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Sensory perception profiles in children with epilepsy: A prospective controlled study

Epilepsili çocuklarda duyusal algı profilleri: Prospektif kontrollü bir çalışma

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ABSTRACT

Aim: Epilepsy is a chronic neurological disorder that disrupts the functional organization of the developing brain, with consequences extending beyond recurrent seizures to cognitive and sensory processes. This study aims to elucidate the effects of epilepsy on sensory perception by comparing the sensory profiles of children with epilepsy to those of their typically developing peers.

Material and Methods: In this a prospective controlled study, the sample size was determined based on an a priori power analysis, and a total of 49 children aged 5-12 years (25 with epilepsy and 24 typically developing controls), selected using convenience sampling, were included in the study. Demographic and clinical data were collected from the participants, and sensory perception was evaluated using the validated Turkish version of the Sensory Processing Measure-Home Form. The scale comprises the domains of social participation, vision, hearing, touch, taste and smell, body awareness, balance and motion, and planning and ideas. Group differences were analyzed using appropriate statistical methods with adjustments for potential confounders.

Results: No significant differences were observed between children with epilepsy and healthy controls in total sensory processing scores ($p>0.05$). Deficits in taste and smell perception were significantly associated with an increased body mass index ($p=0.010$). Sensory profiles were found to be primarily influenced by clinical sub-components, including structural brain abnormalities, antiepileptic drug use, and seizure timing. These findings indicate a heterogeneous sensory structure shaped by specific clinical and metabolic determinants.

Conclusion: Sensory processing and perception in pediatric epilepsy are influenced by structural, metabolic, and clinical variables rather than the diagnosis alone. It is recommended that individualized strategies considering these parameters be adopted in clinical management.

Keywords: Antiepileptic drugs, children, epilepsy, perception, sensory

ÖZ

Amaç: Epilepsi, gelişmekte olan beynin işlevsel organizasyonunu bozan ve yalnızca tekrarlayan nöbetlerle sınırlı kalmayıp bilişsel ve duyusal süreçleri de etkileyen kronik bir nörolojik bozukluktur. Bu çalışma, epilepsili çocukların duyusal algı profillerini tipik gelişen akranlarıyla karşılaştırarak epilepsinin duyusal algı süreçleri üzerindeki etkisini ortaya koymayı amaçlamaktadır.

Gereç ve Yöntemler: Bu prospektif kontrollü çalışmada örneklem büyüklüğü ön güç analizine dayalı olarak belirlenmiş; 5-12 yaş aralığında, kolayda örnekleme yöntemiyle seçilen toplam 49 çocuk (25 epilepsi tanılı, 24 tipik gelişen kontrol) çalışmaya dahil edildi. Katılımcılardan demografik ve klinik veriler toplandı; duyusal algı, Duyusal İşleme Ölçeği-Ev Formu'nun Türkçe geçerli-güvenilir versiyonuyla değerlendirildi. Ölçek; sosyal katılım, görme, işitme, dokunma, tat-koku, vücut farkındalığı, denge-hareket ve planlama alanlarını içermektedir. Grup farkları, karıştırıcılar için düzeltilerek uygun istatistiksel yöntemlerle analiz edildi.

Bulgular: Epilepsili çocuklar ile kontroller arasında toplam duyusal işlemleme skorlarında anlamlı fark saptanmamıştır ($p>0.05$). Tat ve koku algısındaki zayıflık artmış vücut kitle indeksi ile ilişkili bulunmuştur ($p=0.010$). Duyusal profillerin; yapısal beyin farklılıkları, ilaç kullanımı ve nöbet zamanlaması gibi klinik alt bileşenlerden etkilendiği saptanmıştır. Bulgular, klinik faktörlere göre şekillenen heterojen bir duyusal yapıya işaret etmektedir.

