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ORIGINAL ARTICLE

SENSORY THRESHOLD EVALUATION FOR SWEET TASTE IN CHILDHOOD AUTISM

AVALIAÇÃO DO LIMIAR SENSORIAL PARA GOSTO DOCE NO AUTISMO INFANTIL

EVALUACIÓN DEL UMBRAL SENSORIAL PARA EL SABOR DULCE EN EL AUTISMO INFANTIL

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ABSTRACT

Objective: to evaluate the sweet taste sensitivity of children with Autistic Spectrum Disorder. Method: this is a quantitative, descriptive and cross-sectional study with children diagnosed and undiagnosed with the disorder and their families. The degree of autism was assessed using the Childhood Autism Rating Scale to select children with level of autism compatible with the tests. The whole mouth threshold index test for sweet taste with different sucrose concentrations was performed in all groups. The sensory preference test was performed in the group of children with ASD. Analyzes were performed on the Statistical Package for the Social Sciences. Results: it was observed that children without Disorder presented an average sweet taste threshold of 0.96 g / L sucrose, lower threshold than children with ASD (5.42 g / L sucrose); mothers and siblings of children with the disorder had a mean taste threshold of 1.23 g / l and 1.35 g / l of sucrose, respectively. In the sensory preference test, children with disorder prefer samples with sweeter tastes. Conclusion: it was noticed that children with Disorder have alterations in taste sensitivity for sweets, requiring higher amounts of sucrose to identify this taste. ***Descriptors*:** Autistic Disorder; Taste Perception; Sensory Thresholds; Chronic Disease; Sucrose; Feeding Behavior.

RESUMO

Objetivo*:** avaliar a sensibilidade gustativa ao doce de crianças com Transtorno do Espectro Autista. ***Método*:** trata-se de estudo quantitativo, descritivo e transversal, com crianças diagnosticadas e sem diagnóstico com Transtorno e familiares. Avaliou-se o grau de autismo por meio da *Childhood Autism Rating Scale* para selecionar crianças com nível de autismo compatível com a realização dos testes. Executou-se o teste de índice limiar de boca toda para o gosto doce com diferentes concentrações de sacarose em todos os grupos. Realizou-se o teste de preferência sensorial no grupo de crianças com TEA. Executaram-se as análises no *Statistical Package for the Social Sciences*. ***Resultados*:** observou-se que as crianças sem Transtorno apresentam limiar gustativo médio para o gosto doce de 0,96 g/L de sacarose, limiar inferior ao de crianças com TEA (5,42 g/L de sacarose); as mães e irmãos das crianças com Transtorno apresentaram limiar gustativo médio de 1,23 g/L e 1,35g/L de sacarose, respectivamente. Averiguou-se, no teste de preferência sensorial, que crianças com Transtorno preferem amostras com gostos mais doces. ***Conclusão: percebeu-se que crianças com Transtorno possuem alteração na sensibilidade gustativa para o doce, necessitando de maiores quantidades de sacarose para identificar este gosto. ***Descritores*:** Autismo Infantil; Percepção Gustativa; Limiar Sensorial; Doenças Crônicas; Sacarose; Comportamento Alimentar.

RESUMEN

Objetivo: evaluar la sensibilidad al sabor dulce de los niños con Trastorno del Espectro Autista. ***Método:*** se trata de un estudio cuantitativo, descriptivo y transversal con niños diagnosticados y no diagnosticados con el Trastorno y sus familias. El grado de autismo se evaluó utilizando la Escala de Calificación de Autismo Infantil para seleccionar niños con un nivel de autismo compatible con las pruebas. La prueba de índice de umbral de boca completa para el sabor dulce con diferentes concentraciones de sacarosa se realizó en todos los grupos. La prueba de preferencia sensorial se realizó en el grupo de niños con TEA. Se realizaron análisis en el Paquete Estadístico para las Ciencias Sociales. ***Resultados:*** se observó que los niños sin Trastorno presentaron un umbral promedio de sabor dulce de 0.96 g/l de sacarosa, umbral más bajo que los niños con TEA (5.42 g/l de sacarosa); las madres y los hermanos de niños con el Trastorno tenían un umbral de sabor medio de 1,23 g/l y 1,35 g/l de sacarosa, respectivamente. En la prueba de preferencia sensorial, los niños con Trastorno prefieren muestras con sabores más dulces. *Conclusión:* se notó que los niños con Trastorno tienen alteraciones en la sensibilidad al sabor de los dulces, lo que requiere mayores cantidades de sacarosa para identificar este sabor. ***Descriptores***: Trastorno Autístico; Percepción del Gusto; Umbral Sensorial; Enfermedad Crónica; Sacarosa; Conducta Alimentaria.

