

Feeding Problems in Children With Autism Spectrum Disorders: A Review

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Many parents of children with autism spectrum disorders (ASD) report that their children have feeding problems. A body of literature targeted toward parents of children with ASD includes information about possible interventions for this problem. Most intervention suggestions within this literature have been only anecdotally reported to be effective; few research studies have addressed maladaptive feeding behaviors in children with ASD. This review synthesizes current research regarding the types of feeding problems and interventions used with children with ASD. In addition, the authors briefly discuss the literature on treating feeding problems in other populations as a means of comparison. They also point out differences in empirically supported treatments and treatments used by parents for aberrant feeding behaviors in children with ASD.

In 1943, Leo Kanner first described the syndrome that we now associate with autism (Kanner, 1943). In his discussion, Kanner listed feeding problems as one of the defining characteristics of the disorder, with 6 of his 11 patients showing maladaptive feeding behaviors. More recent reports have suggested that when compared to children who are typically developing, problems with feeding are more prevalent in children with developmental disabilities, with rates up to 74% (Burklow, Phelps, Schultz, McConnell, & Rudolph, 1998; Field, Garland, & Williams, 2003). Some researchers have suggested that the difference in prevalence rates between children who are developmentally delayed and children who are typically developing may be smaller, with about 25% of typical children displaying feeding problems and 33% of children with developmental disabilities displaying similar problems (Patel & Piazza, 2001). Children with delayed motor milestones, especially speech delay, are at an increased risk for feeding difficulties (Hutchinson, 1999).

Although an increasing number of research studies are targeting children with autism spectrum disorders (ASD), not much of this research has been concerned with feeding problems for this population. Anecdotal reports from parents, teachers, and clinicians have suggested that aberrant feeding behaviors are present in a substantial number of children with

ASD and that these problems represent a considerable challenge to parents and teachers. Schwarz (2003) concluded that most of these problems in children with ASD can be categorized as behavioral feeding disorders, including aversive eating behaviors (food refusal, choking, gagging, and expulsion with no medical basis) and sensory-based feeding problems (textural aversions to specific kinds of foods, usually involving the refusal of foods with greater texture). Schwarz explained that feeding difficulties in children without ASD, on the other hand, are usually due to a medical condition, such as esophageal problems, swallowing disorders, and motor delays. For the purpose of this review, we have defined *feeding problems* (aberrant feeding behaviors, maladaptive feeding behavior, problem feeding behavior) in children with ASD as selective acceptance of food or refusal to eat many or most foods with no known medical explanation.

A number of reasons have been suggested for the prevalence of feeding problems in children with ASD, including a concentration on detail, perseveration, impulsivity, fear of novelty, sensory impairments, deficits in social compliance, and biological food intolerance (Cumine, Leach, & Stevenson, 2000). Parental anxiety, reinforcement of negative feeding patterns, and communication difficulties have been suggested as additional social reinforcers that contribute to the maintenance of maladaptive feeding behaviors in this population (Shaw, Garcia, Thorn, Farley, & Flanagan, 2003). Ahearn, Castine, Nault, and Green (2001) suggested that selective feeding in children with ASD was a manifestation of their restricted interests and activities.

Mealtime behavior and eating problems are usually not assessed unless a child exhibits failure to thrive (Hutchinson, 1999), which might explain the lack of research on problem feeding behavior in children with ASD. When nutritional rehabilitation is delayed until after a child is 8 years of age, however, growth rates fall below average (Schwarz, 2003). Thus, some evidence has indicated that even when failure to thrive is not evident and health is not immediately at risk, assessment and treatment of aberrant feeding behaviors in this population should be a priority.

Intervention Studies in Other Populations

Researchers have conducted a number of studies regarding feeding problems in children without ASD. Findings from studies focusing on other populations, however, may not be applicable to children with ASD, especially because many of the studies that target other populations focus on children with medical conditions related to feeding. The etiology of feeding problems in children with ASD may be different from the etiology for other populations of children, and effective interventions in other populations may not generalize to populations of children with ASD due to their unique cognitive and behavioral profiles. Despite these differences, research studies targeting other populations can provide a foundation for research with children with ASD. These studies in other populations have investigated numerous interventions, including differential reinforcement, escape extinction, the Premack principle, behavioral momentum, and textural manipulation.

Few studies have focused on interventions for problem feeding behaviors primarily based on positive reinforcement. Positive reinforcement occurs when a stimulus is delivered contingent upon a behavior, followed by an increase in the rate of that behavior (Alberto & Troutman, 2005). For example, if a child who eats only a few foods is given access to his favorite foods when he rejects nonpreferred foods, the child is being positively reinforced for food refusal. In treating feeding problems, the behavior that is reinforced is generally acceptance or swallowing of food. Hoch et al. (2001) suggested that reinforcement alone is effective only when food refusal occurs solely because of insufficient positive reinforcement for consumption.

Much of the research related to feeding disorders in other populations of children relies on escape extinction to treat maladaptive feeding behaviors. *Escape extinction* is a procedure designed to treat feeding problems based on the principle of negative reinforcement. Negative reinforcement is the contingent removal of a stimulus following a response (Alberto & Troutman, 2005). Negative reinforcement for food selectivity is usually the removal of nonpreferred foods after a refusal behavior. When escape extinction is implemented, the child is not allowed to escape from the demand of eating. One form of escape extinction is *nonremoval* of the spoon, in which an adult holds the spoon in front of the child's mouth until he or she takes a bite of food. Upon acceptance, positive reinforcement is usually provided in the form of descriptive praise or tangible items (Ahearn, Kerwin, Eicher, Shantz, & Swearingin, 1996; Kitfield & Masalsky, 2000). Another form of escape extinction is *physical guidance*, in which an adult physically guides the spoon into the child's mouth and physically assists him or her in opening the mouth. Again, acceptance of the spoon results in positive reinforcement. *Representation*, which is often included in studies that involve either form of escape extinction, involves multiple presentations of expelled food, continued until the food is ingested (Reed et al., 2004). The effectiveness of escape extinction was demonstrated by Ahearn

et al. (1996). In their study an increase of food acceptance occurred for two participants with developmental delays and one participant with numerous medical problems, with both non-removal of the spoon and physical guidance used. Gains were maintained at follow-up. Social validity data revealed that physical guidance was more preferred by parents, and empirical findings showed that physical guidance resulted in shorter meals and fewer behavior problems. Most studies involving escape extinction for treating feeding problems have used invasive measures to ensure that the child did not escape the demand. These more intrusive measures have not been studied extensively with children with autism, and in general, positive reinforcement procedures are seen as best practice for that population.