Sonuç: Çocukluk çağı epilepsisinde duyusal işlemleme ve algı, tanıdan ziyade yapısal, metabolik ve klinik değişkenlerden etkilenmektedir. Klinik yönetimde bu parametreleri dikkate alan bireyselleştirilmiş stratejilerin benimsenmesi önerilmektedir.

Anahtar Kelimeler: Antiepileptik ilaçlar, çocuklar, epilepsi, algı, duyusal

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Highlights

- Overall sensory processing did not differ between children with epilepsy and typically developing peers; however, taste and smell perception was associated with body mass index.
- Structural brain abnormalities and seizure distribution play a decisive role in shaping sensory profiles in children with epilepsy.
- Detailed assessment of sensory profiles is essential for clinical follow-up and the planning of individualized management strategies.

INTRODUCTION

Epilepsy is a chronic disorder characterized by recurrent seizures, arising from abnormal and synchronized neuronal discharges, which have two causes: neuronal hyperactivity, neurotransmitter imbalances, and impairments in energy metabolism in the brain (1-3). Epileptic seizures disrupt the functional organization of the developing brain, leading to various functional limitations in motor coordination, cognitive functions, sensory processing, and social interaction (4,5). The involvement of sensory cortices such as the parietal, temporal, or occipital lobes in seizures may lead to disruptions in the central processing and perception of sensory information. This indicates that in children with epilepsy, effects are felt not only in the responses to stimuli but also in the perceptual components—such as recognition, discrimination, and interpretation of sensory stimuli (6-8).

Sensory perception is a neurodevelopmental process that enables the central nervous system to regulate and integrate a wide range of environmental inputs: visual, auditory, tactile, proprioceptive, vestibular, gustatory, and olfactory, thereby rendering them meaningful (9,10). Visual perception plays a central role in cognitive processes such as object recognition, spatial orientation, and motor planning; these processes are mediated by different neural networks, enabling the individual to interact harmoniously with their environment (11-14). Auditory perception is a determining factor in distinguishing environmental sounds, language development, and social communication, and its deficiencies may lead to limitations in language and communication skills (14,15). Tactile and proprioceptive perception contribute to the maintenance of body awareness, postural control, and motor coordination, whereas vestibular perception supports balance and spatial orientation processes. Deficiencies in these domains may adversely affect motor control and daily life activities (16,17). Gustatory and olfactory perception play a role in food choices, emotional memory, and the recognition of environmental stimuli, therefore, disruptions in these perceptual processes may negatively affect eating behaviors, mood, and social interaction (18-20).

The healthy functioning of these sensory perception processes is critically important for children's independence in daily life activities, harmony in social interactions, and cognitive development; however, neurological disorders such as epilepsy may impair the efficiency of these mechanisms, leading to various limitations. In children with epilepsy, this process can be affected by reductions in inhibitory circuits along with alterations in synaptic and cortical networks, resulting in behavioral problems in daily life, excessive or insufficient responses to sensory stimuli, and difficulties in adapting to social life (21-24). Therefore, identifying sensory perception impairments in children with epilepsy may contribute to creating a more holistic approach to co-occurring neurodevelopmental problems and the development of individualized intervention strategies. The aim of this study is to reveal the impact of epilepsy on sensory perception processes through a comparison of profiles of children with epilepsy and their typically developing peers.

MATERIAL and METHODS

Study Design

This study was designed as a prospective controlled study.

Sample Size Calculation

No study directly assessing sensory perception in the target population was identified in the literature. However, previous research indicates that sensory perception and sensory modulation are closely related constructs and may produce comparable outcomes. Therefore, a study assessing sensory modulation was used as a reference. In that study, a large effect size of d = 1.31 was reported between patient and control groups (25). Based on this effect size, the required sample size was calculated for an independent samples t test with 90 percent power and a two sided significance level of 5 percent. The analysis indicated that at least 14 participants per group were required. Assuming a potential dropout rate of 20 percent, the sample size was increased to 17 participants per group, resulting in a minimum total sample size of 34 participants. Sample size calculations were performed using G*Power version 3.1.9.7.