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INTRODUCTION

Autistic Spectrum Disorder (ASD) is understood to be a neurological disorder characterized by behavioral heterogeneity, affective dullness and stereotyped behaviors.[1] Although the causes remain unknown, there is a multifactorial correlation associated with ASD involving both environmental, physiological and chemical factors, from conception to birth, as well as genetic factors.[2-4] Approximately 50% of the causes of ASD are estimated to be inherited, [3] which demonstrates the importance of genetic factors in the pathogenesis of the disease.[4]

There is a considerable increase in the prevalence of ASD in recent years. An estimated prevalence of 16.8 per 1,000 in children aged up to eight years in the United States.[5] ASD symptomatology is understood as a group of psychiatric neurodevelopmental disorders characterized by deficits in social interactions, interpersonal communication, repetitive and stereotyped behaviors that may be associated with intellectual disabilities.[6] Often also associated with this disorder are sensory processing difficulties, which include excessive or insufficient sensitivity to sensory stimuli in the environment, [7] and these sensory changes may lead to changes in eating behavior.

Studies on eating behavior of children with ASD have been gaining ground in public health research and programs, as food choices are important for children's quality of life.[7-9]

It is understood that food selectivity seems to be the most frequent problem observed in the eating behavior of this public. Children with autistic spectrum disorder are reported to have atypical sensory characteristics, refuse more food, and eat less vegetables when compared to children without ASD,[7] characteristics of selective eating behavior. High child food selectivity is associated with mealtime behavioral problems, which can have a negative impact on family routines and become a significant stressor.[8-9]

It is noteworthy that sensory processing in children with ASD seems to be an important factor for food selectivity.[10] In this population, the presence of olfactory and taste dysfunctions is evident, but little has been reported about the sensory detection threshold.[11]

Several methods are used to evaluate the taste sensitivity, among them, the electrogustometry, [12] the taste strip test[13] and the whole mouth test.[14] Through stimulation of the whole mouth, broad contact of the stimulus is allowed with the taste buds present on the taste buds located on the surface of the tongue and on the mucosa of the palate and to a lesser extent in areas of the throat.[14] It is considered the most physiologically appropriate and least tiring mouth test that can be used for all primary tastes.[14]

The diet of children with ASD is shown to be a key factor for worsening symptoms, [15] as children with autism have limited food selectivity and diets due to smell, taste or other food characteristics.[15]

Therefore, eating routines and patterns of food consumption are observed, with consequent deficiency or excess of some foods, therefore, a better understanding of taste sensitivity to basic tastes can help in prevention of chronic diseases and behavioral disorders and promotion of oral health.[16]

OBJECTIVE

- To evaluate the sweet taste sensitivity of children with Autistic Spectrum Disorder.

METHOD

This is a quantitative, descriptive and cross-sectional study, conducted in the first half of 2017, in the municipality of Jequié, in the interior of Bahia, Brazil. The sample consisted of children diagnosed with ASD, their relatives (mothers and siblings) and children without diagnosis of ASD (control group).

Participants were recruited from the Multiprofessional Support Center for People with Special Needs (CAMPE), the Pedagogical Care Center (PCC) and two schools of the municipal public network. Studies were conducted in both centers with children diagnosed with ASD and in municipal schools studies with children without ASD.

Information was collected on the number of children diagnosed with ASD treated at the CAMPE and PCC centers and the contact of families. Children aged from six to 12 years old were selected by the professionals of the centers, as they observed a better social life in them.

Families were contacted to clarify the research and to verify the interest in participating in the study. For data collection with families who agreed to participate, visits to their homes were scheduled. Data collection in the homes of children with ASD was also allowed to collect information from family members. In addition, through the family environment, a sense of security for children is usually transmitted, thus minimizing possible difficulties in data collection, especially related to the affective dullness common in children with ASD.

