Children’s Eating Behavior Inventory-Revised (CEBI-R), a standardized parent-report instrument. The authors found that although eating problems occurred in both clinic and non-clinic referred children, eating problems occurred more frequently in a sample of children with autism than in the non-referred group (Archer, et al., 1991).

Lukens (2002) also employed standardized measures to compare the mealtime behavior and nutritional intake of children with autism to that of typically developing children and children with developmental disabilities. The results of the study demonstrated, as did Archer and colleagues (1991), Raiten and Massaro (1986), and Schreck et al. (2004) that children with autism presented with more mealtime behavior problems than did typically developing children. Regarding nutritional intake, the author’s findings were consistent with those of Raiten and Massaro (1986) and Shearer,
Larson, Neushwander, and Gedney (1982) that children with autism did not differ from a control group of typically developing children in percentage of the RDA for most nutrients. Children with autism consumed a higher amount of fats, a higher percentage of the RDA of copper, and a lower ratio of calcium relative to the RDA than did typically developing children. However, none of the children sampled exceeded the RDA of copper, and 58% of the children with autism consumed less than 100% of the RDA for calcium. Shearer and colleagues (1982) similarly found that children with autism consumed less calcium than did children in a control group; however, the children sampled did not consume less than the recommended daily intake of calcium. Additionally, typically developing children were found to consume more foods from the fruit and vegetable groups than did the children with autism.

Similarly, Schreck and colleagues (2004) utilized the CEBI-R and found more mealtime behavior problems in a group of children with autism than in a group of children without autism. Specifically, the authors noted that children with autism presented with higher rates of reported food refusal, a more limited variety of foods consumed, and higher consumption of foods of lower texture than did typically developing children. Additionally, the authors examined group differences in the variety of foods consumed and found that children with autism presented with a more limited diet than did typically developing children.

The findings regarding limited nutritional consumption and behavior problems in children with autism is provisional, given the methodological limitations of the studies. In order to draw more definitive conclusions about the nature and prevalence of feeding behavior problems and nutritional intake in children with autism, it will be beneficial to
utilize standardized self-report assessment instruments. Standardized assessment tools allow for consistency across studies, which may help to unify the literature regarding feeding problems in specific populations. Additionally, parent report measures that have been demonstrated to be reliable and valid provide an efficient method for assessing behavior, as opposed to more time-consuming methods such as behavioral observation. Finally, self-report measures can be utilized as outcome measures in large-scale studies evaluating the efficacy of interventions for feeding problems in children with autism.

Currently, there are few standardized methods available for assessing mealtime behavior problems. Often, studies utilize measures designed specifically for their research, without evaluating the psychometric properties of those measures. Among measures for which adequate psychometric properties have been demonstrated is the CEBI-R (Archer, et al., 1991). Additionally, the Behavioral Pediatric Feeding Assessment Scale (BPFAS) has been shown to have adequate reliability and validity as a measure of mealtime behavior problems (Crist & Napier-Phillips, 2001). The BPFAS has been used to assess the feeding behavior problems of typically developing children, children presenting to a clinic with feeding difficulties, and children with CF. Finally, the Screening Tool of Feeding Problems (STEP) is a 23-item caregiver report measure designed to assess feeding problems in individuals with mental retardation (Matson & Kuhn, 2001). Reliability and validity data for the STEP has been reported in a series of studies conducted by the authors (e.g., Kuhn & Matson, 2002; Matson & Kuhn, 2001).

Although these measures have demonstrated adequate psychometric properties and include items indicative of the general problems seen in the literature on pediatric feeding disorders, they do not include items specific to the feeding problems alleged to be
seen in children with autism (e.g., aggressive and self-injurious behavior at mealtime, ritualistic behavior around mealtime, severe food selectivity). Additionally, these measures assess feeding problems in children of a variety of ages, rather than those that may be specific to young children.

The Current Investigation

The available research suggests that children with autism demonstrate significantly more feeding problems and unusual mealtime behaviors than do typically developing children. However, the current literature provides little information regarding the specific food preferences, nutritional intake, and behavior problems of children with autism as compared to typically developing children. Exploring this area has many significant implications. For example, children with autism may prefer foods high in gluten and casein proteins, lending support for biochemical theories of the etiology of autism. On the other hand, they may avoid particular foods, lending support to the idea that children with autism display more food sensitivities than do typically developing children. Finally there are implications for early intervention, prevention, and treatment of feeding problems and behavioral difficulties in children with autism if more is learned about their eating patterns.

The purposes of the proposed study are to develop a psychometrically sound measure of feeding problems that can be utilized with children with autism and to evaluate the nature and prevalence of feeding difficulties in children with autism as compared to typically developing children. To this end, this study will describe the development and validation of the Brief Autism Mealtime Behavior Inventory (BAMBI).
Additionally, this study will utilize the BAMBI along with other reliable and valid indicators of feeding problems to address the second goal of the study.

An additional goal of the study is to evaluate data collection via the World Wide Web (WWW) as a valid methodology in behavioral research. Since the 1990’s, the Internet has become a more widely utilized forum for data collection in research in a variety of fields, particularly in psychological research (Ferrando & Lorenzo-Seva, 2005; Gosling, Vazire, Srivastava, & John, 2004). However, more research is necessary to confirm the validity of this methodology as well as to further examine ethical considerations.

Web-based data collection. There are many advantages to collecting data via the Internet for psychological research. For example, web-based studies can be conducted at low cost and provide ease of data collection (Krantz & Dalal, 2000; Schmidt, 1997). Many authors suggest that using the Internet allows efficient access to large numbers of participants, subsequently decreasing the likelihood of Type II error (Ferrando & Lorenzo-Seva, 2005; Krantz & Dalal, 2000; Schmidt, 1997). Additionally, Krantz and Dalal (2000) suggest that using the Internet to collect data allows access to a broader cross-section of the population. However, many argue the true representativeness of samples collected via the Internet (Mathy, Kerr, & Haydin, 2003).

Another methodological advantage of collecting data via the WWW is the elimination of data entry errors (Ferrando & Lorenzo-Seva, 2005; Schmidt, 1997). Utilization of the Internet for data collection allows for the computerized scoring of data and automatic transfer of information to a database used to perform statistical analyses. Additionally, with proper construction of a web-based survey, responses can be limited to
an acceptable range, and participants can be prompted to review and subsequently complete incomplete responses.

Biases common to laboratory studies can be eliminated as well. For example, observer biases are eliminated, in that the investigators do not have to be present as the respondent is completing the study (Ferrando & Lorenzo-Sevas, 2005). Thus, demand characteristics are reduced and the likelihood of experimenter influence is eliminated (Reips, 2000).

However, data collection via the Internet presents some disadvantages as well. For example, many authors suggest that sampling bias may occur when collecting data via the WWW due to the specific characteristics of the population of individuals with access to the Internet. Mathy, Kerr, and Haydin (2003) reported demographic information regarding internet usage presented by the United States Department of Commerce (DOC) in 2002. The DOC reported that in 2002, 70% of the United States population had Internet access in some form (e.g., at home, at work, public library), and more than 60% of the population was able to access the Internet from home (Mathy, Kerr, & Haydin, 2003). Additionally, 50% of the population of most states had online access in 2002. Internet use among ethnic minorities and individuals of low socioeconomic status was significantly lower than that of the rest of the United States population. However, in 2002, the fastest growing population of Internet users was low-income families.

In sum, Mathy, Kerr, and Haydin (2003) note that the population of internet users cannot be considered to be representative of the United States population. However, traditional laboratory-based studies have not been demonstrated to be representative of
the United States population (Gosling, et al., 2004; Mathy, et al., 2003). Gosling and colleagues (2004) compared samples from previously published studies to a sample collected via the Internet and found that overall, demographic data was comparable between the two methods.

Additionally, Schmidt (1997) notes that taking measures to monitor and control demographic variables can eliminate sampling bias in internet studies, as has been done in laboratory studies. For example, collecting demographic data will help the investigator to ensure the generalizability of results. Additionally, over-sampling a specific subset of the population (e.g., ethnic minorities, individuals of lower socioeconomic status) can help to obtain a more representative sample (Mathy, et al., 2003).

The validity of data collected via the Internet has been questioned and subsequently examined in both experimental and quasi-experimental studies. The conclusion drawn from the literature is that data collected via the Internet is comparable to data collected via more traditional methods (e.g., paper and pencil surveys, mail surveys, touch tone telephone surveys) (Gosling, et al., 2004; Mathy, et al., 2003; Krantz & Dalal, 2000; Ritter, Lorig, Laurent, & Matthews, 2004).

Ferrando and Lorenzo-Seva (2005) note that there are multiple methods to evaluate the equivalence of data collected via different methods. For example, data can be collected from two independent samples using two distinct methodologies and compared or the same sample can be used for each (i.e., a repeated measures design). Most studies comparing Internet data collection to more traditional methods use statistical methods consistent with Classical Test Theory to compare data (e.g., comparing means and standard deviations of scores, reliability coefficients, factor
structure, and correlations with external criteria) (Krantz & Dalal, 2000). Ferrando and Lorenzo-Seva (2005) provide evidence that utilizing a repeated measures design and conducting analyses using Item Response Theory (e.g., comparing information curves of each method, assessing equivalence of scaled scores using structural equation modeling) may be a superior methodology for comparing Internet data to data collected via more traditional methods.

Studies that have utilized Classical Test Theory have found that data collected via the internet is comparable to that collected via traditional methods. For example, Ritter and colleagues (2004) randomly assigned participants to complete 16 inventories via the Internet or through paper and pencil measures. The only demographic difference found between the samples was marital status. The authors found no differences in any of the outcome variables and the internal consistency of each of the measures used was nearly identical for the two presentation methods.

