

Original Article

# Sensory factors involved in feeding difficulties in autism spectrum disorder

## *Aspectos sensoriais envolvidos nas dificuldades alimentares no transtorno do espectro autista*

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### Abstract

**Introduction:** Approximately 90% of individuals with autism spectrum disorder (ASD) have sensory processing alterations, showing difficulty registering, modulating, interpreting, and/or responding to sensory information from the environment. This scenario may affect eating patterns in these patients, leading to feeding difficulties, such as food selectivity. **Objectives:** To identify and compare sensory processing and possible changes in eating behavior in ASD patients with feeding difficulties (CDA) and without feeding difficulties (SDA). **Method:** A case-control study with 32 patients with ASD (ages 4 to 11 years), conducted in two stages: (1) review of medical records and (2) application of questionnaires for the clinical assessment of feeding difficulties (BREB-ASD) and sensory factors (Sensory Profile 2). **Results:** Significant differences were observed in the general ( $p = 0.050$ ), visual ( $p = 0.059$ ), and oral ( $p = 0.000$ ) sensitivity domains. Food choices were influenced by texture and consistency, with 50% preferring dry, crunchy foods “almost always” and 21.4% “frequently”. In addition, 57.1% of the CDA group maintained the same menu at each meal, and 28.6% required that foods be served in the same way. **Conclusion:** Sensory factors may be closely related to feeding difficulties, and early identification of clinical manifestations contributes not only to a specific and appropriate intervention but may also ensure adequate development with respect to the nutritional status of this group. Specific assessments, through validated questionnaires, combined with clinical observation, are indicated for a more comprehensive identification of the clinical manifestations presented.

**Keywords:** Autistic Disorder, Sensation Disorders, Child Development.

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### Resumo

**Introdução:** Aproximadamente 90% das pessoas com transtorno do espectro autista (TEA) apresentam alterações no processamento sensorial, demonstrando inabilidade para registrar, modular, interpretar e/ou responder às informações sensoriais provenientes do ambiente. Esse cenário pode afetar a alimentação desses pacientes, gerando dificuldades alimentares, como a seletividade alimentar. **Objetivos:** Identificar e comparar o processamento sensorial e possíveis alterações do comportamento alimentar em pacientes com TEA com dificuldades alimentares (CDA) e sem dificuldades alimentares (SDA). **Método:** Estudo caso-controle com 32 pacientes com TEA (4 a 11 anos), conduzido em duas etapas: (1) revisão de prontuários e (2) aplicação de questionários para avaliação clínica de dificuldades alimentares (BRCA-TEA) e dos aspectos sensoriais (Perfil Sensorial 2). **Resultados:** Foram observadas diferenças significativas nos critérios de sensibilidade geral ( $p = 0,050$ ), visual ( $p = 0,059$ ) e oral ( $p = 0,000$ ). As escolhas alimentares foram influenciadas por textura e consistência, com 50% preferindo alimentos secos e crocantes “quase sempre” e 21,4% “frequentemente”. Além disso, 57,1% do grupo CDA mantinham o mesmo cardápio em cada refeição e 28,6% exigiam que os alimentos fossem servidos da mesma forma. **Conclusão:** Os aspectos sensoriais podem estar intimamente relacionados às dificuldades alimentares e a identificação precoce das manifestações clínicas contribui não apenas para uma intervenção específica e correta, mas também pode garantir um desenvolvimento adequado no que concerne ao estado nutricional desse grupo. Avaliações específicas, por meio de questionários validados, aliadas à observação clínica, são indicadas para a melhor identificação das manifestações clínicas apresentadas.

**Palavras-chave:** Autismo, Transtornos Sensoriais, Desenvolvimento Infantil.

## Introduction

Autism spectrum disorder (ASD) is characterized by impairments in social interaction, language deficits, and behavioral alterations related to restricted and repetitive interests. More recently, the diagnostic criteria for ASD have expanded to encompass increased or decreased reactivity to sensory input, or an unusual interest in sensory aspects of the environment. Examples include visual fascination with lights or spinning objects, adverse responses to sounds, specific textures, smells, or excessive touching of objects, and apparent indifference to pain, heat, or cold (American Psychological Association, 2022).