The first test for children with ASD is reported to be the Childhood Autism Rating Scale (CARS-BR)[17] to select children with mild to moderate degree of autism. The CARS-BR scale was applied, translated, validated and appropriate to the Brazilian population by a psychologist. This scale presents the distribution of the degree of autism

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in four levels (1 to 4), with level 1 described as no evidence of the disorder; level 2 indicates mild traces of autism; At level 3, the traits are defined as moderate and, finally, level 4 brings severe impairment.[17]

Thus, the test population of this study was formed, which was composed of 14 families with children between six and 12 years old, diagnosed with mild to moderate ASD, and among the families, 15 children with ASD participated, besides 14 mothers and nine brothers without diagnosis of ASD.

In the researched institutions, 37 children diagnosed with ASD were found. However, 22 children were excluded, as 12 were classified at level 4 of autism by the CARS-BR scale, which indicates children with a high degree of impairment, which would make it impossible to perform the research activities. Ten children who were older than the established age for the study were also excluded. Thus, the sample consisted of 15 participants with ASD. The purpose and methodology of the study were informed to the parents or legal guardians of the children through the Free and Informed Consent Form, and all who agreed to participate signed the Free and Informed Consent Term (FICT).

Some difficulties were found for the formation of the sample size of children with ASD, including: family resistance to participate in the study to avoid possible stress situations for the child due to affective dullness; The assessment of the taste threshold required understanding and choice skills and, therefore, the age range proposed by the professionals who worked directly with the institutionalized children was respected. In addition, many children were assessed by the CARS scale with levels of autistic spectrum disorder incompatible with the feasibility of the tests performed in this study. It is noted that some parents of children with ASD were unable to participate in the tests due to long working hours, including in other cities, or even not living with the child, which also contributed to the reduced number of participants in this group.

The group of children without diagnosis of ASD was composed of 15 children. Inclusion criteria were children aged between 6 and 12 years old who had no diagnosis of ASD and had a permanent residence in Jequié-BA, The children who agreed to participate had their Informed Consent Form duly signed by their parents or legal guardian and were informed about the methodology and purpose of the Consent Term research.

Exclusion criteria for all groups were people with mental inability to answer the questionnaires, as well as people who presented with cold, fever, diabetics, alcoholics, users of antidepressant drugs, people with dental prosthesis or with any oral cavity complication. Also excluded were individuals unable to understand the commands and present a conscious response during the experiment.

Diabetic individuals, alcoholics, and users of antidepressant medications were excluded, as impairment in taste sensitivity is evident in these groups.[18-20]

A structured questionnaire was applied to the families of children with ASD and to families of children without diagnosis of ASD who participated in the research to characterize the group, and this questionnaire collected information such as age, gender and skin color.

The threshold index test was performed according to the International Organization for Standartization methodology.[18-9] All participants were submitted to the sweet taste perception limit sensory analysis test by means of the sensory detection threshold or Threshold (group without diagnosis of ASD, group with ASD and their relatives).

A series of five 3-AFC (Alternative Forced Choice) sensory sections were performed. In each series, the participants were presented with three samples, two samples were water and one was sucrose solution. The participant was asked to indicate which of the three samples he / she judged different, and during the series the sucrose concentrations in the solution progressively increased.

It is described that the ingestion of the solutions was not necessary because the participants were instructed to pass the solutions throughout the mouth and then discard them. Concentrations of sucrose-containing solutes were prepared with increasing concentration intensity between series, 0.5; 1.0; 2.0; 4.0; 8.0 g / l sucrose in water as described in the literature.[18,19]

Solutions were served to participants in an individual room without noise and distraction at random in color-coded plastic cups at room temperature, accompanied by test response form, mouthwash and disposal container. The participant was asked which sample was different and the researcher noted in the form which color was fixed in the sample, which was flagged as different by the participant in each section. For this, the form described in figure 1.

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Name: _____

We are serving sweet taste solutions. Please try the samples from left to right and tell which sample is different. Pass the solutions through your mouth and then discard it. Remember to rinse your mouth with water between samples.

First section

Which sample is different for the sweet attribute?

Color:_____

Figure 1. Threshold Index Test score sheet. Jequié, (BA), Brazil, 2017.