Mathy, Kerr, and Haydin (2003) and Krantz and Dalal (2000) summarize the existing literature comparing Internet data collection to other data collection methods. The authors found that studies using correlational methods as well as experimental studies have found the data collection methods described above to be comparable. Overall, no differences were found in outcome or demographic variables and response rates were found to be comparable. Personality characteristics were not found to explain variance in internet usage (Mathy, et al., 2003), and Gosling et al. (2004) found that the incidence of psychopathology and psychological maladjustment were not found to be different between previously published studies utilizing traditional data collection methods and a sample collected via the Internet.
Other disadvantages noted include the chance of multiple submissions by the same research participant (Schmidt, 1997). Additionally, some web-browsers change the presentation of a web-page, and thus, variation in the equipment available to prospective participants may influence data collection (Krantz & Dalal, 2000). Finally, misrepresentation of participants can occur (i.e., participants give inaccurate demographic data, participants provide false responses to questionnaires) (Mathy, et al., 2003). However, each of the authors note that such threats to validity are also threats to validity in research conducted using more traditional methods.

Ethical considerations also affect data collection via the Internet. For example, informed consent for potential participants can not be obtained directly by the experimenter. Mathy, Kerr, and Haydin (2003) recommend a number of ways to present the risks and benefits of participation to prospective subjects in order to obtain informed consent in accordance with standards put forth by Institutional Review Boards. For example, after providing prospective participants with information regarding the study, including risks and benefits, participants should then submit a request via email for survey materials. Alternatively, participants should be presented with information necessary for informed consent on the first page of the study website. An individual’s choice to continue to the next page of the site can then be considered consent to participate in the study. Finally, the address of the study web-page can be disclosed only to those individuals interested in participating in the study.

An additional ethical consideration involves the standard of nonmaleficance to which researchers are held. The major risk presented by web-based data collection is the risk of unauthorized disclosure of a study participant’s confidential information,
particularly personal health information (Mathy, et al., 2003). This must be taken into consideration when designing the study site. For example, as participant information is acquired, it should be encrypted and secured in a database that is password protected. Additionally, the computer on which data is stored and accessed should be password protected. If data is stored on a removable disk drive, it should be secured in a locked file cabinet. Finally, virus software should be utilized on any computer on which data will be manipulated.

Thus, the Internet can be a valuable tool for collecting data. Data can be collected efficiently and many biases can be eliminated. However, ethical issues must be addressed and threats to validity controlled for, just as they are controlled for in traditional studies.

**Hypotheses**

Regarding the Brief Autism Mealtime Behavior Inventory (BAMBI), it is hypothesized that the instrument will demonstrate adequate psychometric properties. More specifically:

(1) It is expected that the BAMBI will demonstrate high reliability. It is predicted that internal consistency for the full scale as well as for each factor will be adequate (Cronbach’s alpha greater than .7) and that test-retest correlations will be high, given the stable nature of feeding problems.

(2) Given the previous data collected on the BAMBI, it is anticipated that factor analysis will reveal three factors: limited variety of foods consumed, disruptive and aggressive mealtime behaviors, and ritualistic and routine-oriented mealtime behaviors.
(3) It is hypothesized that correlations between the total scores on the BAMBI and BPFAS will be strong and positive, and that negative correlations will be found between total scores on the BAMBI and nutrient intake.

(4) With regard to the factor structure of the BAMBI, it is expected that correlations between the BAMBI limited variety factor and the variety of foods consumed as assessed by two dietary assessment methods will be negative, while correlations between the ritualistic behavior factor and the Stereotyped Behaviors factor of the Gilliam Autism Rating Scale (GARS) will be in the positive direction.

(5) It is expected that correlations between the BAMBI ratings by caregivers and primary educational interventionists will be in the positive direction.

With regard to feeding behavior and nutritional intake, it is expected that the participant groups will differ in terms of multiple feeding related variables. More specifically:

(1) It is expected that children with autistic disorder will present with more behavioral feeding problems than typically developing children. This hypothesis is based on the available treatment literature and the indication that there are multiple factors predisposing children with autism toward feeding difficulties.

(2) Given the available literature regarding the nutrient intake of children with autism, it is hypothesized that children with autism will differ in the consumption of some nutrients from typically developing children.

(3) It is hypothesized that children with autism will consume a smaller variety of foods than will typically developing children.
(4) It is expected that feeding problems in children will be related to degree of autism and specific autistic characteristics such as communication difficulties, social interaction difficulties, degree of stereotyped behaviors, and level of developmental disturbance.

In terms of examining methodological factors, it is expected that data collected in the pilot study utilizing the BAMBI will be highly correlated with data collected via the World Wide Web. More specifically:

(1) It is hypothesized that participants in the pilot study will not differ in terms of demographic information (e.g., household income, caregiver completing the study, child’s ethnicity, child’s weight and height) from those participants invited to participate via list serve/list group promotion of the study.

(2) It is expected that high correlations for behavioral and nutritional variables will be found between a sample of data collected via pencil and paper measures in the pilot study and the data collected via the World Wide Web.
Participants

Participants included the caregivers of 68 children diagnosed with autistic disorder. Inclusion criteria required that children be between 3 and 10 years of age with a caregiver-reported diagnosis of Autistic Disorder or Pervasive Developmental Disorder, Not Otherwise Specified. In addition, the caregivers of 40 typically developing children between the ages of 3 and 10 years were included in the comparison group. Exclusion criteria were a diagnosis of mental retardation, any of the pervasive developmental disorders, or other developmental delay or disability. For both groups, caregivers were excluded from the study if they reported that their child was eating a restricted diet that was not self-selected (e.g., due to food allergy, casein and gluten free diet, caregiver restriction of food, medically prescribed diets). This exclusion criterion was implemented to ensure that any observed food selectivity was on the part of the child, rather than imposed by their caregiver. Additionally, children who had been treated for feeding problems within the past year were excluded from the study. No ethnic or racial groups were excluded.
Schmidt (1997) recommends limiting access to web-based surveys to the target population in order to reduce biases and threats to validity. Subsequently, Mathy, Kerr, and Haydin (2003) suggest distributing study information by email, posting information about the study to selected electronic mailing lists, or posting study information to targeted web-pages, rather than posting information more generally on the Internet. Thus, participants in the group of children with autism were recruited from list serves/list groups comprised of caregivers of children with autism in the states of Ohio, Pennsylvania, New Jersey, Maryland, and Delaware (e.g., Autism Ohio, Autism Maryland). Participants in the typically developing group were recruited from facilities in the greater Columbus area providing pediatric services, as well as from list serves/list groups comprised of caregivers of young children in the states of Ohio, Pennsylvania, New Jersey, Delaware, and Maryland (e.g., Moms in Ohio, Moms in PA).

Mathy, Kerr, and Haydin (2003) suggest multiple methods for determining response rates when collecting data via the internet. The authors suggest that using a database to collect data via the WWW allows the researcher to determine the proportion of returned surveys relative to those who read the initial information about the study. They also note that comparisons can be made between the number of completed studies and those who have visited the informed consent page of the study site. Of the 270 prospective participants who accessed the website in the current study (i.e., read the informed consent page), 173 participants (64%) began the study (i.e., completed the demographic measure). Of those participants, 45 did not complete enough of the research protocol to be considered in data analyses (i.e., did not complete at least the demographic form, the BPFAS, and the BAMBI), and 16 participants were excluded.
from the sample because their children consumed a diet restricted by caregivers. Thus 42% of prospective participants (i.e., those that viewed the study web-page) completed the study and were included in data analysis.

**Sample Size and Characteristics**

Because factor analysis was utilized as a method of data analysis, sample size for the proposed study was determined by reviewing the literature regarding factor analytic procedures. As recommendations for sample size are inconsistent throughout the literature, MacCallum and colleagues used simulated data to explore multiple outcomes (e.g., patterns of factor loadings, congruence between sample and population factors) of factor analysis using varying sample sizes (MacCallum, Widaman, Zhang, & Hong, 1999). The researchers found that the values of the communalities and the level of overdetermination of factors influenced the minimum number of subjects needed. Their findings suggest that if communalities are close to .5 and factors are well determined (five or six items per factor), sample sizes of approximately 100 are adequate.

Preliminary psychometric analyses were conducted in a pilot study using the 20 item BAMBI (Lukens, 2002). An exploratory factor analysis conducted during the pilot study revealed three unique factors with five or more items loading on each factor. In addition, communalities for the first two factors ranged from .3 to .7 with a mean of .5. Given the small number of well-determined factors paired with communalities around .5 found in the pilot study, it was determined that data collected in the current study from the obtained sample of 108 participants would likely yield a similar factor structure as was found in the pilot study, corresponding to what would be seen in the population (MacCallum, et al., 1999). Additionally, a power analysis was conducted utilizing effect
sizes based on results found in the pilot study and in Schreck et al. (2004). Power analysis indicated that a total sample size of 76 participants was necessary to detect group differences at an alpha level of .05 with power equal to .95, thus the obtained sample of 108 participants was adequate to proceed with the planned analyses.

Children of the participants ranged in age from 3 to 11 years with a mean age of 6 years, 8 months. The sample was comprised of the primary caregivers of 75 males (70%) and 32 females (30%), with 87% of the sample identifying their child as Caucasian, 3% as African American, 2% as Asian or Pacific Islander, and 7% as belonging to an ethnic group not specified. Of the caregivers that responded to the questionnaires, 94% were mothers, 4% were fathers, and 3% were other legal guardians (e.g., foster parent, grandparent). Additional demographic information is summarized in Table 1.

Procedure

Data was collected via inventories posted on a World Wide Web page. This methodology was selected in order to reach a large number of prospective participants in a cost-effective manner. Additionally, web-based inventories allow more direct access to a targeted population and provide easy access to study materials for study participants. Finally, data collected via the Internet minimizes experimentwide error caused by data entry mistakes.