Differential reinforcement involves the positive reinforcement of the desired behavior coupled with removal of reinforcement for undesired behavior. For example, if children were refusing food to get adult attention, adults would attend to them for eating and would not attend when they were demonstrating behaviors other than eating. Gutentag and Hammer (2000) effectively used differential reinforcement involving planned ignoring of food refusal and disruptive behaviors for a 3-year-old girl with mental retardation and a gastronomy tube. Differential reinforcement for food acceptance may involve escape extinction if food refusal was a previously reinforced behavior. In another study, Kahng, Boscoe, and Byrne (2003) used differential reinforcement as an intervention for selectivity. The form of reinforcement they used was escape from eating demands to increase the number of bites consumed for one 4-year-old with speech delay and possible pervasive developmental disorder. Kahng et al. found it to be more effective than both differential reinforcement (in the form of tangibles) and physical guidance.

The results from several studies have shown that differential reinforcement involving escape extinction is effective in improving feeding in young children with varied cognitive abilities and medical problems who were dependent on tube feedings (Coe et al., 1997; Didden, Seys, & Schouwink, 1999; Hoch, Babbitt, Coe, Krell, & Hackbert, 1994). Additional studies have also indicated the usefulness of differential reinforcement for a variety of children: four children with developmental milestones within normal limits and no medical problems related to feeding (Cooper et al., 1999), three young children with gastrointestinal problems and total food refusal (Kerwin, Ahearn, Eicher, & Burd, 1995), and a 21-month-old with language delays and failure to thrive (Cooper et al., 1995). Reed et al. (2004) and Patel, Piazza, Martinez, Volkert, and Santana (2002) demonstrated the effectiveness of escape extinction—regardless of the presence or absence of differential reinforcement—with children from 15 months to 4 years of age who had various medical conditions and limited food intake.

The *Premack principle*, known informally as “Grandma’s Law,” refers to the premise of requiring a nonpreferred activity to be completed before allowing access to a preferred ac-

tivity. This approach is widely used by parents in an informal manner (e.g., “After you eat your carrots, you can have your pudding”). It is similar to escape extinction because the child is not allowed to escape the nonpreferred activity of eating until a prespecified amount of food has been consumed, at which time the child accesses a preferred activity. The Premack principle is different in that the reinforcer is not simply escape from the nonpreferred activity; it also involves the additional component of access to a preferred activity. Brown, Spencer, and Swift (2002) demonstrated the effectiveness of this procedure by increasing the amount of food eaten by a 7-year-old with “moderate learning disabilities” who refused food.

Behavioral momentum refers to the use of a high-probability instructional sequence and is based on the premise that given a chain of commands, a low-probability command (“Eat your carrots”) will be more readily followed when preceded by a high-probability command (“Eat your pudding”). This procedure involves the presentation of preferred activities or items immediately preceding the presentation of nonpreferred activities or items. This sequence is opposite of the sequence used when implementing the Premack principle. Behavioral momentum has been used in many areas, including treating educational noncompliance (Romano & Roll, 2000), increasing academic productivity (Lee, Belfiore, Scheeler, Hua, & Smith, 2004), and reducing problem behavior maintained by negative reinforcement (Cipani & Spooner, 1997). Behavioral momentum has also been used to treat compliance in children with ASD in areas not related to feeding (Ray, Skinner, & Watson, 1999). This procedure has not been shown to be independently effective in treating feeding problems. Dawson et al. (2003) demonstrated that behavioral momentum, as an intervention for feeding problems, was effective only when combined with escape extinction to treat food refusal by a 3-year-old girl with developmental delays and gastroenterology tube dependence.

Texture manipulation is the altering of the consistency of a food (i.e., chopping food, pureeing fruit). This procedure might be especially applicable to children with autism, who often have sensory differences. Patel, Piazza, Santana, and Volkert (2002) demonstrated that changing the texture of one or more kinds of food resulted in an increase in food acceptance by a 3-year-old girl with feeding problems and gastroenterology tube dependence.

Much of the research on feeding problems in other populations has targeted (a) children whose levels of food selectivity or refusal were dangerous to their health and their ability to thrive (Cooper et al., 1999; Hoch et al., 2001; Patel, Piazza, Santana, et al., 2002), (b) children who relied on tube feedings (Coe et al., 1997; Gutentag & Hammer, 2000), and (c) children who had medical diagnoses related to food consumption, such as gastroesophageal reflux (Ahearn et al., 1996; Dawson et al., 2003; Kerwin et al., 1995). Anecdotal reports of aberrant feeding behavior in children with ASD have not suggested that the majority of children with ASD suffer from poor health or require alternative methods of feeding due to

their selective food consumption. Many of these children eat an adequate amount of food to maintain normal growth but do not eat an adequate variety of food (Bowers, 2002; Cornish, 1998). Regardless, studies of feeding problems in other populations can provide a basis for conducting research with children with ASD.

GENERAL METHOD

For this study, we obtained information regarding maladaptive feeding behaviors in children with ASD by conducting electronic and ancestral searches. We conducted an electronic database search using ERIC, PsycInfo, and the University of Georgia library databases. Keywords used during this electronic search included *autism, autistic, autism spectrum disorder, pervasive developmental disorder, Asperger's, feeding problems, eating problems, feeding disorders, food choice, food selectivity, and food refusal*. Furthermore, inclusion criteria for articles selected using these keywords included publication date between 1994 and 2004 in a peer-reviewed journal, inclusion of children with ASD in the study, and chronological age of participants between 2 years and 18 years. In addition, we included studies targeting problem feeding behaviors that did not involve children with ASD as references for comparison. We searched the references of selected articles for additional relevant resources.

We conducted ancestral searches in a number of journals relevant to children with autism and other developmental disabilities, feeding, and behavior therapy. We conducted these searches for years 1994 to 2004 by examining the title indices of each journal and searching by keywords in the topic indices, if available. Journals included in the ancestral search were *Focus on Autism and Other Developmental Disabilities, Journal of Autism and Developmental Disorders, Education and Training in Developmental Disabilities, Journal of the Association for Persons with Severe Handicaps, Research & Practice for Persons with Severe Disabilities, Mental Retardation, Journal of Mental Retardation, American Journal of Mental Retardation, Behavior Research & Therapy, Journal of Positive Behavior Interventions, Journal of Human Nutrition & Dietetics, Behavior Modification, Journal of Applied Behavior Analysis, Journal of Pediatrics & Child Health, American Journal of Speech Language Pathology, and American Journal of Occupational Therapy*.