Sensitivity test results were analyzed from each participant's threshold, which corresponds to the geometric mean of the highest undetected concentration and the next concentration. For this purpose, data were tabulated followed by the application of equation 1 to determine the threshold of each individual evaluated.

Equation **1**

$$Ai = \log (Li) = [\log (C0) + \log (C+)] / 2$$

It is explained that considering that C0 is the highest concentration not detected / recognized by the taster and C +, the lowest concentration detected / recognized by a particular taster Ai, then, for this taster, the individual threshold was given by the equation.

After determining the individual thresholds of each participant, a second equation was applied to obtain the threshold of the three groups, and the geometric mean Li values were calculated.

Equation **2**

$$L_i = 10^{Ai}$$

Equation **3**

$$B = \frac{1}{n} + \sum_{\log(Li)}$$

To compare the mean threshold index of the groups - typically developing children and children with ASD; family and children with ASD - initially, the Kolmogorov-Smirnov test to verify data normality, followed by the Mann-Whitney unpaired means test to compare two variables, numerical abnormal distribution, adopting a significance level of 5% ($p < 0.05$). Statistical Package for Social Sciences (SPSS) version 21.0 was used for statistical analysis of the results.

A preference ordering test was also performed with the group of children with ASD.[21] Five samples of cashew juice were prepared in increasing order of intensity of the sweet attribute (0.5; 1.0; 2; 0, 4.0, and 8.0 g sucrose per ml cashew juice). Cashew juice samples were used: cashew pulp (30%), mineral water and sucrose, and the cashew pulp concentrations in the five samples were the same, and the only variation between samples was sucrose concentration. The same sucrose concentrations used in the threshold index test were used.

The five samples were served to the participant at the same time, in white-light booths, in five-color coded plastic cups containing 30 mL of cashew juice at 15 ° C accompanied by mouthwash and answer sheet.

The participant was asked, in front of the five samples, to indicate their favorite, with the first indication being for the most preferred sample (number 1) and the last indication was for the least preferred (number 5). In addition, the participant was asked to consume water between assessments, and the researcher noted in the chart (Figure 2) the taster's choices.

You are receiving five samples of cashew juice. Please order the samples according to your preference by placing number 5 for the least preferred sample and number 1 for the most preferred. Intake water between ratings.

Sample color	Preference 1 to 5

Figure 2. Preference Test Evaluation Sheet.

Statistical analysis of the order preference sensory test by the Friedman test at 5% probability to verify whether or not, by the affective opinion of the children, a significant preference between samples.[21]

The preference test was applied only to the group of children with ASD. The necessity of applying this test was based on the group's difficulty in performing the threshold index test. Therefore, it was decided to use another sensory test to evaluate the choice regarding the intensity of sweet taste. The sensory test contributed to the information collected in the threshold index test on sweet taste choices in children with ASD.

Prepared and standardized, at the Food Technology Laboratory of the Southwest Bahia State University, with mineral water and sucrose, the threshold index test samples, and cashew

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pulp, mineral water and sucrose, the test samples preferably by sorting, which were quantified using the SHIMA-DZU AUW220D analytical balance and then placed in plastic containers at room temperature.

This research was conducted according to the guidelines and norms of Resolution 466 of December 12, 2012, of the Ministry of Health, which regulates research conducted with human beings. The research was submitted to the Research Ethics Committee of the State University of Southwest Bahia (CEP / UESB), approving it with CAAE number 51432415.1.0000.0055.

RESULTS

Children with Autistic Spectrum Disorder (ASD) were selected for the research by applying the Childhood Autism Rating Scale (CARS-BR) test, 17 including only children who were at levels 2 and 3 of CARS-BR (Table 1).

Table 1. Childhood Autism Rating Scale (CARS-BR) test score applied to children with ASD. Jequié (BA), Brazil, 2017.

CARS-BR score	N	%	Level of autism
From 30 to 36	15	40.54	2 to 3
Over 36	12	32.44	4
From 30 to 36 (over 12 years old)	10	8.11	2 to 3
Over 36 (over 12 years old)	07	18.91	4
Total	44	100	

The CARS test was used to ensure that the children with selected ASD had the necessary development to respond to the threshold index test. Thus, 15 children who had the autism degree of mild (level 2 of the CARS scale) to moderate (level 3 of the CARS scale) participated in the research. Twelve children were excluded from the study because they had level 4 on the CARS scale, considering that, at this level of autism, children could present difficulties in performing the taste tests.