Prospective participants were directed to the World Wide Web page containing the inventories for the proposed study. Those participants recruited via web-based list serves were able to connect directly to the page from the announcement posted to the group. Those in the group of typically developing children recruited through their pediatrician’s office were given a flyer with the address of the study website. Once
linked to the study page, participants viewed a letter introducing the researchers and providing a brief explanation of the nature and goals of the study, as well as the information necessary for informed consent, as per the Institutional Review Boards (IRB) of Columbus Children’s Hospital and The Ohio State University. Once enrolled in the study, participants were asked to complete the inventories described below. Completion of the inventories served as consent to participate, as approved by the IRBs.

Participants were asked to provide contact information in order to complete a follow-up telephone interview. If information was provided, participants were contacted upon completion of the study and a 24-hour recall interview was conducted (see below for description of the interview). At the time of the interview, participants were invited to complete one of the measures a second time in order to gather test-retest reliability data. Additionally they were asked if another care-provider was available to complete that same measure in order to gather validity information.

Measures

Demographic information form. Caregivers were asked to provide general demographic information regarding themselves and their child including their child’s age, weight and height, number of siblings, medical diagnosis, and developmental disability, as well as the caregiver’s age, caregiver’s occupation, and household income. Information was also collected regarding previous treatment for feeding problems and dietary restrictions.

Behavioral Pediatric Feeding Assessment Scale (BPFAS; Crist & Napier-Phillips, 2001; Crist, et al., 1994). The BPFAS is a 35-item standardized caregiver report inventory designed to obtain information about the mealtime behavior of children
between the ages of 9 months and 8 years of age. The measure requires a caregiver to indicate how often his/her child engages in a particular eating behavior using a 5-point Likert scale, ranging from 1 (never happens) to 5 (always happens). The inventory consists of 25 positively scored items and 10 items that are reverse scored (1 = 5, 2 = 4, 3 = 3, 4 = 2, 5 = 1). Items are summed to create a total problem score, with higher scores representing more problematic mealtime behavior. The measure yields three scores indicative of mealtime behavior problems: child behavior frequency, parent’s feelings/strategies frequency, and total frequency. In addition, the inventory requires respondents to answer yes or no as to whether an item is perceived to be a problem (i.e., rating of the severity of the behavior problem). A severity score is calculated by summing the number of items endorsed as problematic.

The BPFAS demonstrates satisfactory psychometric properties. Test-retest reliability was reported to be .85 for the total frequency score over a two year interval (Crist, et al., 1994). Internal consistency scores were .88 in the initial study using 42 subjects for a normative sample and .78 in a study collecting data on both normative and clinical samples (n = 345) (Crist, et al., 1994; Crist & Napier-Phillips, 2001). Additionally, the BPFAS has been shown to discriminate between children referred to clinics for feeding problems and non-clinic referred children (Crist & Napier-Phillips, 2001).

**Brief Autism Mealtime Behavior Inventory (BAMBI; Lukens, 2002).** The BAMBI was initially designed as a 20-item scale created to evaluate the nature of mealtime behavior problems in children with autism (Lukens, 2002). The inventory employs a Likert scale for reporting the frequency of behavior, as well as a yes or no
response as to whether an item is perceived as a problem. A total frequency score is derived from the sum of the items (including the reversed scores) with higher scores representing more problematic mealtime behavior. Severity scores were calculated for this inventory as described above. Preliminary psychometric analyses conducted in a pilot study revealed a reliability coefficient of .61 for the full scale. The scale as initially developed was comprised of a Limited Variety factor and a Food Refusal factor (see Appendix A for the version of the measure initially administered to participants).

**Gilliam Autism Rating Scale (GARS; Gilliam, 1995).** The GARS is a 56-item behavioral checklist designed to identify individuals with autism between the ages of 3 and 22 years. It allows the quantification of the frequency and severity of observable behavioral characteristics of autism. The GARS can be completed by caregivers and is comprised of four subscales assessing the frequency of stereotyped behaviors, communication ability, level of social interaction, and number of developmental disturbances. Standard scores are calculated for each of these subscales. An Autism Quotient, a standardized score that represents the overall assessment of the characteristics of autism displayed by the individual, can be calculated from the caregiver ratings.

The GARS demonstrates adequate psychometric properties. Internal consistency for the GARS is high for the full scale ($\alpha = .96$) as well as for each individual subscale ($\alpha_s = .88 -.93$) (Gilliam, 1995). GARS scores can be used to identify individuals with autism, and scores are strongly and positively correlated with scores on the Autistic Behavior Checklist, indicating adequate validity (Gilliam, 1995).

**Youth/Adolescent Questionnaire (YAQ; Rockett, et al., 1997).** The YAQ is a food frequency questionnaire designed to assess the nutritional intake of children
between the ages of 9 and 18 years. This is a standard dietary assessment technique, used
to provide an estimate of an individual’s average nutrient intake over a specified period
of time as well as the serving frequency per day for six food groups. The YAQ is a self-
report inventory; however, for the purposes of this study, primary caregivers were asked
to complete the measure regarding their child’s eating habits.

Validation of the YAQ was conducted by examining correlations between
nutritional assessment via the YAQ and 24-hour recall interviews. A validation study of
the YAQ revealed a correlation of .54. Test-retest reliability coefficients ranged from .26
to .58 for nutrients and from .39 to .57 for food groups. These results indicate adequate
psychometric properties of the YAQ.

24-Hour Recall Interview (Johnson, et al., 1986). The 24-Hour Recall Interview,
a standard dietary assessment technique which has been used to assess a child’s average
nutrient intake, was conducted (Johnson, et al., 1986). Dietary information provided by
this method has been demonstrated to be highly correlated with that provided by three
day diet records and other reliable dietary assessment methods (Mullenbach, et al., 1992;
Posner, et al., 1992). In addition, the 24-Hour Recall Interview has been demonstrated to
be less costly to implement than three-day diet records (Mullenbach, et al., 1992; Posner,
et al., 1992).

Participants were asked to recall a day’s events in temporal sequence, starting
with the time the child woke up in the morning until the time the child went to bed. The
interviewer recorded the amount and type of all food and drink consumed by the child
that day. To increase the accuracy of reporting, caregivers were asked to take out a set of
measuring cups and spoons while estimating the amount of food eaten. If the caregiver
did not offer the desired information independently, a set of prompts was used as indicated in the 24-Hour Recall script (see Appendix A). The number of calories consumed by each child and each child’s intake of a variety of nutrients were calculated using ESHA Food Processor version 7.8, and some data was checked for reliability using the book *Bowes and Church's Food Values of Portions Commonly Used* (Pennington & Douglass, 2004).
PRELIMINARY ANALYSES

The sample was comprised of the caregivers of 108 children: 68 children with autism and 40 typically developing children. Subjects were included in the study if they had completed the demographic inventory, the BPFAS, and the BAMBI. If participants did not complete more than half of the items on the BPFAS or the BAMBI, they were excluded from the study. Once these participants were excluded, the database was examined for missing data. None of the 108 participants were missing items on the BPFAS or the BAMBI. With regard to nutrition data, 10 of the included participants did not complete the food frequency questionnaire and 46 of the included participants could not be reached to conduct the telephone interview. These participants were excluded from analyses of nutritional data.

Since it is possible that the children’s age, weight, or sex could contribute to differences in eating behavior and nutritional intake, it was necessary to ensure that the two groups did not differ in terms of these variables. T-tests and chi-square analyses were used to compare the groups in terms of age, weight, height, sex, and ethnicity of the children, relationship of the caregiver completing the inventories to the child, and
household income of the caregivers. Eight participants did not provide information about their child’s age, one participant did not provide information about their child’s weight, six participants did not provide information about their child’s height, one participant did not provide information about their child’s sex, and six participants did not provide information regarding household income. Statistically significant differences were not found between the groups on any of the demographic variables noted above, with the exception of sex. Means and standard deviations are summarized in Table 1.

The ratio of males to females in the autism group was higher than that in the control group, as expected, given that prevalence rates for autism are four to five times higher for males than for females (APA, 1994). Prior to conducting further analyses, correlations between sex of the child and the dependent variables of interest were conducted within each group. No significant correlations were noted between sex and any of the outcome variables. Additionally, t-tests revealed no significant sex differences in eating behavior or nutritional intake within either the autism group or the control group.

Miller and Chapman (2001) note that when pre-existing groups are studied, as in clinical research, group differences in variables not of interest to the researcher may contribute to hypothesized group differences in outcome variables and are thus considered a threat to the validity of the study. The authors note that many researchers attempt to statistically control for these group differences (e.g., by using analysis of covariance [ANCOVA]). However, they indicate that there is no statistical technique that can truly control for group differences when groups are not randomly assigned (i.e., sex would not be meaningful as a covariate). Given that results of preliminary analyses
described above indicate no correlations between sex of the participants and dependent measures of interest, there is no empirical or conceptual reason to conduct ANCOVA. Additionally, preliminary analyses suggest no reason to create equivalence between the groups on this variable by randomly selecting a subset of the autism sample to match the comparison sample. Thus subsequent analyses were conducted utilizing the full sample, and identified group differences can be attributed to group membership.

In order to protect the participants’ rights to confidentiality, confirmed diagnoses by trained professionals could not be obtained for the children of the participants. Subsequently, assignment to groups was determined by each caregiver’s report of his or her child’s diagnosis. To confirm that the groups differed in terms of characteristics related to a diagnosis of autism, a $t$-test was conducted using the GARS Autism Quotient as the dependent measure. A statistically significant difference was found between the groups, $t (103) = -13.41, p < .0001$, with higher scores for the children in the autism group than for the children in the comparison group. The mean Autism Quotient for the children in the autism group was 92.5, and according to Gilliam (1995), 50% of the normative sample for the GARS had an Autism Quotient between 90 and 110.