Patients

A total of 49 children aged 5-12 years were included in this study, comprising an epilepsy group (n=25) and a typically developing control group (n=24). The participants were recruited through convenience sampling based on their willingness to participate. Epilepsy diagnosis was established by a pediatric neurologist based on clinical evaluation and electroencephalography (EEG) confirmation, in accordance with ILAE criteria. Children were required to have had at least two unprovoked epileptic seizures to meet the diagnostic criteria. The inclusion criteria for children with epilepsy were being within the 5-12 age range and having a documented history of epileptic seizures. For the control group, eligibility required being in the same age range and including clinically healthy children with no neurological, developmental, sensory, or chronic medical conditions, as confirmed through parent-reported medical history and available health records. During the research process, children were excluded if they were found to have missing data or neuromuscular or neurodevelopmental disorders (e.g., cerebral palsy, hydrocephalus, autism spectrum disorder). Convenience sampling continued throughout the study period and involved recruiting children with epilepsy and typically developing peers who fulfilled the inclusion criteria.

Data Collection Process

The data collection process was carried out between February 2025 and July 2025 by the research team from the Department of Physiotherapy and Rehabilitation at Bolu Abant İzzet Baysal University. All assessments were conducted face-to-face in a quiet, distraction-free room within the university's clinical practice area, with parents present during each stage of the procedure.

Demographic information (age, height, body weight, and sex), medical history, seizure characteristics, seizure frequency, and antiepileptic medication use were obtained through parent interviews and by reviewing the children's hospital medical records. No additional clinical examinations, laboratory tests, or neurological assessments were performed for the purposes of the study; only height and weight measurements were taken on-site using standard procedures.

Sensory perception levels were assessed using the Sensory Processing Measure-Home Form, completed by parents. During the administration of the questionnaire, the research team provided clarification when needed to ensure parents fully understood the items; however, all responses were given independently by the parents. All forms were completed within the assessment environment, and the research team verified the accuracy and completeness of the collected data.

Ethical Considerations

Ethical approval for the study was obtained from the Clinical Research Ethics Committee of Bolu Abant İzzet Baysal University (Decision No: 2024/387, Date: 07.01.2025). The study was registered at ClinicalTrials.gov with the registration number NCT06818357. In accordance with the principles of the Declaration of Helsinki, the research was conducted between February 2025 and July 2025 in the Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, Bolu Abant İzzet Baysal University. After information about the study was provided, verbal and written informed consent was obtained from the participating children and their parents.

Measurements

Additional Information on Children's Demographic and Epilepsy Characteristics

In addition to general demographic information such as age, sex, body weight, and height, a parents completed a structured questionnaire in order to comprehensively assess the clinical characteristics of children with epilepsy. This involved collecting data on the use of antiepileptic drugs, the name of the medication used, treatment response status (whether seizure control was achieved), seizure frequency within the past year, the time of day when seizures were more common, and their relationship to sleep (occurring exclusively during sleep, exclusively during wakefulness, or in both states). Furthermore, EEG and magnetic resonance imaging (MRI) findings of children with epilepsy were classified as either "normal" or "abnormal" by a pediatric neurologist.

Sensory Processing and Perception

The Sensory Processing Measure, developed by Parham and Ecker, is a norm-referenced assessment tool designed to evaluate sensory processing, planning, and social participation in children aged 5-12 years, based on parent or teacher reports. The scale consists of structured questions that provide a holistic perspective on the child's sensory functioning within home, school, and community settings. In the present study, children's sensory processing and perception characteristics were assessed using parents' responses to the Home Form of the Sensory Processing Measure. The scale includes a total of 75 items, each rated on a four-point Likert scale ranging from "never" (1) to "always" (4), based on parental observations.

