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Sensory Issues and Feeding Difficulties in Children: A Clinical Perspective

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Abstract

Children with sensory issues often exhibit feeding difficulties, particularly selectivity (limiting the number or types of foods consumed). Disorders with a high occurrence of sensory processing dysfunction such as autism, developmental delay, genetic disorders or conditions such as prematurity or head injury are often associated with feeding problems. Typically developing children who exhibit early tactile defensiveness may also have similar sensory related feeding difficulties. Both hyper-sensitive and hyposensitive responses to stimuli and how they relate to feeding are discussed as well as the potential impact of selectivity on growth and development. Interventions for selectivity that are used in a clinical setting are reviewed with practical suggestions for managing patients with sensory feeding issues.

Keywords: *Sensory processing dysfunction; Neophobia; Selectivity; Picky eater; Hypo-responsive; Hyper-responsive; Feeding difficulties; Food refusal*

Abbreviations: ASD: Autism spectrum disorder; SOR: Sensory over-responsive; SUR: Sensory under-responsive; DSM-V: Diagnostic and Statistical manual of mental disorders, fifth edition; ADHD: Attention deficit hyperactivity disorder

Introduction

Eating is a sensory experience involving taste, smell, touch, vision and hearing. Therefore it is no surprise, that sensory dysfunction contributes to eating problems in some children. Feeding difficulties are common in the general population with approximately 25% of all children having some type of feeding difficulty [1,2]. In developmentally delayed children feeding problems are even more prevalent with as many as 80% of these children being affected [1,2]. Recently, the Diagnostic and Statistical Manual of Mental Disorders, fifth edition (DSM V) [3] characterized avoidant/restrictive food intake disorders and Kerzner., *et al*. [4] suggested a general classification for feeding difficulties in young children. Both suggested that early feeding problems manifest themselves in three basic ways; limited appetite (inadequate volume consumed); selectivity (limited variety consumed) and fear of feeding (phobic response to eating).

Sensory processing issues may influence the type of feeding problems that develop and there is evidence of an association between feeding problems and sensory processing issues in children [5,6]. While less common than feeding difficulties, sensory processing dysfunction occurs in about 5-16% of children and becomes evident when responses to sensory input are extreme enough to interfere with daily functioning, including eating [7]. In typically developing children as well as those with developmental disabilities, sensory issues are most often related to selectivity although they may also influence appetite or aversive responses to food.

All children, to some extent, exhibit a form of selectivity called neophobia. This is a normal part of development that induces caution in children when approaching new foods and prevents them from routinely eating dangerous foods [8]. Neophobia peaks at 18 months of

age and usually resolves by the time the child is 3 to 5 years of age [8]. Some children, however, are extremely selective and the selectivity they exhibit does not necessarily resolve with age. Early behaviors and temperament may yield clues as to which children will develop food selectivity. Smith., *et al*. found that young children who showed tactile defensiveness (strong or negative reaction to touch stimuli) had a lower preference for vegetables, often refused foods based on their smell, were more averse to foods of different textures and were sensitive to high or low food temperatures [5]. Tactile defensiveness is present in 6-17% of infants, and children with difficult or irritable temperaments are more likely to be tactilely defensive [9]. Although not every child who is tactilely defensive becomes selective, these children may be at increased risk. In certain conditions such as autism, 90% of children may have feeding difficulties with selectivity present in 70% of the cases [10]. In addition neurological disorders, genetic disorders, extreme prematurity or brain injuries are also associated with sensory processing dysfunction that impacts feeding [11,12].

Identifying the problem

There are many types of sensory issues and an in-depth discussion of them is beyond the scope of this paper. The best way to characterize how sensory issues impact feeding is to use Dunn's model of sensory processing. She describes two types of sensory dysfunction based on a child's threshold of accepting sensory input and his/her reaction to it [13]. Children with selectivity are most often considered to be "hypersensitive" to tastes, smells and textures of food. This means they have a very low threshold for sensory input of any kind; are sensitive to tags in clothing; to bright lights and loud noises. They are also sensitive to environmental textures like the feel of grass, rough carpet or concrete on bare feet; play-dough or clay on their hands; or a hairbrush or shower's water stream on their skin. Children who are hypersensitive or exhibit sensory over-responsivity (SOR) to sensory characteristics of food react by avoiding those foods. Avoidant eating behaviors can range from simple food refusal to tantrums to gagging or vomiting [14]. Hyper-responsive children often limit the foods they will eat to less than a total of 5-6, potentially impacting nutrient intake by creating a dietary imbalance.