In this literature review related to feeding disorders in children with ASD we looked for two types of articles: descriptive studies and intervention studies. *Descriptive studies* were defined as studies that included quantitative information about feeding problems in children with ASD but had no experimental design. *Intervention studies* were defined as studies that included quantitative information about children with ASD and feeding problems that were evaluated using an experimental design. In addition, we used books about children with ASD to compare research-based interventions with those in-

interventions presented to or by parents, teachers, and clinical professionals. After analysis of the available literature, the electronic and ancestral searches yielded seven quantitative descriptive studies and nine experimental design studies addressing maladaptive feeding behaviors in children with ASD.

DESCRIPTIVE STUDIES

Four of the seven descriptive studies included children with ASD only, one study included children with other disabilities and their siblings, one study included a group of children with Down syndrome and cerebral palsy, and one included a non-ASD comparison group of children who were typically developing. We did not include in our review any studies that included children with ASD but did not report results for that group separately.

Method

Participants

The total number of children with ASD included in all seven descriptive studies was 381, as noted in Table 1. Three studies (Bowers, 2002; Collins et al., 2003; Schreck, Williams, & Smith, 2004) reported mean age: 6.36 years, 8.03 years, and 8.25 years. Three studies (Ahearn, Castine, et al., 2001; Cornish, 1998, 2002) reported an age range for participants, for a total range of 3 years to 18 years, but did not report a mean age. One study (Field et al., 2003) reported no separate age information for children with ASD. All of the studies reported diagnosis information for the study participants. In two studies, a total of 47 children had a diagnosis of autism, and 9 children had a pervasive developmental disorder, not otherwise specified (PDD-NOS). Five studies did not specify which autism spectrum diagnosis (autism, PDD-NOS, Asperger syndrome, etc.) each child had received; this resulted in 325 children with a nonspecific ASD diagnosis. Thirty-four girls and 194 boys participated in the studies, with no information presented regarding gender for 153 participants.

Purpose

The purpose of the descriptive studies was to obtain information about feeding problems in children with ASD. Specifically, Ahearn, Castine, et al. (2001) attempted to categorize and describe specific maladaptive feeding behaviors in children with ASD by presenting children with various foods from each food group and recording acceptance, expulsion, and disruption across trials. Bowers (2002) sought to identify key dietary issues in children with ASD and to describe factors that influenced the outcome of dietary management. Collins et al. (2003) described mealtime behavior problems and feeding skill deficits in children with ASD and other developmental disabilities

in comparison with sibling groups. Cornish (1998) sought to describe specific dietary issues faced by parents of children with ASD, whereas Cornish (2002) attempted to determine whether specific dietary restrictions (gluten and casein) affected food choice and nutrient deficiency. The purpose of the study by Schreck et al. (2004) was to determine (a) whether children with ASD had eating habits different from children without ASD, (b) what kinds of food children with ASD eat and refuse, and (c) whether families of children with ASD ate more restricted diets than other families. Field et al. (2003) sought to determine if children with developmental disabilities, including autism, had common feeding problems.

Comparison Groups

Three of the seven descriptive studies reviewed used children without ASD as comparison groups. Field et al. (2003) used 21 children with Down syndrome and 44 children with cerebral palsy as comparison groups. A comparison group of 298 children without ASD was used in Schreck et al. (2004) to determine differences in maladaptive feeding behavior for children with and without ASD. Collins et al. (2003) used 69 siblings of children with ASD, as well as children with Down syndrome, Cri du Chat syndrome, and their siblings, to compare feeding skills and problems among the children in each disability group and between each group and their respective sibling group.

Procedure

The most common procedure for collecting information about the aberrant feeding behaviors of children with ASD was a postal questionnaire, which was used in three studies (Collins et al., 2003; Cornish, 2002; Schreck et al., 2004). One study (Bowers, 2002) used audits of referrals, and one (Field et al., 2003) used reports from an interdisciplinary feeding program. Ahearn, Castine, et al. (2001) directly examined feeding problems by presenting various foods to children with ASD and reporting responses for each trial. Cornish (1998) used an interview format.

Results

All descriptive studies found evidence of substantial feeding problems with children with ASD. Specifically, Ahearn, Castine, et al. (2001) found that 87% of children with ASD enrolled in a private educational program ($N = 30$, chronological age range = 3–14 years) showed either a low or moderate level of selectivity (accepting less than 30 or 60 bites of food, respectively, out of a total of 90 presented), whereas 57% showed low selectivity (accepting less than 30 bites of food out of a total of 90 presented). These results may underestimate food selectivity in children with ASD because the researchers ex-

TABLE 1
Feeding Problems in Children With Autism: Descriptive Studies

Study	Participant diagnosis, gender, & age	Comparison group	Purpose	Procedure	Results
Ahearn, Castine, et al. (2001)	N = 30 (21 autism, 9 PDD-NOS), 22 boys, 8 girls; age range: 3 years 9 months to 14 years 2 months	None	Categorization of feeding problems in children with ASD	Direct observation and data collection	57% of children exhibited food selectivity by type or texture; 87% of children exhibited low or moderate food acceptance
Bowers (2002)	N = 26 (ASD)	None	Identify dietary issues and describe factors that influence diet management in children with autism	Audit of referrals to dietary service	14 cases referred for advice on GFCF diet, 12 referred for food selectivity
Collins et al. (2003)	N = 107 (ASD), Mean age = 8.03 yrs	Children with Down and Cri du Chat syndromes, siblings of children with autism	Determine differences in feeding problems among children with autism, siblings, and children with other disabilities	Questionnaires	Children with autism did not eat the normal family diet, had an inappropriate rate of eating (51%–63%), gorged on food (27%–33%), refused food for no reason (52%–59%), and had obsessive eating habits (14%–33%)
Cornish (1998)	N = 17 (ASD), age range: 3 years 6 months to 9 years 9 months	None	Determine selectivity, nutrition deficits, and abnormal feeding patterns for children with autism	Questionnaires	59% of children ate fewer than 20 foods, 53% of children had nutrient deficits, 100% of parents cited introduction of new foods as the major feeding problem
Cornish (2002)	N = 37 (ASD), 31 boys, girls; age range: 3 years–16 years	None	Determine if restrictive diets had an effect on food choice in children with autism	Questionnaires	Between 32% and 50% of children had nutrient-deficient diets, 89% exhibited selectivity; differences between children on GFCF diet and children not on the diet were not significant
Field et al. (2003)	N = 26 (autism)	Children with Down syndrome and cerebral palsy	Identify feeding problems in children with autism, identify differences in feeding problems between groups	Audit of reports from a feeding program	62% of children with ASD exhibited selectivity by type, 31% exhibited selectivity by texture; food refusal and dysphagia were less common in children with autism
Schreck et al. (2004)	N = 138 (ASD)	Children without autism	Determine differences in feeding problems between children with autism and controls without autism	Questionnaires	Children with autism have more feeding problems and refuse more foods than other children; 72% of children with autism eat a narrow variety of foods