In the Sensory Processing Measure, higher scores indicate greater sensory processing difficulties, whereas lower scores reflect more typical sensory functioning. Raw scores are converted into standardized T-scores, with values of 40-59 considered typical, 60-69 indicating mild to moderate difficulties, and scores ≥70 reflecting definite sensory process-

ing dysfunction. Each sensory domain—Social Participation, Vision, Hearing, Touch, Taste and Smell, Body Awareness, Balance and Motion, and Planning and Ideas—generates its own raw score and corresponding T-score. Because each subscale is evaluated independently, domain-specific interpretations can be made rather than relying solely on a total sensory score. In this study, between-group comparisons were conducted using the scores obtained from all relevant subdomains (26,27). The tool used in our study was Turkish version of the Sensory Processing Measure-Home Form, which has established validity and reliability (28).

Statistical Analysis

Data analyses were performed using IBM SPSS Statistics ver 26 and R ver 4.0.5. For descriptive statistics, numerical variables were summarized as mean ± standard deviation (SD) or as median and minimum-maximum values, while categorical variables were presented as frequencies and percentages. The normality of the data was evaluated using both graphical methods (e.g., Q-Q plots, histograms) and hypothesis testing (Shapiro-Wilk test). Comparisons of numerical variables between two groups were conducted with either the independent samples t-test or the Mann-Whitney U test, depending on distributional assumptions. Group comparisons for categorical variables were performed using appropriate chi-square tests (Pearson's chi-square test, Fisher's exact test, etc.). To examine differences between groups in total and subscale scores while accounting for potential confounders (age, sex, and BMI), a linear regression model was employed. Model assumptions were checked using residual plots, including residuals versus fitted values and normal Q-Q plots. Robust methods were applied to estimate the standard error. Effect sizes were reported alongside p-values. For independent samples t-tests, Cohen's d was used and interpreted as 0.2=small, 0.5=medium, and 0.8=large. For the Mann-Whitney U test, effect size r was calculated as $r=z/\sqrt{n}$ and interpreted as 0.10=small, 0.30=medium, and 0.50=large. For categorical data analyses, Phi or Cramer's V coefficients were reported, with the same interpretation thresholds (0.10=small, 0.30=medium, 0.50=large). In R, the following packages were used for analyses: lmtest (29), emmeans (30), and sandwich (31). A p-value of<0.05 was considered statistically significant.

RESULTS

Patient Selection

A total of 49 children aged between 5 and 12 (mean= 8.67±2.11) years were included in the study. The patient group consisted of 25 children diagnosed with epilepsy, and the control group, 24 typically developing children. No statistically significant difference was observed between groups in terms of age and sex distribution (p=0.131 and p=0.058, respectively). However, the effect size values indicated approaching moderate difference for age (d=0.439) and sex (Φ=0.271). Children in the patient group had significantly higher mean weight and height compared to the control group (p=0.016 and p=0.037, respectively), with medium-to-large effect sizes (d=0.717 and d=0.614, respectively). No significant difference was observed in body mass index (BMI) between groups (p=0.077), although the effect size suggested a moderate difference (d=0.514). A significant difference was also found with respect to children's place of residence (p=0.014): 87.5% in the control group lived in the city center, compared with 56% of the patient group. The participants' demographic and clinical characteristics are presented in Table 1.

Sensory Processing and Perception

The comparison results of the sensory processing subscales and the total sensory system scores between groups are presented in Table 2. Group comparisons were performed both without adjustment and after adjusting for potential confounding variables, including age, sex, and BMI and place of residence. Due to the small number of participants residing in villages, the district and village categories were combined and included in the model as 1 = province and 2 = district plus village. Both unadjusted and adjusted analyses, no statistically significant differences were observed between groups in subscale and total scores. However, BMI was negatively associated with taste and smell scores, and this relationship reached statistical significance (b = -0.138, (95% CI: -0.241; -0.034); p = 0.010).