Consistent with these diagnostic criteria, children with ASD often show alterations in sensory processing, with aversive behaviors or slowed perception in response to environmental stimuli and/or stimuli from their own body (proprioception), sleep disturbances, feeding difficulties, and impaired ability to self-regulate or adapt to new situations (Tomchek & Dunn, 2007). Although sensory processing alterations are not exclusive to this population, a substantial proportion of children with ASD (78-90%) present these difficulties (Leekam et al., 2007). Because these sensory processing differences affect functional performance in this population, they are currently considered one of the core characteristics of ASD (Hazen et al., 2014).

Children with ASD frequently present significant sensory alterations that contribute to impairments in the performance of everyday activities, self-care, and social interaction (Chen et al., 2024). In this context, assessing sensory aspects in individuals with ASD assists the understanding of their reactions to specific stimuli and supports the development of strategies that can contribute effectively to their development (Watkyns et al., 2024).

One activity that may be affected by atypical sensory processing is feeding. Regarding feeding difficulties, this is understood as an umbrella term that encompasses multiple related characteristics, such as decreased or absent appetite, food refusal, fear of or disinterest in food, tantrums and rigidity at the table, distractibility, agitation, and maternal dissatisfaction (Kerzner et al., 2015).

In this sense, it is important to understand that the development of feeding results from the complex interaction between the nervous system, multiple physiological systems, and the environment (Rogers & Arvedson, 2005). Eating involves exposure to a complex sensory experience, with a varied set of stimuli: the appearance, odor, texture, consistency, and taste of foods, in addition to sounds (Nadon et al., 2011).

Moreover, the Diagnostic and Statistical Manual of Mental Disorders, 5th Edition, Text Revision (DSM-5-TR) (American Psychological Association, 2022) highlights the importance of differential diagnosis, such as gastrointestinal diseases, allergies, and food intolerance, which may interfere with a child's feeding process. Gastrointestinal symptoms have been increasingly described in patients with ASD, and reviews suggest that over 70% of these patients have at least one gastrointestinal symptom (Holingue et al., 2018; Leader et al., 2022). Kerwin et al. (2005) identified, in a group of children with ASD, symptoms such as abdominal pain, constipation, and diarrhea associated with feeding problems (Kerwin et al., 2005).

Children with alterations in sensory modulation, that is, in the neurological process by which the central nervous system regulates the intensity of responses to sensory stimuli from the environment and from their own body, may retain a "sensory memory" of esophagitis, reflux, or discomfort even after the organic problem has been resolved, because of the strong association between eating and the sensation of pain or discomfort.

These children reject food because they continue to believe that oral intake will result in discomfort. Thus, when these children receive aversive gastrointestinal stimuli, they may misinterpret hunger and satiety signals, anticipating that the physiological messages indicate that significant discomfort will occur (Morris & Dunn, 2000).

Unlike food selectivity in neurotypical children, which occurs around age three and, in most cases, resolves without intervention, children with ASD tend to maintain or worsen their feeding difficulties over time in the absence of appropriate treatment (Taylor & Emmett, 2019). A study of U.S. children aged 0 to 18 years estimated that children with ASD are five times more likely to present feeding problems compared with children without autism (Sharp et al., 2013).

A recent systematic review analyzed eight studies investigating the relationship between feeding difficulties and sensory alterations in individuals with ASD aged 1 to 18 years. Seven of these studies (87.5%) identified a positive correlation between sensory alterations and feeding difficulties, with sensory and taste hypersensitivity as the most prevalent factor (reported in six studies). Greater oral sensitivity was particularly highlighted, associated with preferences for specific textures and flavors. In addition, tactile, olfactory, and gustatory sensitivity also showed a direct impact on food acceptance (Page et al., 2022).