This sample of children with autism is similar to the population of children with autism in terms of demographics. According to the DSM-IV, onset of Autistic Disorder is prior to age three with prevalence rates 4 to 5 times higher for males than females (APA, 1994). The youngest children in this sample were three years of age and the male to female ratio for the group of children with autism was approximately 5:1.
Psychometric Properties of the Measures

Behavioral Pediatric Feeding Assessment Scale (BPFAS; Crist & Napier-Phillips, 2001; Crist, et al., 1994). To ensure that the BPFAS would assess mealtime behavior problems the way it was intended by Crist and Napier-Phillips (2001), the psychometric properties of the measure were evaluated for the current sample. Evaluation of internal consistency for the current sample revealed alpha coefficients of .88 for the total frequency scale, .81 for the child behavior frequency scale, and .82 for the parent’s feelings/strategies frequency scale, which are comparable to the findings of Crist and colleagues (1994) and Crist and Napier-Phillips (2001), who reported internal consistency coefficients of .88 and .78.

Gilliam Autism Rating Scale (GARS; Gilliam, 1995). To determine if characteristics of autism were being evaluated in a similar manner to that which was intended by the authors of the GARS, psychometric properties of the GARS were evaluated. Gilliam (1995) reported alphas ranging from .88 to .96 for the individual subtests and the full scale score. In the current sample, internal consistency coefficients were as follows: $\alpha = .89$ for the Stereotyped Behaviors scale, $\alpha = .90$ for the Communication scale, $\alpha = .94$ for the Social Interaction scale, $\alpha = .79$ for the Developmental Disturbances scale, and $\alpha = .96$ for the full scale.

Youth/Adolescent Questionnaire (YAQ; Rockett, et al., 1997). Previous validation of the YAQ was conducted by examining correlations between nutritional assessment via the YAQ and 24-hour recall interviews and revealed a correlation of .54, while test-retest reliability coefficients ranged from .26 to .58. In the current sample,
significant correlations were found between the YAQ and nutrition data collected via 24-Hour Recall Interview for all of the nutrients examined with the exception of carbohydrates ($r$s ranged from .30 to .76, $p$s < .05) (Table 2). No significant correlations were found between the measures on number of servings of food for each food group.

**Brief Autism Mealtime Behavior Inventory (BAMBI; Lukens, 2002).** The BAMBI was initially a 20-item scale designed to evaluate the nature of mealtime behavior problems in children with autism (Lukens, 2002). Preliminary psychometric analyses conducted in the pilot study revealed an internal consistency coefficient of .61 for the full scale. Exploratory factor analysis revealed three unique factors, accounting for 45% of the variance in total behavior problem score. Nine items loaded significantly on a Food Refusal/Disruptive Behavior factor, accounting for 20% of the variance. Five items loaded on a Limited Variety factor, accounting for 18% of the variance, and five items loaded on a third factor that could not be interpreted. This study aimed to further develop the BAMBI and improve its psychometric properties.

**Item Generation**

The initial pool of 20 items was generated from the literature describing and evaluating interventions for pediatric feeding problems. Feeding problems specific to children with autism were listed, and items were developed from those problems. Items that did not load on any factors in the pilot study were removed. To make sense of the third factor, items that were similar in content to some of the items loading highly on the third factor were added (e.g., items related to ritualistic or stereotyped behaviors around mealtimes). Items are concise, simple, and were designed such that they are on a fifth grade reading level. Both positively and negatively worded items were included to avoid
acquiescence bias. Items are worded such that the caregiver is asked to indicate how often his/her child engages in a particular eating behavior. The items utilize a 5-point Likert scale, with response options ranging from 1 = never to 5 = always, including a neutral midpoint. A total frequency score is derived from the sum of the items (including reversed scores), with higher scores representing more problematic mealtime behavior. In addition, the inventory requires respondents to answer yes or no as to whether an item is perceived as a problem. A severity score is calculated by summing the number of items endorsed as problematic.

Item Selection

Item variances were examined; those items with variances greater than .35 were considered for retention. The mean item variance for the scale was 1.48, with individual item variances ranging from .27 to 2.44, and only Item 6 (self-injurious behavior during mealtimes) had variance less than .35. Item distributions were examined next, as retention and elimination based on item distributions would allow the final version of the measure to be comprised of items that could discriminate among individuals with varying degrees of feeding difficulty (Clark & Watson, 1995; DeVellis, 2003). Items with skewed distributions (i.e., those to which greater than 95% of the sample respond similarly, Clark & Watson, 1995) were considered for elimination, while those with a range of scores were considered for retention. Item distributions were slightly skewed for many items, including items 1, 2, 4, 5, 6, 7, 8, 9, 10, 13, 14, and 20. However, when examining individual item responses, on only Items 5 (aggressive during mealtimes) and 6 did greater than 70% of the sample respond in a similar manner.
Item-scale correlations were then examined, and those items with item-total
correlations greater than .30 were considered for retention, as they are likely to perform
better in a factor analysis (Smith & McCarthy, 1995; Floyd & Widaman, 1995). Items 6, 9
(insists on using certain utensils), 12 (plays with food during mealtimes), and 18
(prefers “starchy” foods) were considered for removal from the scale, as they had item-
total correlations of .29, -.18, .19, and .26, respectively. Additionally, an improvement in
the value of Cronbach’s alpha was attained only with deletion of Item 9.

Inter-item correlations were also examined. Clark and Watson (1995)
recommend retaining items with correlations ranging from .15 to .50 so as not to
eliminate items to the extent that construct validity is sacrificed. Items 6, 9, 10, 12, and
18 were noted to have correlations with more than half of the remaining items of less than
.15.

Subsequently, it was determined that Items 9, 12, and 18 would be eliminated. Although there was evidence for elimination of Item 6, it was retained, as its content was
determined to be important in delineating the construct of mealtime behavior problems in
children with autism. Similar analyses were run using only the sample of children with
Autism, and results support the elimination of these three items.

Factor Structure

To examine the underlying structure of the BAMBI, an initial exploratory factor
analysis was conducted on the 18-item measure. The maximum likelihood (ML) method
of parameter estimation with the Crawford-Ferguson Varimax oblique rotation procedure
was used. This oblique rotation procedure was selected because it does not require that
rotated factors be uncorrelated (Browne & MacCallum, 2000). Given that there is little a
priori knowledge regarding the relationship between the latent variables, an oblique rotation procedure that allows the rotated factors to be correlated was appropriate for these analyses.

Prior to evaluating factor analytic solutions, adequacy of the sample for factor analysis was examined. Sample size was determined to be adequate based on results of factor analysis from the pilot study of the 20-item BAMBI and an initial factor analysis conducted with the current sample on the 18-item BAMBI. The exploratory factor analyses conducted during the pilot study and in the current study revealed communalities ranging from .3 to .7 with a mean of .5, as recommended by MacCallum et al. (1999), suggesting adequate sample size. Additionally, in the pilot study, three unique factors were revealed with five or more items loading on each factor. Using the current sample, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett’s test of sphericity were conducted. The KMO value was .82 (values close to 1 indicate adequate sampling for factor analysis) and Bartlett’s test was significant ($p < .0001$), indicating rejection of the hypothesis that the population matrix is an identity matrix and subsequently, justification for factor analysis. Given the small number of well-determined factors found in the pilot study, paired with communalities around .5, and tests evidencing sampling adequacy, it was determined that a minimum sample size of 100 would likely yield a similar factor structure to what was found in the pilot study (MacCallum, et al., 1999).

Examination of the eigenvalues resulting from the initial solution using Kaiser’s criterion (i.e., retain factors with eigenvalues greater than or equal to one) suggested that five factors be extracted from the rotated factor matrix. However, this criterion is
typically an overestimate of the number of factors when using small samples and under certain conditions it can result in extracting too few or too many factors (Browne & MacCallum, 2000). Thus, in addition to considering the eigenvalues, the scree plot was examined, which suggested the extraction of three or four factors.

Based on the scree plot and eigenvalues, solutions with two through five factors were evaluated. Items with factor loadings of greater than .35 were examined for retention, and items not loading highly on any factor and considered conceptually irrelevant to the construct were considered for elimination from the measure. Additionally, model fit indices (root mean square error of approximation [RMSEA] point estimates and tests of close fit) were examined to determine the plausibility of each solution.

The root mean square error of approximation point estimates were evaluated using criteria indicated by Browne and Cudeck (1993) (RMSEA < .05 indicates close fit, between .05 and .08 indicates reasonable fit, between .08 and .10 indicates mediocre fit, and >.10 indicates unacceptable fit). The two-factor solution was considered to be a mediocre fit of the model (RMSEA = .092), while solutions for three and four factors were considered to be a reasonable fit (RMSEA = .076 and .072, respectively), and the solution for five factors was considered to be a close fit (RMSEA = .052). Tests of close fit were not significant at the .05 level for the three, four, and five factor models, indicating failure to reject the null hypothesis of close fit.

Based on model fit indices, solutions with three, four, and five factors were further examined. The four factor solution resulted in a model including a factor with only two clinically unrelated items loading significantly and three items that loaded on
two different factors. The five factor solution, although considered to be a model of close fit based on RMSEA values, resulted in a solution containing two factors with only two items and three items that loaded on multiple factors and was thus rejected. Based on the interpretability of the factors, eigenvalues, scree plot, and model fit indices, the three factor solution was selected as the most clinically interpretable.

Examination of the three factor solution suggested that these factors accounted for 45.09% of the variance in total behavior problem score. Eight items related to limited variety of foods consumed loaded on Factor 1 and accounted for 23.2% of the variance. Five items related to food refusal and disruptive mealtime behavior loaded on Factor 2 and accounted for 13.2% of the variance. Finally, five items loaded on Factor 3 and accounted for 8.7% of the variance. Items loading on this factor were behaviors that occurred at mealtime which are related to characteristics associated with autism such as short attention span, aggressive and self-injurious behavior, rigid and repetitive behavior, and abnormal responses to sensory input. Factor loadings are displayed in Table 3.