The comparisons of sensory processing subscale scores and total sensory system scores according to different clinical characteristics of the patient group are presented in Table 4. A moderate difference was observed between patients using antiepileptic medication and those not using medication in terms of Body Awareness and Balance and Motion scores, with higher scores in patients receiving antiepileptic treatment (r = 0.312, p = 0.132 and r = 0.292, p = 0.154, respectively). A moderate difference was also found between patients who responded to antiepileptic treatment and those who did not with respect to Hearing scores, with higher scores observed in patients with a continued treatment response (r = 0.342, p = 0.107). In addition, a moderate difference was identified between sleep related seizure groups in terms of Social Participation scores, with lower Social Participation scores observed in both the asleep and awake groups (r = 0.342, p = 0.107). Furthermore, moderate differences were observed between patients with normal and abnormal MRI findings in Vision, Taste and Smell, and Planning and Ideas scores, with higher scores in the non normal MRI group. Moreover, a statistically significant difference was found between MRI groups with respect to Total Sensory Systems scores, with significantly higher scores in the non normal group.

Table 1: Demographic and Clinical characteristics of participants (n=49)

	Group			
	Patient (n=25)	**Control (n=24)**	**ES**	**p**
Age	9.12 ± 2.07	8.21 ± 2.08	0.439	0.131*
Sex				
Female	11 (44.0)	17 (70.8)	0.271	0.058**
Male	14 (56.0)	7 (29.2)		
Weight (kg)	40.83 ± 17.78	30.69 ± 8.91	0.717	0.016*
Height (cm)	140.92 ± 15.80	131.29 ± 15.53	0.614	0.037*
BMI (kg/cm^2)	19.63 ± 5.46	17.47 ± 2.20	0.514	0.077*
Place of Residence				
Province	14 (56.0)	21 (87.5)	0.377	0.014**
District	7 (28.0)	3 (12.5)		
Village	4 (16.0)	0 (0.0)		
Type of Epilepsy				
Focal	11 (44.0)			
Generalize	14 (56.0)			
Use of Epileptic Medication				
Yes	21 (84.0)			
No	4 (16.0)			
Medication (n=21)[A]				
Antiexcitatory drugs	3 (14.3)			
Sodium channel-blocking AED				
Drugs enhancing inhibition				
AED acting on GABA	2 (9.6)			
AED with multiple mechanisms of action	6 (28.6)			
Other mechanisms	6 (28.6)			
Response to Antiepileptic Medication				
Under Control	22 (88.0)			
Continue	3 (12.0)			
Seizure Status in the Last Year				
Yes	13 (52.0)			
No	12 (48.0)			
Relationship Between Seizure and Sleep				
Asleep	9 (36.0)			
Awake	11 (44.0)			
Both	5 (20.0)			
EEG Results				
Normal	9 (36.0)			
Non-Normal	16 (64.0)			
MRG Results (n=24)				
Normal	20 (80.0)			
Non- Normal	4 (16.0)			

Descriptive statistics were defined as mean±standard deviation or median (minimum - maximum) values for numerical variables, and frequency (percentage) for categorical variables. **AED:** antiepileptic drugs. * Independent t test (with Cohen'd effect size as d=0.2 small, d=0.5 medium, and d ≥ 0.8 large), ** Chi-square tests (Pearson, Yates Correction or Fisher's Exact test wirh Phi/Cramer V effect size as d=0.1 small, d=0.3 medium, and d ≥ 0.5 large). *** Mann-Whitney U test (with formula as d=0.1 small, d=0.3 medium, and d ≥ 0.5 large), **BMI:** body mass index, **GABA:** gamma-aminobutyric acid, **MRI:** magnetic resonance imaging, **ES:** effect size, **[A]:** Multiple Selection

DISCUSSION

This study aimed to compare the sensory processing and perception profiles of children with epilepsy to those of their typically developing peers, identifying the neurological and clinical determinants underlying these processes. Our findings demonstrate that children with epilepsy exhibit performance levels comparable to their peers in both total sensory