In this regard, despite the heterogeneity of sensory characteristics, factor analyses by Tomchek et al. (2014, 2015) identified features that characterize the primary sensory behaviors observed in children with ASD, including sensitivity to taste and smell. This sensory alteration may lead to restriction and acceptance of certain flavors, selection of foods based on texture and temperature, and avoidance of flavors and smells typical of childhood foods.

Assessing sensory factors in relation to feeding difficulties is essential because alterations in sensory modulation may directly influence food acceptance and refusal, affecting nutrition and quality of life. For example, children and adults with tactile, gustatory, and olfactory hyperresponsiveness may exhibit extreme food selectivity, whereas those with hyporesponsiveness may not adequately perceive flavors and textures, compromising adequate food intake (Chistol et al., 2018; Nadon et al., 2011).

Despite the growing attention to sensory processing, there remains a gap in the scientific literature systematically and comprehensively linking feeding difficulties to differences in sensory modulation. Studies integrating these factors are essential to develop more effective therapeutic strategies and to promote targeted, individualized interventions.

Thus, this study aims to identify and compare sensory processing and potential changes in eating behavior in patients with ASD with and without feeding difficulties.

## **Method**

This is a cross-sectional case-control study of 32 patients with ASD, with and without feeding difficulties, aged 4 to 11 years, conducted at Priorit Institute in Rio de Janeiro, a multidisciplinary outpatient clinic that provides transdisciplinary care for patients with ASD and other comorbidities. The study is conducted in two stages: the first involved collecting clinical data from the patients' medical records (age, age at diagnosis, and the presence and duration of nutrition and occupational therapy follow-ups), and the second consisted of interviews with the children's caregivers to collect data on feeding difficulties and sensory profile.

Feeding difficulties were investigated using the Brief Record of Eating Behavior in ASD (BREB-ASD) (Castro et al., 2019), an instrument used to assess atypical eating behaviors in children with ASD. This instrument examines aspects such as food selectivity, disruptive behaviors during meals, and sensory difficulties related to eating. It is a useful tool for health professionals and researchers seeking to understand and address eating patterns in children with ASD, supporting the development of strategies to improve food acceptance and dietary variety. At present, it is the only instrument translated and validated for Brazilian Portuguese to assess these specific domains in ASD. Patients who scored  $\geq 47$  on this questionnaire were classified as having feeding difficulties (CDA group), and the others were classified as without feeding difficulties (SDA group). Cases and controls were matched by sex and age.

The Sensory Profile 2 was administered to all patients in the sample (32 participants). The items in the Sensory Profile 2 questionnaire comprise a sensory systems section and behaviors associated with the individual's sensory processing, including behavioral patterns, socioemotional and attention responses, all related to sensory processing (Dunn, 2017).

Participants with other disorders or comorbidities, or who could not be assessed with the aforementioned questionnaire, were excluded.

Descriptive statistics were used (absolute and relative frequency tables). Comparisons between patients were performed using the *t*-test. Caregivers provided written informed consent (ICF). The study was approved by the Research Ethics Committee of the Federal Fluminense University (CAAE: 32458120500005243).

## **Results and Discussion**

### **Sample characteristics**

The total sample comprised 32 participants, with 16 patients in each group, matched by sex and age. Most patients were male (81.25%). Mean age was  $6.22 \pm 0.47$  years in the group with feeding difficulties (CDA) and  $6.31 \pm 0.48$  years in the group without feeding difficulties (SDA) ( $p = 0.796$ ). In the CDA group, only 31.1% received nutrition follow-up as a strategy to expand eating patterns, whereas no patient in the SDA group received this follow-up.

Eating involves being immersed in a setting with multiple sensory stimuli, many of which occur simultaneously. To perform this activity satisfactorily, individuals must process sensory information appropriately and respond successfully to environmental demands (Morris & Dunn, 2000). Accordingly, the results are presented alongside a discussion of sensory processing profiles, highlighting the relationship between sensory factors and eating behaviors.