Some characteristics of the group of children without ASD and children with ASD were evaluated and the results are shown in table 2.

Table 2. Sociodemographic characteristics of children without autism spectrum disorder (ASD) and children with ASD. Jequié (BA), Brazil, 2017.

Sociodemographic characteristics		Groups	
		Control (without ASD)	Children with ASD
Sex	Female	53.32%	13.33%
	Male	46.68%	86.67%
Age (average ± standard deviation)		9.46 ± 1.35	9.93 ± 1.35
Skin color	White	20.00%	26.69%
	Black	26.71%	26.71%
	Brown	53.29%	46.60%

There was homogeneity for the age and skin color attributes between the groups of children without ASD and children with ASD by Mann-Whitney for unpaired samples at 5% probability; However, there is no homogeneity for the sex attribute, as in the group of children with ASD, 86.67% are male, while in the group without children, there is homogeneity between genders.

In the taste sensitivity test, it was found that the group of children without diagnosis of ASD presented a threshold index of 0.96 ± 0.71 g / L sucrose, while the group of children with ASD had 5.42 ± 2.31 g / L sucrose (Figure 3). There was a statistically significant difference at 5% probability between the group without diagnosis of ASD and the group of children with ASD for the sweet taste threshold index (ρ = 0.009). These results show that the group of children without diagnosis of ASD has less taste sensitivity to sweet taste when compared to the group of children with ASD, that is: the group of children with ASD required a higher amount of sucrose. to identify sweet taste in samples.

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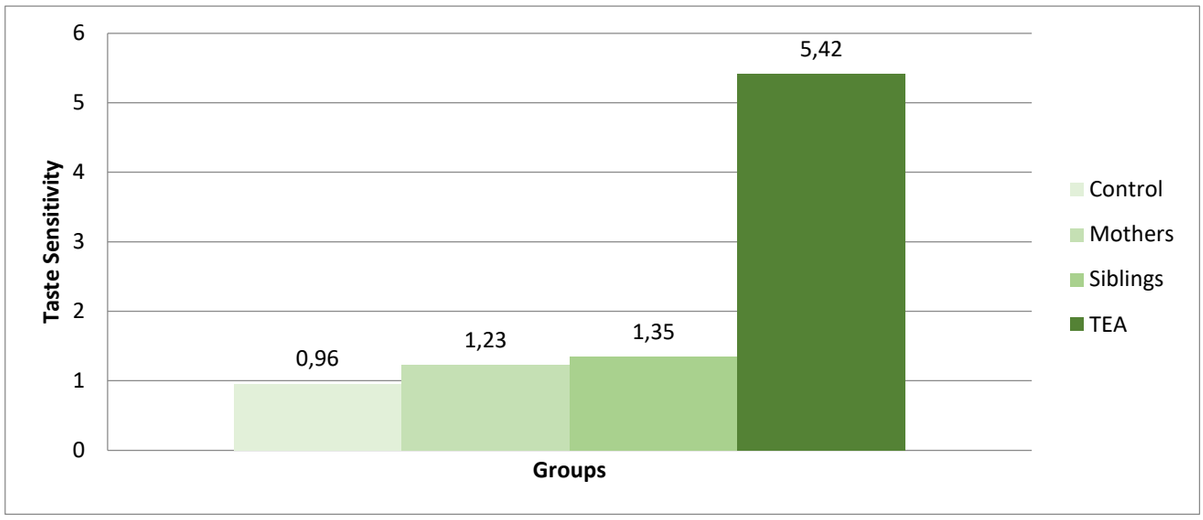

Figure 3. Taste sensitivity of children without Autistic Spectrum Disorder (control), children with ASD and family members of children with ASD (mothers and siblings). Jequié (BA), Brazil, 2017.

When assessing the taste sensitivity of family members of children with ASD, the average detection thresholds for sweet taste were identified, and the mothers presented an average threshold of sweet taste detection of 1.23 ± 0.13 g / L of sucrose, while siblings had a mean threshold of 1.35 g / L ± 0.09 sucrose (Figure 3). When comparing the mean thresholds for sweet taste, between the groups of children with ASD and mothers and children with ASD and siblings, a statistically significant difference at 5% probability between them ($p < 0.05$).