Table 2: Comparison of sensory processing subscale scores and total sensory system scores between groups

	Group			
	Patient (n=25)	**Control (n=24)**	**p^{unAdj}**	**p^{Adj}**
Social participation	35.36 ± 5.22	34.5 ± 5.57	0.588	0.629
Vision	14.96 ± 3.32	15.04 ± 3.91	0.939	0.579
Hearing	10.28 ± 2.65	10.42 ± 2.95	0.868	0.484
Touch	15.56 ± 3.75	14.87 ± 3.78	0.538	0.621
Taste and Smell	6.12 ± 1.39	5.46 ± 0.83	0.053	0.116
Body Awareness	12.76 ± 3.31	13.13 ± 4.51	0.754	0.983
Balance and Motion	15.80 ± 3.07	17.04 ± 4.67	0.289	0.105
Planning and Ideas	12.08 ± 3.90	11.58 ± 4.77	0.699	0.594
Total Sensory Systems	75.48 ± 12.97	75.35 ± 16.64	0.976	0.658

PunAdj: Unadjusted regression model results, **PAdj:** Adjusted regression model results for age, sex, BMI, and place of residence

systems and sensory subdomains. This similarity suggests that epilepsy does not invariably lead to widespread sensory impairment in children, who may maintain functionality levels close to their peers across various sensory domains. Notably, however, deficits in taste and smell perception were found to be associated with an increase in Body Mass Index (BMI), independent of the epilepsy diagnosis itself. Furthermore, it was determined that the sensory profiles are primarily shaped by clinical sub-components—such as structural brain differences, antiepileptic drug (AED) use, and the timing of seizures—rather than the diagnosis of epilepsy alone. These results confirm that sensory processes in pediatric epilepsy do not follow a homogeneous course but instead present a heterogeneous structure tailored to each child's clinical presentation.

Sub-domain analyses revealed that impairments in taste and smell perception were correlated with increased BMI. These findings align with existing literature reporting that visceral adiposity and high BMI values weaken odor discrimination and perception skills (32-34). In the literature, structural mechanisms such as a reduced number of taste buds and deficiencies in taste identification abilities accompanying obesity in children and adolescents have been highlighted (35,36) Moreover, impaired taste perception may trigger a cycle of high-energy food consumption and obesity by delaying the sensation of satiety (37). In light of these data, we suggest that impairments in taste and smell perception identified in childhood epilepsy should be evaluated within the framework of the general metabolic profile and physical growth parameters rather than as a direct reflection of seizure activity.

Another significant finding of our study is that children with abnormal brain MRI findings had significantly higher total sensory system scores compared to the group with normal findings. This suggests that sensory processing and perception disorders observed in childhood epilepsy may be closely linked to structural differences and neuroanatomical abnormalities in the central nervous system. Existing literature demonstrates that structural volume losses in sensory integration centers such as the thalamus, insula, and putamen, along with the disruption of functional connectivity between these regions and cortical networks, impair sensory organization (38-40). Given that thalamocortical and insular networks serve as primary sensory relay stations where environmental stimuli are filtered and integrated (41), it is expected that abnormalities in these structures lead to impairments in sensory processing and perception. The high sensory scores—indicating dysfunction—found in children with MRI abnormalities suggest that these patients are insufficient in processing sensory information and that structural damage exerts a holistic disruptive effect on sensory processes. Thus, we believe that radiological anomalies are a critical parameter to consider in clinical evaluations as they may play a restrictive role in an individual's sensory performance.

Clinical subgroup analyses revealed that children using antiepileptic drugs (AEDs) had higher body awareness, balance, and motion scores compared to the non-medicated group. The effects of AEDs on neurotransmitter systems and brain regions where sensory information is regulated are well-documented (42,43). While it is theoretically anticipated that these neurochemical changes might negatively impact the processing of body awareness and vestibular perception systems (44), the literature remains inconclusive. Our findings suggest that AED use may have restrictive effects on the processing and perception of sensory stimuli in these two specific domains. Although current data are limited for establishing a direct cause-and-effect relationship, these differences highlight the clinical importance of monitoring perceptual processes in children receiving AED therapy. Consequently, further research with larger samples is needed to isolate the specific effects of medications on sensory-perceptual systems.