### **Sensory and nutritional factors**

Analyses of sensory factors in this study showed significant differences between groups for overall ( $p = 0.050$ ), visual ( $p = 0.059$ ), and oral ( $p = 0.000$ ) sensitivity. It is worth noting that, for the “food avoidance” profile, nine participants were classified as “more than others”, indicating a high frequency of this behavior during meals. In addition, socioemotional factors affected twice as many patients in the CDA group compared with the SDA group.

Sensory modulation problems, expressed as hyperresponsiveness and/or hyporesponsiveness, are the most frequent in the ASD population (Watling et al., 2001). Oral hyperresponsiveness is more common in children with ASD than in children with typical development (Watling et al., 2001). This condition, also referred to as oral defensiveness, involves avoiding specific food characteristics (texture, consistency, temperature) and showing irritation or discomfort with activities involving the mouth more generally (e.g., drinking through a straw, toothbrushing, and taking medications). Avoidance patterns are individual-specific: some children avoid soft foods, whereas others may avoid foods with rough textures.

Chistol et al. (2018) compared children aged 3 to 11 years with autism and with typical development and found a predominance of altered oral sensitivity in the autism group, based on the Sensory Profile 2. Smith et al. (2005) reported an association between tactile defensiveness and food selectivity in children with ASD. They noted that children with tactile defensiveness may be less likely to explore foods with their hands, and others may have difficulty with the feel of utensils, the proximity of other children, or routine hygiene after a meal. Similarly, findings have indicated that children with ASD and altered sensitivity to taste and/or smell also experience difficulties during meals (Nadon et al., 2011).

The avoidance pattern corresponds to children who commonly withdraw from situations in which they are exposed to stimuli they cannot modulate adequately. Seeking routine characterizes this sensory profile because of the predictability and familiarity of the stimuli involved in a given activity (Dunn, 2017). When applied to eating, this perspective broadens the understanding of a feature common in ASD: restricted and repetitive patterns of behaviors, interests, and activities (American Psychological Association, 2022).

This relationship between an avoidance profile and the search for predictability may help explain the food selectivity often observed in ASD. Children with this pattern tend to prefer foods with familiar textures, flavors, and colors, avoiding novelty or variation in food presentation. According to Dunn (2017), this selectivity may be directly related to sensory modulation difficulties, making exposure to new foods a significant challenge. Therefore, understanding the influence of restricted and repetitive patterns on eating behaviors supports the development of more effective strategies to promote a more varied and balanced diet.

A study comparing children aged 16 to 36 months with ASD and children without ASD showed a higher frequency of sensory seeking in the ASD group (Niedźwiecka et al., 2020), consistent with the present findings, in which participants with ASD tended to actively self-regulate by avoiding and escaping sensations and by controlling sensory input.

Oral defensiveness and food selectivity in patients with ASD may lead to up to twice the level of food refusal in this population and significantly lower consumption of fruits and vegetables compared with controls (Chistol et al., 2018). This pattern may be associated with sensory hyperresponsiveness, commonly observed in individuals with ASD, which can increase susceptibility to discomfort in response to specific food characteristics, such as texture, temperature, and taste. In a group of participants with food refusal, with and without ASD, greater oral and tactile sensitivity and behavioral rigidity related to feeding difficulties were also observed in the ASD group (Hubbard et al., 2014). Thus, children who are hyperresponsive to taste, smell, appearance, or texture may experience overload, become irritable, or leave the table during meals (Page et al., 2022). These feeding difficulties not only affect nutrition and growth but can also affect family and social interactions, because meals are key opportunities for social engagement and learning. Therefore, understanding the underlying mechanisms of food selectivity in ASD is essential for the development of effective interventions that promote a more varied diet and reduce the negative impact of these sensitivities on the child's well-being.

In this study, altered oral sensitivity was observed in the CDA group compared with the SDA group ( $p = 0.050$ ).