Reliability

Internal consistency of the BAMBI with Items 9, 12, and 18 removed was assessed using Cronbach’s coefficient alpha. Assessment of internal consistency in the pilot study revealed an alpha coefficient of .61 for the full scale (Lukens, 2002). In the current sample, alpha for the full scale comprised of 18 items was .88 in the full sample and .80 in the sample of children with autism. Assessment of the internal consistency of each of the factors was conducted using Cronbach’s alpha. An alpha coefficient of .87 was found for the Limited Variety factor, .76 for the Food Refusal factor, and .63 for the Features of Autism factor.
To assess the temporal stability of the measure, participants were invited to complete the BAMBI a second time after the initial administration. Mean length of time between initial administration and retest was 7 months and ranged from 5 to 13 months. Data from the second administration were available for 31% of the sample. A test-retest reliability coefficient was calculated between the initial administration of the BAMBI and the second administration and was found to be significant ($r = .87, p < .0001$).

Validity

Validity assesses the extent to which an inventory measures what it purports to measure. Although they contain the same core components, there exist different frameworks for evaluating the validity of a measure. For the purposes of this study, Loevinger’s conceptualization of scale validation will be utilized (Loevinger, 1957). Loevinger argues that construct validity is the test developer’s main concern, and all other types of validity are subsumed under construct validity. Loevinger separates construct validity into substantive, structural, and external validity. This conceptualization has been translated into practical strategies for scale development by Clark and Watson (1995).

Substantive validity. Substantive validity involves clear conceptualization of the construct of interest and encompasses what is traditionally considered content validation (Clark & Watson, 1995). Conceptualization of the construct of feeding problems was discussed in the Introduction of this study. In short, the purpose of the BAMBI is to assess the level of feeding difficulty in an individual child or sample of children with autism. To specify the domain of observable variables that are related to this latent construct, the literature on the treatment of feeding problems was reviewed, and items
were generated from the problems described. Additionally, exploratory factor analysis resulted in interpretable item content, thus further evidencing content validity.

**Structural validity.** Structural validity evaluates how closely the structure of a scale corresponds to the structure of the latent trait being measured, and encompasses analyses typically considered to be reliability analyses (Clark & Watson, 1995). For example, the evaluation of internal consistency, inter-item correlations, and item distributions, as described in the Reliability section of this study, supports the structural validity of the BAMBI. Factor analytic procedures as described above further establish the structural validity of the measure. Finally, correlations among the factors of the BAMBI were assessed as evidence of the structural validity of the measure. The Limited Variety factor was positively correlated with both the Food Refusal ($r = .54, p < .0001$) and the Features of Autism ($r = .48, p < .0001$) factors. Additionally, the Features of Autism factor was positively correlated with the Food Refusal factor ($r = .45, p < .0001$) (Table 4).

**External validity.** External validity incorporates what others have described as criterion-related validity (concurrent, predictive, and convergent validity), construct validity, or representational validity (Cronbach & Meehl, 1955; Foster & Cone, 1995). To evaluate the concurrent validity of the BAMBI, Pearson product-moment correlations were calculated between the BAMBI total frequency score and scores on the BPFAS. Correlations between the BAMBI total frequency score and the BPFAS child behavior frequency, parent’s feelings/strategies frequency, and total frequency scores were all significant ($ps < .0001$) (Table 4). As expected, these correlations are high, but not perfect, given that the BAMBI was not only expected to assess mealtime behavior
problems but also to tap into slightly different subdomains of feeding problems than do currently existing measures.

To evaluate the convergent validity of the factor structure of the BAMBI, Pearson product-moment correlations were calculated between individual factor scores and external criterion measures (e.g., nutrition variables, GARS scores). The Limited Variety factor was negatively associated with servings of meats, fruits, and vegetables as assessed by the YAQ and vegetables as assessed by the 24-Hour Recall Interview \((ps < .05)\), providing evidence that this factor measures restricted variety (Table 5). The Features of Autism factor was strongly and positively correlated with each of the subscales of the GARS, as well as the Autism Quotient \((rs \text{ range from } .37 \text{ to } .62, ps < .0001)\), suggesting that this factor taps into DSM-IV characteristics and associated features of autism (Table 6).

Additionally, to evaluate convergent validity, mealtime behavior problems were assessed by an alternate method. Ideally, observation of mealtime behavior by the researchers would have been utilized as an alternate method for assessing the construct of feeding problems; however, direct observation was not possible within the confines of the current study. Instead, mealtime behavior as assessed by the BAMBI was evaluated by teachers, primary educational interventionists, or another regular caregiver for 15% of the sample. The correlation between the BAMBI total score as rated by caregivers and the BAMBI total score as rated by another caregiver or teacher was strong and positive \((r = .78, p < .0001)\), indicating adequate convergent validity of the BAMBI.
Mealtime Behavior Problems

Means and standard deviations were calculated for the outcome variables related to mealtime behavior, including the BPFAS child behavior frequency, BPFAS parent’s feelings/strategies frequency, BPFAS total frequency, BAMBI total frequency, and BAMBI factor scores (Table 7). Additionally, analyses were conducted to ensure that assumptions for further statistical analyses were not violated. All outcome variables related to mealtime behavior were normally distributed, values for Levene’s tests did not indicate unequal variances across groups for any of the mealtime behavior variables, scatterplots were examined and linearity of the dependent variables ensured, and Bartlett’s test of sphericity was significant and Box’s test of equality of covariance matrices was not significant, suggesting that covariance residuals were uncorrelated and covariance matrices were equal.

During the validation phase of the study, significant bivariate correlations were found among the behavioral outcome variables (Table 4). Additionally, both the BPFAS and the BAMBI have been previously determined to measure the construct of mealtime behavior problems. Thus, the four outcome measures related to mealtime behavior were considered for combination into a single variate representing the construct of mealtime behavior problems. This was considered in order to control for experimentwide error and to examine group differences in the construct of mealtime behavior problems, rather than in mean scores on individual measures. Subsequently, group differences in the frequency of mealtime behavior problems were assessed using one-way Multivariate Analysis of Variance.
Due to high multicollinearity among the three BPFAS frequency scores and to avoid redundancy among the dependent variables, the BPFAS total frequency score was dropped from the analyses. A one-way MANOVA was conducted with mealtime behavior problems as the dependent variate. The Pillai’s trace significance test was examined, due to unequal cell sizes. This analysis revealed statistically significant group differences in the frequency of mealtime behavior problems, $F (6, 210) = 52.45, p <.0001$. Univariate tests indicated significantly higher scores for the children with autism than for the typically developing children on each variable.

As a follow-up to MANOVA to further evaluate the nature of group differences in mealtime behavior problems, a discriminant analysis was conducted (Bray, Maxwell & Cole, 1995). Discriminant analysis is used to determine the linear combination of the mealtime behavior outcome variables that best discriminates between the group of typically developing children and children with autism. In other words, discriminant analysis can be used to determine if typically developing children can be distinguished from children with autism based on the frequency of mealtime behavior problems. Results of the discriminant analysis revealed a significant discriminant function ($\Lambda=.58$, $\chi^2 [3, N = 108] = 56.42, p = .0001$). Results suggest that overall, the predictors differentiated between the groups. Additionally, the BAMBI total frequency score was the best predictor of group differences, followed by the BPFAS parent’s feelings/strategies frequency score and the child behavior frequency score. Examination of classification statistics suggests that 82% of the original cases are correctly classified by the discriminant function.
To evaluate group differences in more specific mealtime behavior problems, a series of analyses was conducted utilizing the observed factor structure of the BAMBI. The scores of the items comprising each of the factors were summed and used as dependent variables for these analyses. Reversed scores were used when appropriate to keep the direction of the factors consistent with the total scores (i.e., higher scores indicate higher levels of maladaptive behavior). Because the assumptions of normality and homogeneity of variance were violated for the factors, non-parametric analyses were conducted for those dependent variables. Means and standard deviations are presented in Table 7. Significant differences in scores on each of the three factors were found between the groups ($p$s < .0001). For all factors, children in the autism group had higher scores than children in the typically developing group.

**Nutrition Information**

Preliminary analyses were conducted on the outcome variables related to nutrition, to ensure that assumptions for further statistical analyses were not violated. Only outcome variables related to variety (e.g., food frequency data), macronutrients (e.g., calories, protein, carbohydrates), and vitamins and minerals previously found to be different between groups in the pilot study (e.g., calcium, copper) were examined in these analyses. Approximately two thirds of the outcome variables related to nutrition were not normally distributed, and values for Levene’s tests indicated unequal variances across groups on three of the nutrition variables. Thus nonparametric analyses were conducted for these variables.

**Variety of foods consumed.** Information regarding the variety of foods consumed by each child was obtained in two ways. First, number of servings of foods from each of
six food groups was calculated from the YAQ (dairy, meat, grain, fruit, vegetable, snacks). Secondly, the number of servings consumed of each of six food groups was obtained from analyses of the 24-Hour Recall Interview data (dairy, meat, grain, fruit, vegetable, fats/oils). The average number of servings per food group was calculated for each of the participant groups (see Table 7).

Independent sample t-tests were conducted for some of the food groups, but because assumptions of normality and/or homogeneity of variance were violated for others, Mann-Whitney U analyses were conducted for those outcome variables. Analysis of variety data collected via the YAQ revealed that children with autism consumed fewer foods from the vegetable group and more foods from the snack group than did typically developing children ($U = 436.5, p < .0001$ and $U = 853.5, p < .05$, respectively). Using the 24-Hour Recall Interview data, the difference in the number of servings of fats and oils consumed approached significance ($t [59] = -1.85, p = .07$), with children with autism consuming more foods from the fats/oils food group than typically developing children.