Table 3: Regression Coefficients and 95% Confidence Intervals for sensory processing subscale scores and total sensory system scores

	Factors	Coefficient	95 % Confidence Interval for Coefficient		P
			LL	UL	
Social participation	Group	0.968	-3.045	4.981	0.629
	Age	0.074	-0.781	0.928	0.863
	Gender	1.160	-2.607	4.927	0.538
	BMI	0.098	-0.295	0.419	0.618
	Place of Res.	-2.208	-8.029	3.614	0.449
Vision	Group	-0.848	-3.908	1.211	0.579
	Age	-0.084	-0.749	0.582	0.801
	Gender	0.533	-1.936	3.002	0.666
	BMI	0.001	-0.374	0.375	0.998
	Place of Res.	2.220	-1.158	5.598	0.192
Hearing	Group	-0.664	-2.563	1.235	0.484
	Age	0.075	-0.466	0.617	0.781
	Gender	0.839	-1.053	2.732	0.376
	BMI	-0.197	-0.398	0.004	0.055
	Place of Res.	2.071	-0.417	4.560	0.100
Touch	Group	-0.636	-3.217	1.944	0.621
	Age	0.533	-0.067	1.132	0.080
	Gender	1.757	-0.481	3.995	0.121
	BMI	-0.224	-0.474	0.026	0.077
	Place of Res.	2.191	-1.141	5.523	0.182
Taste and Smell	Group	0.607	-0.156	1.371	0.116
	Age	0.117	-0.043	0.277	0.147
	Gender	0.066	-0.608	0.740	0.845
	BMI	-0.138	-0.241	-0.034	**0.010**
	Place of Res.	0.709	-0.274	1.691	0.153
Body Awareness	Group	-0.029	-2.765	2.707	0.983
	Age	-0.301	-0.952	0.350	0.357
	Gender	-0.822	-3.332	1.687	0.512
	BMI	-0.283	-0.581	0.015	0.062
	Place of Res.	2.417	-1.875	6.709	0.262
Balance and Motion	Group	-2.031	-4.501	0.439	0.105
	Age	0.128	-0.442	0.699	0.652
	Gender	-0.133	-2.322	2.056	0.903
	BMI	-0.079	-0.363	0.203	0.573
	Place of Res.	2.786	-0.827	6.405	0.128
Planning and Ideas	Group	-0.867	-4.122	2.388	0.594
	Age	0.091	-0.542	0.724	0.774
	Gender	1.574	-1.701	4.850	0.338
	BMI	0.053	-0.331	0.437	0.781
	Place of Res.	2.367	-2.669	7.402	0.349
Total Sensory Systems*	Group	0.039	-0.136	0.214	0.658
	Age	-0.013	-0.054	0.028	0.520
	Gender	-0.051	-0.194	0.093	0.482
	BMI	0.014	-0.002	0.031	0.087
	Place of Res.	-0.158	-0.373	0.057	0.146

LL: lower limit, **UP:** upper limit, **BMI:** body mass index. * Values were transformed using the reciprocal (1/y) transformation.