Selectivity due to hyper-responsiveness is common in children with developmental disabilities. This is particularly true of children with autism spectrum disorder (ASD). They appear to have a greater number of sensory symptoms than children with other developmental disorders, especially in the realm of taste and smell [3]. Dunn also found that children with ASD had greater oral sensitivity than children with ADHD [13] and Lane., *et al*. further described a subset of child with ASD as having sensory modulation with taste/smell sensitivity [15]. The selectivity children with autism exhibit seems to be significantly correlated with their sensory over-responsivity and has been nicely described in a study by Suarez., *et al*. [16] reflecting what we observe in our clinic. The children we treat with ASD are sensitive to textures, colors, shapes, smells, and visual changes as well as any change in their environment or daily routine. They want to smell their food and sometimes everything else, including the physician who is treating them.

Similar to the selectivity observed in autistic children, a subset of obese children may also have sensory driven eating patterns. Although a direct relationship between selectivity and obesity has not been described in the literature, several longitudinal studies have shown an inverse relationship between fruit and vegetable intake and childhood obesity [17]. While many obese children have a learned selectivity where early rejection of vegetables and the development of a preference for junk foods are reinforced by indulgent parental feeding practices, a small percentage may have significant sensory issues. From unpublished data collected in our clinic, we estimate approximately 10% of obese children exhibit sensory issues that impact their food selection. This sub-group of obese children is hyper-responsive to taste or texture and show extreme avoidance behavior; often vomiting if made to eat vegetables.

The second type of sensory processing dysfunction that Dunn describes is seen in the child who has a high threshold for sensory input. In this case the child often does not respond at all or very little to sensation both in the mouth and in the environment. These children often don't respond to noises or bright lights. Hypo-responsiveness is frequently seen in children with developmental delays and is sometimes referred to as sensory under-responsivity (SUR). Children who are hypo-responsive to the sensory characteristics of food in their mouth may react by stuffing their mouths to increase the sensation or by seeking out foods that are strongly flavored [13]. In clinic, we see, in various genetic syndromes, a dysphagia that is hypo-responsive. At least half of the children with dysphagia in our practice have a hypo-sensory diminishment and are not sensitive to their swallowing apparatus. If food enters the airway by aspiration

or penetration we see a delayed cough - anywhere from 30 seconds to several minutes before the child coughs weakly. This represents diminished sensation in and around the airwayand results in cough receptors, which are not immediately responsive.

It is important to understand that while hyper-responsive and hypo-responsive describe two distinct responses to sensory input, both can be present in the same child. We have seen children with developmental delay and dysphagia who are hyper-responsive to bright lights and loud noises and textures but are hypo-responsive in their airway and exhibit a delayed cough followed by aspiration.

Impact of the problem

There are potential negative effects of dietary selectivity due to sensory issues in children, both physiologically and behaviorally. Severely limited diets may not provide all the nutrients children need to grow well and can change family dynamics, especially during mealtimes. The impact of selectivity depends on the severity of the problem. Although there is no consensus on what constitutes typical, mild, moderate or severe selectivity, the greater the severity, the greater the risk of nutrient or growth deficits. Suarez suggests that severe selectivity occurs when a child limits her diet to < 10 foods; moderate selectivity when foods are limited to 11-20; and a normal or typical diet includes > 20 foods [16]. Others suggest that it is not just the number of foods but whether or not the feeding difficulty results in a suboptimal nutritional state that determines severity [18].

Research suggests that children with mild to moderate selectivity or children considered to be "picky" eaters by their parents have few long term growth problems, particularly after 3 years of age [19-21]. Although these children's diets are lower in some nutrients than children without feeding problems, their overall nutrient intake is within normal limits [1,19].