### **Influence of the environment and family management**

Additional observations related to the BREB-ASD responses corroborated the literature, showing that caregivers identified their children's preferred foods and limited the offering of new options, thereby minimizing potential disruptive behaviors in this context. At the same time, difficulty managing food refusal and introducing new foods in a careful and responsive manner may lead to more passive behaviors in this setting. Additionally, an indulgent caregiver profile during meals may result in difficulty maintaining consistency in offering new foods and setting limits, with caregivers offering only the foods the child wants to eat (Kerzner et al., 2015). Some mealtime behaviors may be related not only to feeding difficulties but also to family management during meals.

It is understood that even children in the SDA group may show resistance to remaining at the table. This finding indicates that some behaviors may not be strictly related to feeding difficulties but rather to immaturity in the neurological process of vestibular system modulation. This scenario may lead to restlessness while seated or frequent standing up, as reported by Nadon et al. (2011).

Consistent with this information, children with altered vestibular processing, including both hyperresponsiveness to movement and gravitational insecurity, showed a significant relationship with food refusal (Johnson et al., 2014).

Difficulty remaining at the table may often be related to discomfort with the visual aspect of food. Visual and olfactory stimuli are sensory inputs that reach the child first and, depending on how these inputs are processed, may trigger unwillingness and rejection of tasting food. Furthermore, limited preparation and organization of the mealtime environment, such as not minimizing distractors (electronic devices and toys) and not preparing the child for the meal in advance, may increase psychomotor agitation, raise the child's level of alertness, and, consequently, increase difficulty remaining at the table until finishing the meal.

Children with ASD may have difficulties in executive functioning, such as anticipating tasks and schedules and even understanding the function and importance of eating (Czermainski et al., 2014). Therefore, organizing the environment and reducing sensory stimuli during meals are important factors in facilitating eating behaviors in children with ASD, given difficulties managing discriminative stimuli and filtering relevant information.

With respect to food refusal in patients with ASD in the same age range, the literature describes this behavior and confirms a lower variety of foods consumed by this group (Schreck & Williams, 2006). The limited variety of foods consumed by these patients may worsen nutritional status and overall quality of life, because some children with ASD have extremely selective diets with specific nutritional deficiencies (Page et al., 2022).

Children in the CDA group persisted in consuming a limited variety of foods for a given period because of a restricted menu, making eating patterns cyclical, not always for identifiable reasons. In fact, atypical eating patterns have been considered a risk factor for abnormalities in weight and nutritional intake in patients with ASD (Liu et al., 2016).

In this study, caregiver reports also indicated low consumption of food groups such as legumes, leafy greens, and fruits. These data were reinforced by Sharp et al. (2018), who found that 67% of their sample of children with ASD had a diet that did not include vegetables and that 27% rejected all fruits.

Regarding selection of food groups, acceptance was directly influenced by food texture and consistency. In this study, 50% and 21.4% of patients in the CDA group, almost always and frequently, respectively, preferred dry and crunchy foods. A study on food choices in children with tactile defensiveness also confirmed this relationship, showing that the sensory characteristics of foods constitute a clear barrier to including these items in the diets of children with oral defensiveness, reflecting pronounced aversion to food texture and consistency, smell, and temperature (Smith et al., 2005).

In this study, participants in the CDA group almost always (57.1%) preferred the same menu at each meal, whereas no participant in the SDA group reported this behavior at the "almost always" frequency. In the CDA group, 57.1% almost always required foods to be prepared in a specific way (same consistency and texture, and shape), and 28.6% almost always required foods to be served in the same way.

For children with ASD, always adopting the same menu is a way to ensure the same sensations and greater predictability of the sensory inputs to which they will be exposed.

These children restrict themselves to foods that feel safe and comforting, whose sensory characteristics they already recognize, and therefore tend to refuse any novel stimulus during meals. Sensory preferences interfere with and influence food choices and what will be accepted on the plate (Morris & Dunn, 2000). However, this comfort zone may inhibit advances in food variety and lead to nutritional consequences over the child's development.