**Individual nutrients.** Group differences in the consumption of a number of basic nutrient components, vitamins, and minerals were evaluated (Appendix C). In 1989, the United States Department of Agriculture (USDA) established a set of nutrient and energy standards, or Dietary Reference Intakes (DRIs), which include Recommended Dietary Allowances (RDAs), Adequate Intakes (AIs), and Tolerable Upper Intake Levels (UL). These standards were most recently updated between 1997 and 2004 and are presented in the Dietary Guidelines for Americans (2005). The RDA for an individual depends on a number of factors including age and weight. To account for differences in RDA that are
dependent upon a child’s weight, calories consumed were first converted to calories per kilogram. In addition, to account for differences in RDA that are dependent on an individual’s age, each nutrient was converted to a ratio of the amount of the nutrient consumed to the RDA for that nutrient (Table 7).

With regard to basic nutrient components, significant differences between the groups were found for calories per kilogram ($t \ [95] = 1.98, p = .05$) and fiber intake ($U = 728, p = .05$) as assessed by the YAQ. Differences that approached significance were found for protein ($t \ [90] = 1.88, p = .06$) as assessed via the YAQ and for total carbohydrate intake, as assessed via the 24-Hour Recall Interview ($t \ [57] = -1.87, p = .06$). Children in the autism group consumed fewer calories, protein, and fiber but consumed more carbohydrates than typically developing children. In term of vitamins and minerals, no significant group differences were found.

Relationship between Behavior and Nutrition

Characteristics of autism and mealtime behavior problems. The BPFAS child and parent frequency scores and BAMBI total score were examined in relation to the GARS Autism Quotient and the four subscale scores. In addition, the relationship between the factors of the BAMBI and characteristics of autism were examined. Results are summarized in Table 6.

The GARS scales were found to be strongly and positively correlated with all BPFAS frequency scores ($r_s$ range from .36 to .66, $ps < .0001$). In addition, strong and positive associations were found between the GARS scales and the BAMBI frequency score ($r_s$ range from .52 to .75, $ps < .0001$). Finally, correlations between the GARS scales and the BAMBI factors ranged from .38 to .65, $ps < .0001$. 

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Characteristics of autism and nutrition. To explore the notion that nutritional intake may be related to characteristics of autism, a series of correlational analyses were conducted. The GARS Autism Quotient and the four subscale scores of the GARS were evaluated in relation to the number servings of food consumed from each food group. In addition, correlational analyses were conducted for the GARS scores and the relative amount of each nutrient consumed. Correlations among these variables are summarized in Table 8.

Correlational analyses revealed a negative relationship between all scales of the GARS and the number of servings of vegetables consumed ($r_s$ range from -.21 to -.39, $p_s < .05$). Additionally, the Social Interaction subscale of the GARS was positively correlated with the number of servings of snacks consumed ($r = .22$, $p = .03$). No significant relationships were found among GARS scales and consumption of specific nutrients.

Behavior inventory scores and nutrition. Correlational analyses were conducted to examine the relationship between the factor scores of the behavioral measures and the variety of foods consumed. All of the significant correlations were in the negative direction, with the exception of snacks, suggesting that higher levels of behavior problems were associated with a more limited variety of foods consumed. The following analyses are summarized in Table 5.

All of the behavioral variables were correlated with the number of servings of vegetables consumed ($r_s$ range from -.22 to -.56, $p_s < .05$). The Parent scale of the BPFAS, the BAMBI total score, and the BAMBI Limited Variety and Features of Autism scale were negatively correlated with number of servings of meats consumed ($r_s$ range
from -.21 to -.32, ps < .05). The BAMBI Limited Variety factor was negative correlated with the number of servings of fruits consumed ($r = -.21, p < .05$). Additionally, the BAMBI total score was positively correlated with the number of servings of snacks consumed ($r = .20, p < .05$), as was the Limited Variety scale ($r = .23, p < .05$). With regard to individual nutrients, the Limited Variety factor and Features of Autism factor of the BAMBI were negatively associated with caloric intake. The BAMBI total score, the Features of Autism, and the Limited Variety were negatively associated with protein intake. Finally, the Limited Variety factor and the BAMBI total score were negatively correlated with consumption of fiber.

**Comparison of Data Collected via Internet and Paper and Pencil Measures**

To examine the validity of data collection via the Internet, comparisons were made between data collected in the pilot study, in which participants completed paper versions of the measures and data collected in the present study, in which inventories were completed online. Comparisons were made utilizing procedures consistent with Classical Test Theory (Krantz & Dalal, 2000; Ferrando & Lorenzo-Seva, 2005; Ritter, et al., 2004).

Comparisons of demographic variables were made between the study samples (Table 9). The ratio of males to females found in the sample collected in the pilot study was not different from the ratio of males to females found in the current sample when examined for the full sample, the group of children with autism, or the group of typically developing children. No differences were found between the study samples in terms of ethnicity of the participants when examined for the full sample, the children with autism, or the typically developing children. Differences were found between the study samples
in terms of annual income within the full sample. Similar differences were found within the group of typically developing children, but no differences were found between the study samples within the autism group.

With regard to age, differences were found between the pilot study data and data collected for the current study within the full sample but not within each of the groups. Additionally differences were found for weight of the child within the full sample but not within the autism group or within the control group. No differences were found between the study samples in terms of height. Finally, the GARS Autism Quotient was not found to be different between the study samples.

With regard to dependent measures, comparisons could only be made for BAMBI data and for nutritional data collected via the 24-Hour Recall Interview, as these were the only measures utilized in both studies. For the BAMBI, only items included on both the original inventory and the revised inventory were included in the total score that was used in this analysis (18 items). No differences in BAMBI total scores were found between the studies in the full sample or in either of the groups. With regard to nutritional data, differences between the study samples were found for calories and carbohydrates. No other group differences were revealed.

Examination of the psychometric properties of the BAMBI revealed identical reliability coefficients for the data collected via paper and pencil and the data collected via the Internet (α = .84). Additionally, item statistics did not differ between the two samples. For example, no differences were found between the samples for any of the item means (ps ≥ .1). The factor structure between the two samples could not be directly compared due to the number of items that were not shared between the two samples.
Finally, the pattern of correlations between the GARS scores and the BAMBI total did not differ.
CHAPTER 4

DISCUSSION

The purpose of this study was to examine the eating behavior and nutrition consumption of children with autism as compared to typically developing children. In order to do this, an inventory was developed to measure the frequency of mealtime behavior problems specific to children with autism. Through examination of its psychometric properties, the BAMBI was determined to be a reliable and valid measure of eating and mealtime behavior problems that improves upon measurement tools previously available.

Initial examination of the 20-item BAMBI in a pilot study revealed moderate internal consistency and preliminary support for the validity of the BAMBI as a measure of mealtime behavior problems. Additionally, the factor structure was internally consistent and revealed two clinically meaningful factors. The third factor was uninterpretable and three items did not load significantly on any factor. Thus, items were removed and new items generated to create a 21-item measure subjected to psychometric analysis in a new sample.

After item analysis, three items were removed and the remaining 18 items were included in the final version of the scale. Results of the current study suggest adequate
support for the hypothesized three factor structure of the measure that is internally consistent with reasonable model fit. The Limited Variety factor was comprised of eight items related to restricted food preferences (e.g., my child is willing to try new foods, my child prefers the same foods at each meal). These items are similar to those loading on to this factor in the pilot study. The Food Refusal factor contained five items related to rejection of food presented by caregivers (e.g., my child expels food that he/she has eaten, my child closes his/her mouth tightly when food is presented). Again, these items are consistent with the factor structure of the original BAMBI.

Similar to findings in the pilot study, the third factor demonstrated weaker clinical interpretability than did the two factors described above. Although internal consistency and factor loadings were adequate, the Features of Autism factor was comprised of items that initially appear to be qualitatively different. However, each of the items is representative of a behavioral characteristic or associated feature of autism (e.g., inattention, self-injurious behavior, rigid behavior patterns). The items that loaded on this third factor are clinically meaningful, in that all of the participants in the group of typically developing children endorsed these items as never or rarely occurring, while participants in the autism group endorsed these items as occurring occasionally or often.

Reliability analyses revealed that the BAMBI has high internal consistency for the full scale, for the Limited Variety factor, and for the Food Refusal factor as was hypothesized and moderate internal consistency for the Features of Autism factor. These findings represent improvement in the internal consistency of the BAMBI over what was found in the pilot study, likely due to the generation of additional items and more thorough examination of item characteristics. Additionally, test-retest reliability was not
considered in the pilot study but was found to be high in the current study, which was hypothesized given the stable nature of pediatric feeding problems, and thus lending additional support to the reliability and validity of the measure.

The validity of the BAMBI as a measure of mealtime behavior problems was confirmed in this study as it was in the pilot study. A reasonable fit of the factor structure was revealed, indicating improvement over the measure evaluated in the pilot study. Significant and positive correlations between the BAMBI and a second, previously validated measure of mealtime behavior problems were also found. Additionally, evidence was found for the validity of the Limited Variety factor as a measure of food selectivity, as indicated by high correlations with a food frequency measure. Strong correlations between the BAMBI total and factor scores and scores on the GARS suggest the validity of the BAMBI as a measure of behavior problems in the population of children with autism. Finally, high inter-rater correlations provide support for the convergent validity of the BAMBI.