This may not be the case with children who have moderate to severe selectivity or those with extreme eating behaviors. Most of the literature that has looked at selectivity beyond picky eating has focused on children with ASD with mixed results. Several authors have found that while children with ASD have less variety in their diet and eat fewer fruits and vegetables; their energy and nutrient intakes are similar to typically developing children [22-24]. Others suggest that there are potential problems with nutrient intake. Cornish., *et al*. found 53% of autistic children had diets low in one or more nutrients including iron, zinc, vitamin D, vitamin C, niacin and riboflavin [25]. In a group of 22 children with ASD, Zimmer., *et al*. found low intakes of protein, calcium, vitamin B12 and vitamin D and that the presence of selectivity was significantly correlated with an increased risk of at least one nutrient deficiency [26].

Clinically, each child with selectivity should be evaluated carefully to rule out nutrient deficiencies. This requires looking at the number and type of foods consumed, the child's eating behavior, growth, biochemical markers of nutrient deficiency and health status. Consuming as few as 4 or 5 foods may provide an adequate nutrient intake if the right foods are eaten in a sufficient quantity. From clinical observations and analysis of patient food records we have observed that selective children who are growly adequately and consume one food from each group of "anchor" foods (see Table 1), frequently have adequate diets. Anchor foods provide baseline nutrition and include foods that are nutrient dense, commonly consumed and often fortified with additional nutrients. Comparing a child's diet to anchor foods provides health care professionals a quick way to estimate nutrient adequacy.

The more aversive the eating behavior, the more it impacts nutrient intake. Gagging, vomiting, or pocketing food in the mouth, for instance, is more likely to lead to inadequate nutrient intake and poor growth. Children with ASD sometimes go on "hunger strikes" where they refuse to eat solid foods putting them at increased risk for poor nutrient intake. Supplementation with liquid supplements may be required during these phases.

In all cases of selectivity from mild to severe, perhaps the most negative effects are seen developmentally and behaviorally. Children don't eat in isolation and food refusal and aversive eating behaviors are very disruptive during mealtimes. Mothers of autistic children with food selectivity, who were interviewed, described mealtimes as being stressful and difficult [27]. Parents who feel stress and anxiety about feeding their children often resort to feeding practices that may exacerbate the problem [28]. Controlling feeding practices, such as pressuring, forcing, bribing or restricting foods initially make parents feel as though they are taking charge of the situation, but have negative consequences. Not only can forcing a child to eat lead to more aversive behavior (gagging, vomiting, etc.) but children, whose

parents use controlling feeding practices, are also more likely to consume too many or too few calories, eat fewer fruits and vegetables and have a greater chance of being underweight or overweight [29,30]. Alternatively, some parents may use indulgent feeding practices such as catering to the child's demands, making special foods and setting no limits on mealtimes. These practices also have negative effects resulting in children who are more likely to be overweight, eat more junk food and have diets lower in most nutrients [29,30]. Conflict during meals also influences the development of the child. Chatoor., *et al*. For instance, demonstrated lower mental development index scores in picky eaters, regardless of their nutrition status, when there was conflict during meals [31] and Jacobi., *et al*. followed picky eaters into adolescence and found a higher incidence of behavioral problems such as social withdrawal, somatic complaints, anxiety, depression, aggressive disorders and delinquency even when growth had been adequate [32].

Dairy or other fortified beverage	Fortified cereal or grain	Brightly colored fruit or vegetable	Protein food
Cow's milk	Ready to eat cereal	Orange: carrot, sweet potato, cantaloupe, etc.	Meat
Soy milk	Oatmeal	Red: berries, tomatoes, red pepper, etc.	Chicken and Turkey
Goat's milk	Infant cereal	Blue/Purple: Blueberries, grapes, plums, etc.	Fish and shellfish
Infant or follow up formula		Dark green: Spinach, kale, kiwi, etc.	Eggs
Oral nutrition supplement		Yellow: corn, yellow pepper, etc.	Yogurt and cheese
			Beans: pinto, black, lentils, etc.