Patients with ASD show greater demands around eating, difficulty eating the same meal as the family, refusal to accept foods that touch on the plate, and aversion to certain tastes and textures (Smith et al., 2005). Often, this rigidity extends not only to foods but also to how they are served and even how they are prepared. Refusals based on color, brand, and shape, for instance, may not be related to sensory processing but to the need for consistency that characterizes the behavior of many children with ASD. The arrangement of foods on the plate (for example, mixed or touching) may hinder acceptance, reflecting both sensory factors, because of changes in taste and consistency, and cognitive rigidity, with a preference for always following the same pattern (Hubbard et al., 2014).

A recent review investigated occupational-therapeutic interventions in children with ASD and food selectivity, indicating increasing demand for the inclusion of occupational therapists in multidisciplinary teams and confirming that these professionals are highly relevant in the care of this population, developing their work through sensory-behavioral and family-centered interventions (Reche-Olmedo et al., 2021). Thus, occupational therapists' contributions to addressing food selectivity associated with sensory dysfunctions in children with ASD are essential.

Additionally, a qualitative case study of a child with ASD and food selectivity showed an important association between sensory factors and the child's eating patterns, as well as the need for clinical reasoning that involves occupational-therapeutic intervention based on Ayres Sensory Integration®, so that sensory foundations mature and integrate, producing positive effects on eating behaviors (Oliveira & Souza, 2022).

Early identification of symptoms that lead to these difficulties contributes not only to specific and appropriate intervention but may also support adequate development regarding the nutritional status of this population. Corroborating this need, a study on mothers' representations of their children's food selectivity in ASD showed that, despite family suspicions of developmental delay, referral for specialized professional evaluation occurred only after the age of two (Uchoa et al., 2024).

Specific assessments using validated questionnaires, combined with clinical observation, are recommended for greater accuracy in identifying the symptoms presented. Moreover, intervention by trained multidisciplinary teams is necessary to ensure patient safety across different domains, including sensory, behavioral, nutritional, and affective factors.

## **Final Considerations**

The results of this study show a direct relationship between sensory factors and food selectivity in children with ASD, highlighting how oral, visual, and tactile sensitivity significantly influences food acceptance. The predominance of avoidance behaviors and the need for predictability in eating reinforce the tendency of these children to restrict their diets to familiar foods, which may compromise nutrition and development.

In addition to sensory factors, the environment and the family management play a key role in these children's eating behaviors. Limited offering of new foods, often motivated by attempts to avoid episodes of stress and refusal, may reinforce selective patterns and hinder the expansion of eating patterns. Therefore, caregiver awareness and guidance on more effective strategies for introducing new foods are essential to minimize the negative impacts of food difficulties.

Behavioral rigidity, often observed in children with ASD, was also reflected in eating behaviors, with a strong preference for specific textures and rejection of changes in food preparation and presentation. This restrictive eating pattern may lead to nutritional deficits and difficulties in social participation during meals, making early and multidisciplinary intervention essential to support a more varied and balanced diet.

Finally, the findings reinforce the importance of therapeutic approaches that consider sensory, behavioral, and environmental factors. The involvement of occupational therapists, nutritionists, and other specialized professionals can contribute significantly to the development of strategies tailored to these children's individual needs. In this way, promoting caregiver awareness and improving clinical interventions are essential steps to improve quality of life and eating-related well-being in the ASD population.

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### Author's Contributions

Thais Schultz was responsible for study design, data collection, manuscript writing, data interpretation and analysis, manuscript review, responsibility for the accuracy and integrity of all aspects of the research. Kamila Castro was responsible for study design, data interpretation and analysis, manuscript review, responsibility for the accuracy and integrity of all aspects of the research. Viviane de Oliveira Freitas Lione was responsible for study design, data interpretation and analysis, manuscript review, responsibility for the accuracy and integrity of all aspects of the research. All authors approved the final version of the text.

### Data Availability

The data supporting the results of this study are available from the corresponding author upon request.

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