Given the dearth of measures to assess pediatric feeding problems and the strong support for the reliability and validity of the BAMBI as a measure of mealtime behavior problems in children with autism provided by the current study, this measure warrants continued development in future study. For example, discriminative validity should be considered. In the current study, the BAMBI was found to be important in discriminating between children with autism and typically developing children. The next logical step is to evaluate the ability of the BAMBI to differentiate between children with feeding problems and children without feeding problems. In future study, the BAMBI should be administered to caregivers of both children referred for treatment of feeding problems.
and children not referred for treatment of feeding problems. It would be expected that the BAMBI scores of clinic-referred children would be significantly higher than those of non-clinic-referred children, supporting the discriminative validity of the measure.

Additionally, cross validation and replication on a larger, independent sample is necessary to confirm the factor structure of the BAMBI. Confirmatory factor analysis should be conducted on models specified according to the results of the exploratory factor analysis conducted in the present study. Finally, to further confirm the convergent validity of the BAMBI, alternative methods for evaluating mealtime behavior should be examined in relation to BAMBI scores. For example, mealtime observation can be conducted and coded according to behaviors delineated in the BAMBI. Additionally, functional analytic techniques can be utilized, according to the procedures described by Ahearn et al. (2001).

Once the psychometric properties of the BAMBI were examined, it was then used to evaluate the eating behavior of children with autism as compared to that of typically developing children. Utilization of the BAMBI allowed for the examination of the specific nature of mealtime behavior problems displayed by children with autism. Associations between mealtime behavior problems as assessed by the BAMBI and nutrition consumption could then be considered.

Mealtime behavior problems were reported at a higher rate by caregivers of children with autism than by caregivers of typically developing children. More specifically, children with autism sampled for this study had a higher reported frequency of behavior problems related to refusal of food and limited variety of foods consumed than did the typically developing children. Additionally, parents of children with autism
reported more negative feelings and reported using more negative behavioral strategies to compel their child to eat during mealtimes than did parents of typically developing children.

The findings that children with autism displayed more mealtime behavior problems than a comparison group support results of previous empirical studies reporting a higher frequency of mealtime behavior problems in children with autism than in typically developing children (Lukens, 2002; Schreck, et al., 2004). Additionally, results are consistent with the literature pertaining to the treatment of pediatric feeding problems. Studies of children referred to clinics for pediatric feeding problems suggest that the primary presenting problems of children with autism are related to mealtime behavior problems, rather than poor weight gain or difficulty initiating oral intake (Babbitt, et al., 1994; Kern & Marder, 1996).

Results also further delineated the specific nature of feeding problems in children with autism. As hypothesized, results of the current study provide evidence that children with autism consume a more limited variety of foods than do typically developing children, as was found by Schreck and colleagues (2004) and Lukens (2002). In the current study, results indicated that children with autism consumed fewer servings of vegetables than did typically developing children. Additionally, caregivers of children with autism rated higher the items on the BAMBI related to limited variety than did caregivers of typically developing children. Overall, ratings of mealtime behavior problems, particularly those related to limited variety, were found to be negatively correlated with the number of foods consumed from three of five food groups, indicating
that a higher frequency of observed behavior problems, as seen in the group of children with autism, is related to the consumption of fewer foods.

Children with autism also presented with higher levels of food refusal behavior, as found in previous studies. Additionally, utilization of the BAMBI allowed for the assessment of mealtime behavior problems associated with characteristics of autism that are not components of other standardized measures of mealtime behavior problems. Results indicate that children with autism presented with higher levels of inattentive mealtime behavior, aggressive and self-injurious behavior at mealtime, and inflexible mealtime behavior, than did typically developing children.

Findings also indicate the stable nature of behavioral feeding problems. The BAMBI was administered again between 5 and 13 months after the initial administration. A strong and positive correlation was found between the two administrations, lending support for the stability of behavioral feeding problems. Additionally, mealtime behavior problems were found to be pervasive across settings and caregivers, as evidenced by the strong inter-rater reliability correlation. Finally, support was provided for considering mealtime behavior problems as an associated feature of autism. This was indicated by high correlations between mealtime behavior problems and ratings of diagnostic criteria for autism, as well as the finding that group membership was predicted by mealtime behavior problems, particularly as rated on the BAMBI.

Results of the study suggest that mealtime behavior differences are associated with nutritional differences. In addition to differences in mealtime behavior, group differences were noted in a number of the nutrients examined. Not only did children with autism consume fewer vegetables and more snacks than did typically developing
children, but they also consumed fewer calories, protein and fiber and more carbohydrate than did typically developing children.

However, these nutritional differences do not necessarily translate into nutritional deficits. Despite group differences, only 2% of the children in the autism group and none of the typically developing children consumed less than the RDA for protein. However, 100% of the control group and 92% of the group of children with autism consumed greater than the RDA of carbohydrate, and 78% of the control group and 85% of the typically developing children consumed less than the RDA for dietary fiber.

Given that significant group differences were found in the frequency of mealtime behavior problems, the design of the study allowed the initial exploration of possible contributors to mealtime behavior problems. A strong association was found between the GARS Autism Quotient, an overall measure of the frequency and severity of behavioral characteristics of autism, and mealtime behavior problems as assessed by both behavior inventories. In addition, the individual subscales of the GARS were all found to be significantly related to mealtime behavior problems. These findings suggest that deficits in communication ability, impairments in social interaction, and atypical behavioral characteristics may be contributing to the mealtime behavior problems experienced by young children with autism.

The relationships between characteristics of autism and nutrition variables were explored as well. The correlations between the autism scores and the nutrition variables were low to moderate as compared to the strong correlations found between the characteristics of autism and mealtime behavior problems. However, the correlations were significant and in the negative direction, suggesting that higher rates of behaviors
related to autism are associated with more limited nutritional intake. Additionally, higher frequencies of mealtime behavior problems were found to be associated with a more limited variety of foods consumed and with a lower intake of calories, protein, and fiber.

In sum, the mealtime behavior problems of children with autism appear to be stable and pervasive and distressing to caregivers. The higher rates of mealtime behavior problems seen in children with autism are associated with the behavioral deficits they experience in the areas of communication skills, social interactions, developmental disturbances, and rigid and repetitive behaviors. Finally, the higher rates of mealtime behavior problems observed in children with autism are related to poorer nutritional intake.

The design of this study also allowed for the exploration of data collection via the World Wide Web as a valid methodology in behavioral science. Support was found for the validity of web-based data collection. Similar to other studies examining this methodology, comparisons were made between a sample of participants who completed paper and pencil measures and a sample that completed the same measures online. No differences between the samples were found for most demographic and outcome variables.

One variable for which differences between the groups were observed was household income. However, further examination of this difference revealed that the sample that completed measures online and was recruited utilizing online recruitment methods was more diverse in terms of household income (i.e., was distributed normally across income level). Conversely, the sample that completed the paper and pencil measures was skewed in the direction of higher income. This finding suggests that data
collection via the Internet may allow access to a broader cross-section of the population in terms of income, as was suggested by Krantz and Dalal (2000).

This study expanded on the current literature regarding eating behaviors in young children with autism in a number of ways. For example, many previous studies were retrospective in nature (i.e., data regarding nutritional intake had already been collected for other studies and was analyzed in terms of nutritional variables of interest). The present study examined these variables in a more controlled way, evaluating nutritional variables of interest in addition to behavioral variables. In addition, multiple methods of assessing the dependent variables were employed in this study. Utilization of multiple methods allowed for more specific conceptualization of mealtime behavior problems and nutrition consumption. Additionally, using multiple assessment methods contributed to the verification of findings.

Most previous studies did not use standardized assessment instruments nor did they examine the psychometric properties of the instruments designed for their studies. This study employed psychometrically sound instruments and continued the development of a new mealtime behavior inventory. Utilization of the BAMBI allowed for the exploration of more specific domains of mealtime behavior problems (e.g., restricted variety, food refusal behavior). Additionally, most prior studies of this nature did not employ a control group, whereas the present study utilized a comparison group of typically developing children to further explore possible predictors and of mealtime behavior difficulties. Further study is warranted to examine the nature of these characteristics as possible mediating or moderating variables in the presentation of mealtime behavior problems.
Finally, this study utilized web-based methods of data collection. As web-based methodologies become more available to researchers as data collection tools, it is important to ensure the validity of such assessment methodology. Findings of this study support the validity of web-based data-collection methods.

Given that the participants in the study were assigned to groups based on caregiver report of diagnosis rather than confirmed diagnosis by a mental health professional, the results of the study should be interpreted cautiously. Due to the research design, no conclusions regarding the causes of mealtime behavior problems or nutritional differences can be drawn from the present study. Future study in this area should include a method for confirming diagnoses prior to assignments to diagnostic groups.

In addition, the study was somewhat limited by the sample size and recruitment procedures employed. Participants were volunteers surveyed from list groups and list serves; those individuals who chose not to participate may differ in some significant way from those included in the present sample. Although it is possible to determine the percentage of participants that completed the study of those who reviewed the study information, it is not possible to determine the number of participants or the characteristics of the prospective participants who did not review the study materials. Additionally, the sample size was smaller than proposed, particularly for the factor analysis, although adequate power was ensured for all analyses.

Additionally, the effects of medication on mealtime behavior and nutritional consumption were not considered. Given that many children with autism are prescribed psychopharmacologic medications with side effects that could potentially adversely affect appetite, results could have been influenced by medication effects. In future study,
medication should be controlled for or examined as a variable with potential influence on mealtime behavior.

Despite the limitations described above, the findings from the present investigation warrant further study. Replication of the current findings could be conducted employing alternative measures and including a larger sample. Further development of the BAMBI as a measure of mealtime behavior problems is advisable. In addition, future study should further examine additional variables that could potentially contribute to differences in mealtime behavior problems (e.g., parent stress levels, nutritional knowledge of caregivers).
LIST OF REFERENCES


APPENDIX A

MEASURES
Brief Autism Mealtime Behavior Inventory

Think about mealtimes with your child over the past 6 months. Rate the following items according to how often each occurs, using the following scale:

<table>
<thead>
<tr>
<th>Never/Rarely</th>
<th>Seldom</th>
<th>Occasionally</th>
<th>Often</th>
<th>At Almost Every Meal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Circle YES if you think an item is a problem for you or NO if you think it is not a problem.