Note. PDD-NOS = pervasive developmental disorder, not otherwise specified; ASD = autism spectrum disorder; GFCF = gluten free and casein free.

cluded children who attended the school and were previously referred or treated for feeding problems.

Bowers (2002) used an audit of dietary referrals for children with ASD ($N = 26$), determining that more than half of the children were referred for advice regarding a gluten-free, casein-free diet regimen. Bowers also found that children with ASD in the study met recommended values for protein and energy, but did not meet recommended levels for other nutrients (specific nutrients not reported). The author noted related diseases and behavior patterns found in family members of these children, including Celiac disease, unspecified chromosomal abnormalities, and "autistic traits." In addition, 12 of the children (46%) exhibited food selectivity.

Collins et al. (2003) found that a smaller proportion of children with ASD ($N = 107$) ate the usual family diet, in comparison to children with Down syndrome, children with Cri du Chat syndrome, and siblings, according to parent report. In addition, questionnaire data (stratified by age) revealed that between 51% and 63% of children with ASD had an inappropriate rate of eating, and between 27% and 55% of children with ASD took food from others' plates. Also, between 27% and 33% of children with ASD gorged on food, and between 52% and 59% refused food for no obvious reason. Between 14% and 33% of children with ASD had "obsessive" eating habits, more than any other group in the study, although Collins et al. did not report a specific definition for these habits.

In a study by Cornish (1998), parents reported the number of different foods eaten by 17 children with ASD. In this study, 59% of children ate fewer than 20 different foods, and 18% ate fewer than 8 different foods. Only 1 child (6%) ate the recommended number of fruits and vegetables, and he reached the recommended number with only one type of food (apples). Three children (18%) in the study ate no meat or meat substitutes, 3 (18%) ate no dairy, and 6 (35%) ate large quantities of dairy, getting more than half of their energy requirements from dairy foods. Cornish found nutrient deficits for 53% of the children studied. Analyses suggested that those most at risk for deficits were children less than 5 years of age and children eating fewer than 20 different foods. Cornish also discovered that a large number of the children always ate in the same place at home, ate a large number of snacks, and were selective by food color, packaging, and presentation. In all 17 cases, the parents listed food refusal and the introduction of new foods as the major problem.

Using a postal questionnaire and a 3-day food diary, Cornish (2002) found that between 32% and 50% of children with ASD studied ($N = 37$) had diets resulting in deficient nutrient intakes, with no significant differences between those children on gluten-free, casein-free diets and those not on restricted diets. The results indicated that 89% of children with ASD exhibited repetitive patterns of food choice. Cornish also found that children with ASD differentially accepted foods based on textures, colors, and packaging. In addition, 66% of children with ASD studied ate no servings or only one serving of fruit

or vegetables per day. Cornish also determined that 19% of the children consumed large quantities of milk products.

In a study of maladaptive feeding behaviors in children with developmental disabilities, Field et al. (2003) compared children with ASD to children with Down syndrome and cerebral palsy by reviewing records from a feeding program. The most common feeding problems for children with ASD ($N = 26$) were food selectivity by type and by texture, affecting 62% and 31% of participants, respectively. Food refusal and dysphagia (swallowing problems) were also present in some children with ASD, although these problems were associated with additional medical complications. Food refusal, dysphagia, and oral motor problems were less common in children with ASD than in children with other developmental disabilities.

The largest descriptive study in this review was conducted by Schreck et al. (2004), and included data from 138 participants with ASD and 298 children who were typically developing. Based on parent report, children with ASD had more feeding problems and refused more foods than other children. The study also suggested that the children with ASD often required specific utensils and presentation and more often only accepted foods of smoother textures. Schreck et al. also found that 72% of children with ASD in the study ate a "narrow" variety of foods, but families of children with ASD did not eat a narrower variety of foods than families of children without ASD.

Discussion

All seven descriptive studies found evidence of maladaptive feeding behaviors in children with ASD. Ahearn, Castine, et al. (2001) reported that 87% of children with ASD in their study demonstrated low to moderate acceptance, accepting 60 or fewer bites of food (of 90 presented). By examining referrals to a feeding program, Bowers (2002) found that 46% of children with ASD were referred because of food selectivity. Collins et al. (2003) noted that between 20% and 40% of children with ASD in their study never ate the normal family diet. In the 1998 study, Cornish reported that 59% of children with ASD ate fewer than 20 different foods, and in the 2002 study noted that 89% of parents of children with ASD stated that their children followed repetitive patterns of food choice. Field et al. (2003) reported that 62% of children with ASD in their study exhibited food selectivity by type and that 31% exhibited selectivity by texture. Schreck et al. (2004) found that children with ASD in their study exhibited more feeding problems than children without ASD. Overall, the results of these quantitative descriptive studies indicate that problem feeding behaviors are present in 46% to 89% of children with ASD.

INTERVENTION STUDIES

For this review, we found nine intervention studies that (a) treated a feeding problem in a child between the age of 2 years and 18 years with a diagnosis of an ASD, (b) used an

experimental design to evaluate effectiveness of the intervention, and (c) were published in a peer-reviewed journal between 1994 and 2004. A study by Ahearn, Kerwin, Eicher, and Lukens (2001) treated children with a range of developmental disabilities, but we have presented results only for the child with the ASD diagnosis. Table 2 summarizes the information for the nine studies that met our inclusion criteria.