Table 1: *Anchor foods - selective diets are most likely adequate if they contain 1 food from each group.*

Interventions

When determining what intervention will be most helpful in the child with sensory feeding issues, it is important not only to do a good medical evaluation, but to also understand which sensory dysfunction is present, the characteristics of the foods the child refuses and accepts and the dynamics of mealtime interaction with the parents. For all children with selectivity, it's important to steer parents to more responsive feeding practices. Table 2 suggests responsive feeding guidelines that are important for parents to adopt when feeding a child with selectivity. In addition, food choices will need to be planned around the sensory issues of the child to expose them to new flavors, textures and smells without overwhelming them [7]. For the mildly selective child, this may mean presenting foods in a playful manner [33], giving foods inviting names [34], gradually introducing textures and flavors by mixing small amounts in sauces or offering vegetables with dips or sauces [35,36].

Responsive Feeding Practices
Set meal times and snack times with 2-3 hours in between
Eat with your children
Model good eating
Offer a variety of healthy foods
Offer age and developmentally appropriate foods
No forcing or coercing to eat
Allow children to make a mess
Don't over react to food rejection or acceptance
Make mealtimes calm and pleasant

Table 2: *Guidelines for responsive feeding adapted from Kerzner., et al. [4]*

Children with severe selectivity will require more intensive intervention and treatment should be focused on their specific sensory issues. When a child is hypo-responsive, interventions must include techniques that protect the child's airway and prevent chest infections and pneumonias. For example, the use of a video-swallow x-ray to clarify textures that are safe for the child is often necessary. Sometimes a child will aspirate liquids because they move too quickly into the airway. Thickening liquids in a range of consistencies from nectar or honey consistency to medium purees may prevent aspiration [37]. This must be individualized for the child - sometimes only thick purees are thick enough to protect the child's airway and other times, a child can handle thinner consistencies but will aspirate with thick liquids. In these rare instances the thickness of the liquid results in food dripping into the airway but is too thick for the child to swallow effectively [37].

In addition, increasing the sensory characteristics of foods, may be helpful both in acceptance of foods and in protecting the child. Lemon juice is sometimes used with dysphagic adults to increase sensation in the oral cavity [38] and similar techniques can be used with children. We routinely "spice up" meals used during our video-swallows at Holland Bloor view Kids Rehab. Strongly flavored spices that don't have a delay such as chili powder, barbeque sauce or cinnamon are added to foods that allow the child to more accurately sense the presence of the food in his/her mouth. In our experience when we add these types of spices to food, approximately half the children with dysphagia in our clinic have a positive response and do not aspirate. By using a combination of thickening agents and/or spices, food travels slower, the child senses it's presence, is better able to manage itand is less likely to require gastrostomy tube placement. In fact, in our clinic since adopting this technique we've found it necessary to place gastrostomy tubes in our dysphagic patients only 28% of the time.

When a child is selective due to hyper-responsiveness, aspiration is usually not a danger and different techniques should be used to improve intake and mealtime behavior. In many of these cases occupational or speech therapists, behavioral psychologists or other specialists may be helpful. A common approach by occupational therapists is the use of sensory integrative approaches to mitigate the hyper-responsiveness. These include techniques that familiarize a child with textures, tastes and other sensory inputs in a gradual manner. They are usually initiated through play and other non-coercive activities [39].

Other techniques used by behaviorists, such as shaping and fading [40] or food chaining [41] described by Fraker., *et al*. may also be helpful. All of these interventions involve changing a particular characteristic of food slightly in a sequential manner. Shaping involves a series of small progressions - for example starting with a small bite of a food and gradually increasing the size of the bite that is offered until an appropriate volume is reached. Fading, on the other hand, gradually moves a child away from a food he likes to a food he dislikes. For instance, in the case of a child who will drink cola but not juice, juice can be mixed into cola in miniscule amounts (5 to 10 cc) and gradually increased by 5-10 cc increments over time until the cola is "faded" out and the child is able to drink juice alone. Food chaining is similar but less specific. Lists of foods with similar characteristics to the child's preferred foods are developed and offered in a consistent, non-threatening way [41]. For instance a child who will only eat one brand of French fry would be offered a different brand once a day until he/she accepts it, followed by a different shape of fried potato or a different flavor of French fry and so on until the child's food choices are gradually expanded. Ketchup, dip or sauce is often used as a medium to encourage the child to take a bite of the new food. In addition rewards, both verbal and tangible, are used in combination with the above techniques [40]. Rewards are most effective when they are given in response to a very specific eating behavior, are items that motivate the child and are pared with the removal of the parent's attention from the child if the child refuses the new food [42]. Treatments should be individualized to each child and family. Parents must eventually be able to carry out the intervention at home, which is often a challenge. It may take as long as a year or more for many of these sensory techniques to result in significant changes in the diet.