In the ordination preference test, children with ASD found it difficult to perform the test, and only 66.77% (n = 10) were able to perform the test coherently, and there were situations in which children with ASD did not accept to taste the samples because they do not drink juice, only water.

It was found by the Friedman test at 5% probability that children with ASD prefer juice with 8g / L sucrose when compared to juice of 2g / L, 1g / L and 0.5g / L. , cashew juices prepared with higher sucrose concentration were preferred by children with ASD.

The preference of children with ASD for sweeter juice may be associated with loss of taste sensitivity, as greater amounts of sucrose are needed for sweet taste to be detected.

DISCUSSION

Male predominance is known to be common in research involving people with ASD, [22] as this disorder affects more men than women.

It can be seen that there is an indication of a higher preponderance of ASD in men than in women, with approximately four men for one woman.[23] The analysis indicates an irregular upward trend in gender indices, confirming a growing representation of men with ASD. Explanations of the difference in the number of people diagnosed with ASD are presented in various ways, such as the hormonal prenatal environment, which may be related to genetic effects.[24] Prenatal testosterone level theory predicts cognitive behavioral characteristics related to autism, [25] among others.

It is added, however, that the difference between the sexes observed in the study does not influence the taste threshold values of the researched population, since, when performing the statistical analysis of comparison of unpaired averages, the Mann-Whitney test at 5% probability, no statistically significant difference was observed in the mean threshold index values between men and women. A similar study reveals that no significant difference was found in the sweet attribute of the mean threshold index in a different sex population.[19]

The loss of taste sensitivity of children with ASD for sweet taste is highlighted when compared to the loss of taste sensitivity related to chronic diseases or inappropriate habits. In a study with adults with type 2 diabetes mellitus, the mean threshold index value for sucrose sweetness was 2.48 g / l.[18] In another study conducted with alcoholics under treatment, a mean threshold index value of 3.78 g / L sucrose[19] was found, and results in users of antidepressant drugs with a threshold index of 3.86 g / L sucrose.[20]

It may contribute, by decreasing and / or losing sensitivity to sweet taste, to increase the intake of processed carbohydrates, influencing the secretion of insulin, responsible for sugar homeostasis.[26] In addition, the consumption of sugar by people with ASD should be monitored, as it corresponds to a factor that stimulates the manifestation of the behaviors characteristic of ASD.[27]

The mean threshold values for mothers and siblings' sweet taste thresholds are close to those reported in the control group, [18-9] with an average of 1.39 g / L and 1.35 g / L, respectively.

It is warned that the preference for sweetened products can harm the health of people with ASD,

such as the development of chronic non-communicable diseases.[28] Studies show that people with ASD are more likely to develop diabetes mellitus; however, authors have failed to explain an association between disease.[29-30] A hypothesis for this incidence of diabetes in children with ASD can be related to high sugar consumption, considering the high index of taste threshold to identify sweet taste and preference for the sweetest products. Thus, early identification of sensory processing abnormalities in children with ASD and interventions in eating habits since childhood seem to be key points for the prevention of possible chronic diseases related to eating behavior.

CONCLUSION

Children with Autistic Spectrum Disorder were found to have a change in taste sensitivity to the candy, requiring greater amounts of sucrose to identify this taste, as children with ASD needed a sucrose concentration approximately 5.6 times higher than children without ASD to identify sweet taste in threshold index test.

These findings suggest that children with ASD have atypical oral sensory sensitivity and food selectivity, so they may benefit from working with a multidisciplinary team of specialists, including pediatrician, psychologist, speech therapist, occupational therapist and nutritionist, to improve feeding-related sensory experiences and increasing nutritional adequacy and diet variety.

It is important that treatment plans are individualized to each child's unique sensory characteristics and have direct observations about their children's sensory processing capacity, such as taste sensitivity tests, which may reveal the limitations of using a tool reported by the child. parents. Longitudinal studies are needed to further elucidate the nature of the relationship between sensory sensitivity and food selectivity in children with ASD and how it evolves over time.

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