Method

Participants

In the nine identified and reviewed articles, a total of 18 children with ASD were treated for feeding problems. Eleven of these participants had a diagnosis of autism, and seven had a diagnosis of PDD-NOS. Ages of participants ranged from 4 years to 14 years, with a mean age of 7 years 3 months (individual age data were not included for 6 participants). Thirteen (72%) of the participants were boys, and five (28%) of the participants were girls. One participant was reported to have medical problems related to feeding, specifically, gastroesophageal reflux and delayed gastric emptying (Ahearn, Kerwin, et al., 2001). Two participants were reported to have current or previous medical problems related to inadequate dietary intake, including weight loss and dehydration (Freeman & Piazza, 1998; Piazza et al., 2002).

Procedures

The most common procedure used to treat feeding problems was differential reinforcement contingent on appropriate eating behaviors, which seven (77%) of the studies employed. In all cases, the researchers paired differential reinforcement with other procedures, including simultaneous or sequential presentation (Freeman & Piazza, 1998), stimulus or demand fading (Freeman & Piazza; Najdowski, Wallace, Doney, & Ghezzi, 2003), appetite manipulation (Levin & Carr, 2001; Piazza, et al., 2002; Kern & Marder, 1996), and escape extinction (Ahearn, 2002; Ahearn, Kerwin, et al., 2001; Anderson & McMillan, 2001; Freeman & Piazza; Najdowski et al., 2003; Piazza et al.).

Research Design

The experimental design employed varied across the nine studies. Ahearn (2002) used a "variant of a changing criterion design" (p. 117) to evaluate food acceptance. Najdowski et al. (2003) employed a changing criterion design across settings to evaluate a treatment designed to increase food acceptance. One study (Anderson & McMillan, 2001) employed an A-B-A-B design, while another (Ahearn, Kerwin, et al., 2001) used an A-B-A-C design. Two studies employed combination designs. Ahearn (2003) used a multiple-baseline-across-conditions plus A-B-A-B design, whereas Levin and Carr (2001) used a multiple-baseline-across-participants plus changing criterion

design. Three studies compared treatments; two of these studies employed an alternating treatments design, also known as a *multielement design* (Freeman & Piazza, 1998; Piazza et al., 2002), and one used what is commonly referred to as an *adapted alternating treatments design* (Kern & Marder, 1996).

Dependent Variables

All nine studies targeted food acceptance or consumption as a dependent variable. For all of the studies, acceptance was described as food being placed in the mouth. Four of the studies (Ahearn, 2002, 2003; Ahearn, Kerwin, et al., 2001; Kern & Marder, 1996) included a time constraint for acceptance. *Consumption* was defined as acceptance of food in mouth without expulsion (Levin & Carr, 2001) or as the ratio of clean mouth divided by number of bites placed in the mouth (Piazza et al., 2002). The method of reporting acceptance varied across studies. Percentage acceptance was reported in Ahearn (2002, 2003), Ahearn, Kerwin, et al. (2001), Kern and Marder (1996), and Piazza et al. (2002). Acceptance was reported as amount of food consumed in grams in Freeman and Piazza (1998) and Levin and Carr. Najdowski et al. (2003) reported number of bites consumed.

Four of the studies (Ahearn, 2002; Ahearn, Kerwin, et al., 2001; Anderson & McMillan, 2001; Piazza et al., 2002) also used expulsion as a dependent variable. The response definition for expulsion in all studies was food appearing outside of the lips after acceptance. Levin and Carr (2001) also recorded aggression episodes (attempting or completing the following actions: hitting, kicking, biting, scratching, pulling hair). Three studies (Ahearn, 2002; Ahearn, Kerwin, et al., 2001; and Anderson & McMillan) also monitored disruption or interruption (blocking the presentation of food by the child). Anderson and McMillan also reported the number of instances of self-injury (head banging, arm banging, arm biting). Negative vocalizations (screaming, crying, or whining) were monitored by Ahearn, Kerwin, et al. (2001).

Settings

Four of the studies were conducted in naturalistic settings: two in school settings (Ahearn, 2002; Levin & Carr, 2001), one in the home setting (Anderson & McMillan, 2001), and one in home and community settings (Najdowski et al., 2003). Four studies were conducted in clinic or hospital settings: three using inpatient procedures (Ahearn, Kerwin, et al., 2001; Freeman & Piazza, 1998; Kern & Marder, 1996) and one with both inpatient and outpatient procedures (Piazza et al., 2002). The researchers of one study reported that the setting consisted of a room with a table and two chairs but did not indicate whether this was a community or clinical setting.

Presenting Problems

In all 18 cases, food selectivity resulting in the refusal of certain foods was the primary presenting problem. In 4 cases, the

TABLE 2
Feeding Problems in Children With Autism: Intervention Studies

Study	Research design	Procedures	Intervention length	Participant gender, age (yrs), & diagnosis	Goals	Results	Maintenance
Ahearn (2002)	Changing criterion	DR, EE:NRS, EE:PG	28–48 sessions	4 boys, 2 girls; age range: 4 yrs–11 yrs; 4 autism, 2 PDD-NOS	Increase variety of foods consumed (number of groups)	All participants met 80% acceptance criteria for eating 3 foods from 4 groups	4 participants maintained gains, no follow-up data for 2 participants
Ahearn (2003)	ABAB	Simultaneous and sequential presentation	40 sessions	14-yr-old boy with autism	Increase vegetable consumption	Rate of vegetable consumption increased from 0% to 100%	Consumption maintained at 1 yr follow-up
Ahearn et al. (2001)	ABAC	EE:NRS, EE:PG	50 sessions	4-yr-old boy with PDD-NOS	Increase variety and texture of food consumed	In baseline all bites expelled; in treatment, acceptance increased to 88% with no expels	Maintenance of acceptance rates at 1 mo–3 mos
Anderson & McMillan (2001)	ABAB	EE:NRS, DR	37 sessions	5-yr-old boy with PDD-NOS	Increase variety of foods consumed (fruits)	Fruit consumption increased from 50% to 100%	None
Freeman & Piazza (1998)	Alternating treatments	Fading, DR, EE:PG	12 wks (2–4 meals daily)	6-yr-old girl with autism	Increase amount and variety of foods consumed	Amount of food consumption increased from 0 g to 150 g at end of treatment	None
Kern & Marder (1996)	Adapted alternating treatments	Simultaneous and sequential presentation	60 sessions	7-yr-old boy with PDD-NOS	Increase variety of foods consumed (fruits and vegetables)	Food acceptance increased from 2% & 11% to 85% & 76%; simultaneous presentation produced more rapid and greater acceptance rates	None
Levin & Carr (2001)	Multiple baseline across participants	DR, environmental manipulation	35 sessions	6-yr-old boy with autism, 5-yr-old boy with autism, 6-yr-old girl with PDD-NOS	Increase variety of foods consumed	Participants consumed NPF only with implementation of both DR & limited access	None
Najdowski et al. (2003)	Changing criterion design across settings	DR, EE:NRS, demand fading	79 sessions	5-yr-old boy with autism	Increase variety of foods consumed	NPF consumption increased from 0 bites to 62 bites	Consumption of NPF maintained at 12 weeks
Piazza et al. (2002)	Alternating treatments	Simultaneous and sequential presentation, EE:NRS	90 sessions	10-yr-old boy with autism, 11-yr-old girl with PDD-NOS, 8-yr-old boy with PDD-NOS	Increase variety of foods consumed	For Boy 1, increased to 100% acceptance with both; for Girl, only with simultaneous presentation; for Boy 2, only with sequential presentation + PG + EE:NRS	None