1. My child cries or screams during mealtimes. 1 2 3 4 5 Y N
2. My child turns his/her face or body away from food. 1 2 3 4 5 Y N
3. My child remains seated at the table until the meal is finished. 1 2 3 4 5 Y N
4. My child expels (spits out) food that he/she has eaten. 1 2 3 4 5 Y N
5. My child is aggressive during mealtimes (hitting, kicking, scratching others). 1 2 3 4 5 Y N
6. My child displays self-injurious behavior during mealtimes (hitting self, biting self). 1 2 3 4 5 Y N
7. My child is disruptive during mealtimes (pushing/throwing utensils, food). 1 2 3 4 5 Y N
8. My child closes his/her mouth tightly when food is presented. 1 2 3 4 5 Y N
9. My child insists on using certain utensils at mealtime. 1 2 3 4 5 Y N
10. My child is flexible about mealtime routines 1 2 3 4 5 Y N.
11. My child is willing to try new foods. 1 2 3 4 5 Y N
12. My child plays with food during mealtimes. 1 2 3 4 5 Y N
13. My child dislikes certain foods and won’t eat them. 1 2 3 4 5 Y N
14. My child refuses to eat foods that require a lot of chewing (e.g., eats only soft or pureed foods). 1 2 3 4 5 Y N
15. My child prefers the same foods at each meal. 1 2 3 4 5 Y N
16. My child prefers “crunchy” foods (e.g., snacks, crackers). 1 2 3 4 5 Y N
17. My child accepts or prefers a variety of foods. 1 2 3 4 5 Y N
18. My child prefers “starchy” foods (pasta, potatoes, bread) 1 2 3 4 5 Y N
19. My child prefers to have food served in a particular way. 1 2 3 4 5 Y N
20. My child prefers only sweet foods (e.g, candy, sugary cereals). 1 2 3 4 5 Y N
21. My child prefers food prepared in a particular way (e.g., eats mostly fried foods, cold cereals, raw vegetables). 1 2 3 4 5 Y N
24-Hour Recall Interview Script

I am calling regarding the Children’s Hospital/Ohio State University study about children’s eating habits. I received your packet of completed questionnaires, and I am calling to conduct the food recall mentioned in the letter.

I would like you to tell me everything that your child ate today, from the time he/she woke up this morning, until the time he/she went to bed tonight. Include all meals and snacks, as well as all foods, additives, and drinks. If you have them available, please take out a set of measuring cups and measuring spoons to help you estimate the amount of each food eaten.

Participants will be asked to recall that day’s events in temporal sequence, starting with time the child woke up in the morning until the time the child went to bed. The interviewer will record the amount and type of all food and drink consumed that day. The following prompts will be used during the recall if the participant does not offer the desired information:

- How much _______ was eaten?
- How much ______ did he/she drink?
- Were there any additives to this food (e.g. salt, butter, sauces, etc.)?
- How was ________ prepared (e.g. fried, baked, etc.)?
- Did your child have any snacks in between breakfast and lunch/lunch and dinner/dinner and bedtime?
- Was your child in school/camp today? If so, do you know what they ate and drank there?
- Did your child spend any time away from you today? If so, do you know if they ate or drank anything while they were away?
APPENDIX B

TABLES
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<tr>
<th>Group</th>
<th>Typically Developing</th>
<th>Typically Autism</th>
<th>%</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (months)</td>
<td>M (SD)</td>
<td>M (SD)</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>69.06 (29.57)</td>
<td>74.77 (29.97)</td>
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<td></td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>21.78 (10.11)</td>
<td>24.85 (10.42)</td>
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<tr>
<td>Height (cm)</td>
<td>105.16 (26.16)</td>
<td>111.84 (26.14)</td>
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**Sex**

Male: 50.0 82.0

Female: 50.0 18.0

**Race**

Caucasian: 90.0 85.0

African American: 2.5 3.0

Hispanic: 0 3.0

Asian/Pacific Islander: 2.5 0

Other: 5.0 9.0

**Caregiver (Participant)**

Mother: 97.5 91.0

Father: 0 6.0

Legal Guardian: 2.5 3.0

*Continued*

Table 1: Demographic characteristics of participants
Table 1 Continued

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<th>Household Income</th>
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<th>Typically Autism</th>
<th>Typical Developing</th>
<th>Typical Autism</th>
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</tr>
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</tr>
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<td>$90,000</td>
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<tr>
<td></td>
<td>Calories</td>
<td>Carb</td>
<td>Protein</td>
<td>Fiber</td>
</tr>
<tr>
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<tr>
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<tr>
<td>Calories</td>
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<td>.12</td>
<td>.17</td>
</tr>
<tr>
<td>Carb</td>
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<td>.13</td>
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<td>.21</td>
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<td>.05</td>
<td>.33*</td>
<td>.36**</td>
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</table>

* $p < .05$
** $p < .01$

Table 2: Correlations among measures of nutrition
| My child… | Factor Loadings | | | |
|---|---|---|---|
| Item | Limited Variety | Food Refusal | Features of Autism |
| 1. cries or screams during mealtimes | -.15 | .74 | .21 |
| 2. turns his/her face or body away from food | .27 | .69 | -.06 |
| 4. expels food that he/she has eaten | .05 | .37 | .12 |
| 7. is disruptive during mealtimes | -.06 | .53 | .37 |
| 8. closes his/her mouth tightly when food is presented | .46 | .42 | -.17 |
| 3. remains seated at the table until the meal is finished | -.18 | -.25 | -.26 |
| 5. is aggressive during mealtimes | -.11 | .26 | .65 |
| 6. displays self-injurious behavior during mealtimes | -.13 | .33 | .31 |
| 9. is flexible about mealtime routines | -.15 | .09 | -.51 |
| 12. refuses to eat foods that require a lot of chewing | .36 | -.23 | .50 |
| 10. is willing to try new foods | -.78 | -.07 | -.17 |
| 11. dislikes certain foods and won’t eat them | .63 | .23 | .03 |
| 13. prefers the same foods at each meal | .81 | .13 | .04 |
| 14. prefers “crunchy” foods | .54 | .25 | -.11 |
| 15. accepts or prefers a variety of foods | -.76 | -.02 | -.27 |
| 16. prefers to have food served in a particular way | .53 | .01 | .13 |
| 17. prefers only sweet foods | .37 | .22 | -.12 |
| 18. prefers food prepared in a particular way | .37 | .10 | .14 |

*Note.* Bolded numbers denote items loading on that factor.

Table 3: Factor loadings for the BAMBI (3 factor solution)
Table 4: Correlations among measures of mealtime behavior problems

<table>
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<tr>
<th></th>
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<th>3</th>
<th>4</th>
<th>5</th>
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<td>1. BPFAS Total</td>
<td>—</td>
<td></td>
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<td></td>
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<tr>
<td>2. BPFAS Child</td>
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<td>.73**</td>
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<td>.77**</td>
<td>.74**</td>
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<tr>
<td>5. BAMBI Variety</td>
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<td>.66**</td>
<td>.68**</td>
<td>.92**</td>
<td>—</td>
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<tr>
<td>6. BAMBI Refusal</td>
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<td>.71**</td>
<td>.71**</td>
<td>.76**</td>
<td>.54**</td>
<td>—</td>
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<tr>
<td>7. BAMBI Features of Autism</td>
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<td>.52**</td>
<td>.38**</td>
<td>.70**</td>
<td>.48**</td>
<td>.45**</td>
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** $p < .01$

* $p < .05$
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<td>.00</td>
<td>-.05</td>
<td>-.01</td>
<td>-.09</td>
<td>-.05</td>
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<tr>
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<td>-.14</td>
<td>-.26*</td>
<td>-.30**</td>
<td>-.32**</td>
<td>-.14</td>
<td>-.21*</td>
</tr>
<tr>
<td>Fruit</td>
<td>-.18</td>
<td>-.19</td>
<td>-.11</td>
<td>-.16</td>
<td>-.21*</td>
<td>-.03</td>
<td>-.07</td>
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<tr>
<td>Vegetable</td>
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<td>-.38**</td>
<td>-.39**</td>
<td>-.48**</td>
<td>-.56**</td>
<td>-.22*</td>
<td>-.24*</td>
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<tr>
<td>Grain</td>
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<td>.13</td>
<td>.01</td>
<td>.04</td>
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<td>.00</td>
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<td>.13</td>
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** $p < .01$
* $p < .05$

Table 5: Correlations among behavioral and nutritional variables
Table 5 Continued

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<th>BPFAS Child</th>
<th>BPFAS Parent</th>
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<th>BAMI Refusal</th>
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<td>.18</td>
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<td>-.09</td>
<td>-.09</td>
<td>-.18</td>
<td>-.21</td>
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<td>Vegetable</td>
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<td>-.26</td>
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** *p < .01  
* *p < .05
Table 5 Continued

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** p<.01
* p<.05

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** $p < .01$
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Table 6: Correlations among autism and behavioral variables

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** $p < .01$
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Table 6: Correlations among autism and behavioral variables
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Table 7: Means and standard deviations for outcome variables
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$^a$ In percentage of Recommended Dietary Allowances
### Table 8: Correlations among autism and nutritional variables

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**  $p < .01$
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** * $p<.01$  
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Table 9: Comparisons between paper and pencil and Internet data
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<td>BAMBI Total (SD)</td>
<td>42.1 (10.3)</td>
<td>43.0 (11.2)</td>
<td>$t = .38$</td>
<td>.71</td>
<td></td>
</tr>
</tbody>
</table>