Recently, we have been using hunger manipulation in this patient population with success. When a child is hungry, his motivation to try new foods and respond to sensory feeding techniques increases. Hunger manipulation or inducement was initially described by Linscheid and was conducted in a hospital setting with patients being weaned from enteral feedings with an 87% success rate [42]. We hypothesized that hunger would motivate children with sensory issues as well and developed a hunger inducement protocol for children 7 years or older with extreme selectivity. Eligible children were given the option of a hospital admission or a community-based

program. In both cases, favorite foods or drinks were no longer offered or available to the children and they were kept well hydrated with water. In the hospital, screen time (television, videos, and phone) was also withdrawn until the child tried the new foods being offered. The vast majority of patients chose the community-based program, where instead of restricted screen time; they were required to take 5 real bites of new foods twice a week and rate all the new foods they tried as good, okay, or bad. The typical pattern that emerged was a refusal to eat for a few days and distress at the unfamiliar foods offered, followed by acceptance of the new foods as feelings of hunger increased. Interestingly, when hunger overrides the sensory hesitancy, these children find that they like the new foods and often rate them as good or okay, but rarely as bad. Statistics kept in our clinic show a 90 to 100% success rate defined by theincorporation of new foods into the children's diet.

An 8 year old patient from our clinic presents a good example of the potential of this program. Initially, the child was drinking 5 cans of lemon soda pop, eating 3 tins of potato chips per day and nothing else. His serum lactate was elevated and weight gain and nutrient intake was poor. He began a community-based hunger inducement program and within 1 week began eating new foods, eventually reaching a total of more than 30 different foods in his diet. An unpublished review of 30 selective children who underwent the hunger inducement program through our clinic shows that all 30 children succeeded in expanding their diets to include at least 20 foods and in many cases greater than 30 foods.

We have also used hunger inducement with selective autistic children. This technique is more effective in the high functioning child with ASD but is still useful with children on the lower functioning end of the spectrum. A parent's ability to follow through with hunger inducement is also a consideration. Tantrums and other inappropriate behavioral responses to the restrictions, as well as a parent's anxiety about the child's welfare may make it difficult to follow through. Parents should know what to expect, understand potential issues and have guidelines to address behavioral problems before beginning the program. The major benefit to using hunger inducement is the quick result. In our clinic, patients were able to expand their food preferences in as little as four weeks versus a year or more with sensory techniques alone.

Conclusion

Sensory feeding problems present a challenge to health care professionals. They are common in children with feeding difficulties and extremely common with some conditions, such as ASD and neurological disorders. However, both the degree of selectivity and specific sensory issues vary greatly between individuals, which makes interventions difficult to study. Until the full range of sensory processing disorders can be defined, evaluating a child's response to foods and the environment remain the best way to begin to develop treatment regimens.

Children suspected of having sensory feeding difficulties should not only be evaluated medically and nutritionally, but a good history of their eating behavior and an evaluation of the types of foods they accept and reject should also be obtained. In all cases, children must be supported nutritionally if necessary before any intervention occurs. For mildly selective children, frequent exposures to new foods should be done in a playful and non-threatening manner. Severely selective children, on the other hand, will most likely require more intensive interventions such as sensory integrative approaches, food chaining, shaping and fading, "spicing", positive reinforcement or rewards and hunger inducement. Additional research is required to understand which children will benefit the most from any particular intervention.

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Potential Conflict of Interest

Both authors have received honoraria from Abbott Laboratories for speaking at conferences on the diagnosis and management of feeding disorders in young children.

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