Note. EE:NRS = escape extinction in the form of nonremoval of the spoon; DR = differential reinforcement; NPF = nonpreferred food; EE:PG = escape extinction in the form of physical guidance; PDD-NOS = pervasive developmental disorder, not otherwise specified; PG = physical guidance.

total number of food groups (e.g., starches) accepted was one (Ahearn, 2002). Two children accepted only two foods (Piazza et al., 2002). Four children accepted only three food types (Ahearn, Kerwin, et al., 2001; Anderson & McMillan, 2001; Najdowski et al., 2003; Piazza et al., 2002), and 1 child accepted five food types (Kern & Marder, 1996). One child was "mildly selective" (Ahearn, 2003). For 4 cases, the authors did not report the number and types of foods accepted prior to treatment (Freeman & Piazza, 1998; Levin & Carr, 2001). Ahearn, Kerwin, et al. (2001) and Anderson and McMillan each reported one participant who was selective by texture, eating only foods of smoother textures (e.g., puree).

Treatment Goals

The goal for all 18 participants was to increase variety of foods consumed. In 10 cases, researchers listed a goal for acceptance of a particular food or food group (Ahearn, 2002, 2003; Anderson & McMillan, 2001; Kern & Marder, 1996; Najdowski et al., 2003). In 1 case, an increase in the amount of food consumed (premeal minus postmeal weight in grams) was an additional treatment goal (Freeman & Piazza, 1998).

Parent Training

In 4 of the 18 cases, the researchers provided parent training (Ahearn, Kerwin, et al., 2001; Anderson & McMillan, 2001; Kern & Marder, 1996; Najdowski et al., 2003). Of these studies, two (Anderson & McMillan, 2001; Najdowski et al., 2003) provided parent training in the home, and two (Ahearn, Kerwin, et al., 2001; Kern & Marder) provided parent training in the clinical inpatient setting.

Results

In all 18 cases, consumption of previously refused foods increased. In addition, for all cases in which follow-up data were collected, gains were maintained. In Ahearn (2003), consumption of three types of vegetables in 40 treatment sessions in a 14-year-old boy with autism and profound mental retardation increased from 0% of bites accepted in baseline to 100% when vegetables were paired with preferred foods in a simultaneous presentation procedure. In a 1-year follow-up, a dietary journal showed maintenance of acceptance, with continued simultaneous presentation of preferred and non-preferred foods.

In Najdowski et al. (2003), consumption of nonpreferred foods increased from 0 bites per session in baseline to 62 bites per session after 79 meals in a 5-year-old boy with a history of food selectivity and a diagnosis of autism. Sessions were held during normal mealtimes and ended after the participant had accepted the required number of bites, which increased within a changing criterion design. His diet consisted primarily of three foods: chicken nuggets (only one brand), chips, and french fries (only one brand). A parent implemented the treat-

ment procedure, which included positive reinforcement of acceptance and nonremoval of the spoon. Maintenance of acceptance of the targeted nonpreferred foods (five items) was maintained during follow-up at 12 weeks.

Ahearn (2002) evaluated the effectiveness of differential reinforcement of acceptance, nonremoval of the spoon, and physical guidance to treat food selectivity within the context of a changing criterion design variant. Ahearn exposed six children (chronological age range = 4 years–11 years) who had been identified by school staff for treatment of food selectivity to nonpreferred foods as single items or in groups of items. Two of the children had a diagnosis of PDD-NOS and four had a diagnosis of autism. Each child ate foods from only one food group during the initial assessment condition (specific foods accepted were not reported). During the treatment condition, participants were exposed to new foods by food group (i.e., breads, meats), either individually or in groups of three. Ahearn found that acquisition of acceptance was faster for single-item presentation but that generalization was more likely to occur for multiple-item presentation. In addition, differential reinforcement alone failed to produce criterion levels of acceptance for any participant. Subsequently, Ahearn implemented escape extinction procedures, resulting in criterion levels of acceptance for all children. Participants increased their consumption of food from all four food groups to at least 80% within 28 to 48 sessions. Gains were maintained at follow-up (at an unspecified time interval) for four of the children. Maintenance data were not collected for two children.

Piazza et al. (2002) evaluated the relative effectiveness of simultaneous and sequential presentation within the context of an alternating treatments design. Both procedures were used to increase food consumption for three children with food selectivity. For all children, Piazza et al. used appetite manipulation, such that all procedures were implemented near normal mealtimes, with access to preferred foods restricted prior to each session. Two children had a diagnosis of PDD-NOS, and one child had a diagnosis of autism. Two children ate only two foods (lettuce and yogurt; chips and chicken skins), and one child ate only three foods (chicken nuggets, apples, crunchy foods) prior to treatment. For one child, the percentage of bites consumed of nonpreferred food items increased from 0% to 100% in both simultaneous and sequential conditions. For another child, consumption increased from 0% to between 50% and 100% in the simultaneous condition but remained at 0% for the sequential condition. For the third child, consumption remained at 0% through baseline, simultaneous presentation, and sequential presentation. When physical guidance was added to the protocol, acceptance increased to 100%, with all bites being expelled. Acceptance increased to between 50% and 100% when representation of expelled bites was added to the treatment. The total number of twice-daily treatment sessions for this child was 90. Piazza et al. did not report any follow-up data.

Anderson and McMillan (2001) used an A-B-A-B withdrawal design to evaluate the effectiveness of differential re-

inforcement of acceptance and nonremoval of the spoon for a 5-year-old child with a PDD-NOS diagnosis and a history of food selectivity by type and texture. His diet consisted primarily of three foods (mashed potatoes, yogurt, and applesauce). The treatment goal was to increase acceptance of fruits. After 37 sessions, using differential reinforcement and nonremoval of the spoon, acceptance of fruits reached 100%, compared to 14% at baseline. No maintenance data were reported.

Ahearn, Kerwin, et al. (2001) used an A-B-A-C design to evaluate the effectiveness of using escape extinction procedures with a 4-year-old boy with a diagnosis of PDD-NOS and a history of type and texture food selectivity. In baseline sessions, the percentage of acceptance ranged from 5% to 93%, but all instances of acceptance were followed by an expulsion. In both treatment conditions (physical guidance and nonremoval of the spoon), acceptance increased to greater than 75%. When the researchers asked the parents to choose a treatment procedure in which to be trained for use at home, the parents chose nonremoval of the spoon. Acceptance of target foods remained at 100% for 3 months of follow-up sessions, during which the parents used nonremoval of the spoon.

Levin and Carr (2001) used a multiple-baseline-across-participants design, and changing criterion design, to evaluate the effectiveness of differential reinforcement of food acceptance and environmental manipulation to treat food selectivity in three children with ASD. Appetite manipulation consisted of restricting access to preferred foods prior to feeding. The results indicated that neither differential reinforcement of acceptance nor environmental manipulation alone increased food acceptance for any of the children; however, in combination these variables led to an increase in food acceptance from 0 g to 28 g in 30 daily sessions for one participant, 0 g to 42 g in 35 daily sessions for a second participant, and 0 g to 80 g in 45 daily sessions for the third participant. Levin and Carr did not report follow-up data.

Freeman and Piazza (1998) used an alternating treatments design to examine the relative effectiveness of two treatment procedures for food refusal in a 6-year-old with autism whose selectivity had historically resulted in medical problems, including weight loss and dehydration. They compared treatment, consisting of differential reinforcement for acceptance, stimulus fading, and physical guidance, to a verbal-prompting-only baseline condition. This study was conducted in an inpatient clinic setting. Food consumption increased from 0 g to 150 g per meal after 12 weeks of daily treatment, and consumption during baseline meal conditions remained at 0 g. The authors did not provide follow-up data.

Kern and Marder (1996) used an adapted alternating treatments design to evaluate the relative effectiveness of a simultaneous presentation procedure versus a sequential presentation procedure on food selectivity in a 7-year-old child with PDD who accepted only five food items prior to treatment. The researchers used appetite manipulation such that sessions occurred during normal mealtimes. In this study, fruits were presented simultaneously with a preferred food,

and vegetables and a preferred food were presented sequentially. Fruit consumption increased from 2% to 85% while vegetable consumption increased from 11% to 76%, across 60 meals. No follow-up data were reported.

Discussion

Of the nine intervention studies reviewed, all reported successful treatment of feeding problems in children with ASD. A variety of approaches, including simultaneous presentation, sequential presentation, differential reinforcement of acceptance, stimulus fading, escape extinction, and appetite manipulation, were studied in isolation or in combination. Research designs also varied across studies. Overall, the results of these studies demonstrate the availability of a wide range of effective intervention strategies for treating feeding acceptance and consumption problems exhibited by children with ASD.

GENERAL DISCUSSION

Although we found only 16 studies that had been published between 1994 and 2004, these studies into the maladaptive feeding behaviors of children with ASD have established that up to 89% of children with ASD exhibit an unusual pattern of food acceptance. All of the descriptive studies in this review found that children with ASD demonstrated selectivity by type or texture, and several found selectivity by brand or type and by presentation or appearance (Cornish, 1998, 2002; Najdowski et al., 2003; Schreck et al., 2004). Cornish (1998, 2002) suggested that this selectivity was cause for concern because of the nutritional deficits found in children with ASD. In addition, other substantial feeding problems for children with ASD included food refusal, failure to eat the usual family diet, inappropriate rate of eating, obsessive eating patterns, failure to accept novel foods, and inappropriate mealtime routines (Collins et al., 2003; Cornish, 1998).

Food groups accepted by children were reported in 10 studies. Schreck et al. (2004) found that children with ASD accepted fewer foods from every food group when compared to children without ASD. Children from both groups accepted more food from the starch group than from any other group. Specific numbers of foods accepted from each group were reported in three studies (five participants). The total number of foods accepted was 10, with 2 accepted from the fruit group, 2 from the vegetable group, 1 from the starches group, 3 from the meat group, and 2 from the milk group (Anderson & McMillan, 2001; Najdowski et al., 2003; Piazza et al., 2002).

Three studies reported percentages of participants who selectively consumed certain food groups. Ahearn, Castine, et al. (2001) found that 2 participants (7%) selectively consumed fruits, 11 (37%) selectively consumed starches, and 3 (10%) selectively consumed meats. Cornish (1998) found that 12 participants (71%) were selective against fruits and vegetables, 6

participants (35%) were selective against meat, and 3 participants (18%) were selective against milk. Cornish (2002) found that 21 participants (58%) were selective against fruits and vegetables, 9 (24%) were selective against meat, and 3 (8%) were selective against milk. Overall, the only agreement among the studies regarding selectivity by food group was that no participants demonstrated selective consumption of vegetables.

Limitations of Current Research

A major limitation of current descriptive studies of feeding problems in children with ASD is the dependence on questionnaires and other parent-report measures to determine the types and severity of problem feeding behaviors in this population. Only Ahearn, Castine, et al. (2001) reported the use of direct observation of feeding responses in children with ASD for categorizing feeding difficulties. Future studies should address this weakness in the current research.

The research base for treatment of feeding disorders in children with ASD is also small. Six of the studies (Ahearn, 2002; Ahearn, Kerwin, et al., 2001; Anderson & McMillan, 2001; Freeman & Piazza, 1998; Najdowski et al., 2003; Piazza et al., 2002) used procedures similar to those used with children without ASD, including physical guidance and nonremoval of the spoon. In addition, several procedures not generally used with other populations were presented for treating feeding problems in children with ASD, including simultaneous and sequential presentation and appetite manipulation (Kern & Marder, 1996; Levin & Carr, 2001; Piazza et al.).

Many of the reviewed studies reported no follow-up data concerning the effectiveness of the treatments that were implemented. Because feeding problems are likely to persist in the absence of continued treatment, parent follow-up of clinically implemented treatments is crucial. Because generalization of behaviors and maintenance of gains is unlikely without active programming, and because better generalization and maintenance results are achieved when parents are trained as treatment providers (Schreibman, 2000), lack of follow-up data limits the conclusions that can be made regarding the long-term effectiveness of these treatments.

Discrepancies in Recommendations

The social and clinical significance of results from empirical studies are jeopardized when treatments are not continued by parents, teachers, and other clinicians. Schreibman (2000) suggested that enhanced communication, both from researchers to parents and clinicians, and from parents and clinicians to researchers, is a critical need in the field of autism research. For this study, we conducted a search to locate recently published books that discussed feeding problems in children with autism, excluding books that primarily discussed food as a treatment for behaviors associated with autism. We found three books

that discussed feeding problems in children with autism and targeted a lay audience. One of these texts (Legge, 2002) was an entire book devoted to feeding problems in children with autism, whereas the other two (Ives & Munro, 2002; Koegel & LaZebnik, 2004) were books about children with autism, with a section that discussed feeding problems. Two of the books (Koegel & LaZebnik, 2004; Legge, 2002) were authored or co-authored by a parent of a child with autism. All three books explicitly stated that they were written for parents.

In general, we found that the procedures reviewed in the empirical literature were not the same procedures that were reviewed in the texts. Many of the empirical studies implemented invasive procedures, such as physical guidance (Ahearn, 2002; Ahearn, Kerwin, et al., 2001; Freeman & Piazza, 1998; Piazza et al., 2002) or nonremoval of the spoon (Ahearn, 2002; Ahearn, Kerwin, et al., 2001; Anderson & McMillan, 2001; Najdowski et al., 2003; Piazza et al., 2002). However, in the reviewed texts, the Premack principle, shaping, simultaneous presentation with fading, multiple presentations of nonpreferred foods, and social modeling were commonly used. Additional research using these procedures, which parents have reported to be effective, would help to clarify which procedures are most effective for treating feeding disorders.

All three reviewed texts reported the Premack principle to be effective. This procedure was often paired with shaping, another parent-reported successful technique (Koegel & LaZebnik, 2004). For example, a child might first only have to smell a new food, later would be required to lick it, and then asked to eat increasingly larger portions. Although this technique is used in empirical studies, it has been paired with invasive techniques of escape extinction (Anderson & McMillan, 2001; Freeman & Piazza, 1998; Najdowski et al., 2003).

Another procedure that parents often reported as useful for treating aberrant feeding behavior in children with ASD is simultaneous presentation (Ives & Munro, 2002; Koegel & LaZebnik, 2004; Legge, 2002). Although there are only a few instances of this procedure in published studies (Ahearn, 2003; Kern & Marder, 1996; Piazza et al., 2002), its anecdotal success is somewhat different. In particular, many instances of success reported by parents involved the use of fading, in which such a small amount of the nonpreferred or new food is first mixed in with the preferred food that its presence is indiscernible to the child (Ives & Munro, 2002; Koegel & LaZebnik). The children thus were unaware that they were eating a new food when the parent-reported simultaneous procedure was used. For example, if a child prefers juice and refuses water, a small amount of water can be added to a cup of juice. Over time, the amount of water added can be increased until the child drinks water alone.

Another procedure reported to be effective in treating food selectivity is multiple presentations of nonpreferred foods (Legge, 2002), in which parents continue to present a rejected food over many trials (even months). Purportedly, the child will become less fearful of the novel food when it becomes familiar.

For some children with ASD, parents have reported success in treating feeding problems with social modeling, which involves peers or family members serving as examples of appropriate eating behavior (Ives & Munro, 2002; Legge, 2002). Other, less reported procedures that have been effective according to parents include use of visual cues (Ives & Munro) and menus (Legge).

Perhaps the most important difference in the reviewed empirical research and the reviewed texts regarding maladaptive feeding behavior in children with ASD is the emphasis on the social implications of atypical feeding patterns. Whereas the research studies focused on attaining acceptance of food and increasing the amount of nonpreferred food consumed, the texts focused on helping children to have more socially acceptable eating habits. For children with ASD, who have a number of traits that can lead to social isolation, feeding problems is one area for which interventions could result in important social acceptance in major childhood settings, such as school cafeterias, birthday parties, and restaurants. To date, empirical studies have not included components of social validation.

Recommendations for Future Research

Findings from this review of feeding problems in children with ASD suggest several implications for future research:

1. More descriptive studies of maladaptive eating behavior in children with ASD, particularly studies that rely on direct observation and measurement, are needed.
2. Studies that include parent questionnaires regarding feeding behavior should include questions concerning treatments or procedures that have been tried, successfully and unsuccessfully, so that researchers can decide which procedures warrant further empirical investigation.
3. More studies that examine the specific types of food that children with ASD selectively consume or refuse are needed.
4. More intervention studies regarding feeding problems in children with ASD, particularly studies with larger samples and comparison groups and studies that are designed specifically for this population, need to be conducted.
5. Social validation of the efficacy of treatment procedures needs to be addressed.
6. More studies that emphasize maintenance of gains, particularly in naturalistic and socially relevant settings, should be conducted.

Recommendations for Practice

In addition to recommendations for additional research, the results from this literature review reveal some important implications for practice in the treatment of feeding problems in children with ASD:

1. The social implications of maladaptive eating behaviors in children with ASD should be considered when deciding on a treatment procedure (e.g., if a school-age child with ASD will only eat an adequate variety of foods when non-removal of the spoon is used, this does not make his or her eating behavior more socially acceptable).
2. Teachers, parents, and clinicians should educate themselves concerning the empirical validity of treatments they are using for feeding disorders in children with ASD.
3. Teachers, parents, and clinicians should collect data regarding the effectiveness of the treatments for feeding disorders so that ineffective techniques can be discontinued.
4. Parents should treat feeding disorders during early childhood, or as early as the problem appears. Because studies have shown that growth rates can be affected if nutritional rehabilitation is delayed (Schwarz, 2003), and because the risk of nutritional deficits is greater for children under 5 years of age (Cornish, 1998), early intervention is important in the area of feeding problems, as it is in other areas for children with autism.

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