While no direct relationship was found between seizure timing and general sensory processing, a notable differentiation was observed in social participation. In our study, children who experienced seizures both during sleep and wakefulness had lower social participation scores (reflecting higher functional capacity in the scale used) compared

Table 4: Comparison several epilepsy features based on the sensory processing subscale scores and total sensory system scores

	SOC	VIS	HEA	TOU
Type of Epilepsy				
Focal (n=11)	37 (16 - 40)	14 (11 - 24)	10 (8 - 19)	15 (11 - 23)
Generalize (n=14)	36 (30 - 40)	14.5 (12 - 22)	9 (8 - 14)	13.5 (12 - 24)
ES	0.205	0.110	0.179	0.133
p	0.317	0.609	0.403	0.536
Use of Epileptic Medication				
Yes (n=21)	37 (28 - 40)	14 (11 - 24)	9 (8 - 13)	15 (11 - 24)
No (n=4)	31.5 (16 - 40)	15.5 (14 - 19)	11.5 (8 - 19)	12.5 (12 - 23)
ES	0.277	0.232	0.190	0.180
p	0.177	0.262	0.369	0.409
Response to Antiepileptic Medication				
Under Control (n=22)	37 (16 - 40)	14 (11 - 24)	9 (8 - 19)	14 (11 - 24)
Continue (n=3)	34 (28 - 37)	14 (11 - 22)	11.5 (8 - 19)	18 (13 - 18)
ES	0.270	0.008	**0.342**	0.178
p	0.206	0.969	0.107	0.398
Seizure Status in the Last Year				
Yes (n=13)	37 (16 - 40)	14 (11 - 22)	9 (8 - 19)	17 (11 - 24)
No (n=12)	37 (28 - 40)	14 (12 - 24)	9.5 (8 - 14)	13.5 (12 - 23)
ES	0.078	0.055	0.022	0.160
p	0.728	0.810	0.936	0.437
Relationship Between Seizure and Sleep				
Asleep (n=9)	37 (16 - 40)	15 (12 - 22)	9 (8 - 19)	17 (12 - 23)
Awake (n=11)	37 (32 - 40)	13 (11 - 24)	10 (8 - 13)	14 (11 - 24)
Both (n=5)	33 (28 - 38)	14 (14 - 17)	9 (8 - 14)	13 (12 - 18)
ES	**0.105**	0.004	0.076	0.077
p	0.116	0.385	0.851	0.862
EEG Results				
Normal (n=9)	37 (30 - 40)	14 (12 - 17)	9 (8 - 14)	14 (12 - 18)
Non-Normal (n=16)	37 (16 - 40)	14.5 (11 - 24)	9.5 (8 - 19)	14.5 (11 - 24)
ES	0.046	0.108	0.012	0.160
p	0.846	0.598	0.978	0.452
MRG Results				
Normal (n=20)	37 (28 - 40)	14 (11 - 24)	9 (8 - 14)	13.5 (11 - 24)
Non- Normal (n=4)	36 (16 - 39)	17.5 (13 - 22)	11 (9 - 19)	17.5 (13 - 23)
ES	0.094	**0.297**	0.269	0.251
p	0.682	0.157	0.210	0.241

	TNS	BOD	BAL	PLA	TOT
Type of Epilepsy					
Focal (n=11)	5 (5 - 8)	12 (10 - 19)	15 (11 - 21)	11 (9 - 17)	73 (56 - 109)
Generalize (n=14)	6 (5 - 10)	11 (10 - 20)	15 (12 - 24)	11 (9 - 22)	70.5 (62 - 100)
ES	0.081	0.039	0.011	0.129	0.055
p	0.727	0.851	0.979	0.536	0.809
Use of Epileptic Medication					
Yes (n=21)	6 (5 - 10)	11 (10 - 20)	15 (11 - 20)	11 (9 - 22)	72 (56 - 100)
No (n=4)	5.5 (5 - 8)	14.5 (11 - 19)	18.5 (14 - 24)	14 (9 - 21)	78 (67 - 109)
ES	0.039	**0.312**	**0.292**	0.190	0.111
p	0.858	0.132	0.154	0.369	0.592
Response to Antiepileptic Medication					
Under Control (n=22)	6 (5 - 10)	11 (10 - 20)	15.5 (11 - 24)	11 (9 - 22)	70.5 (56 - 109)
Continue (n=3)	6 (5 - 7)	12 (10 - 16)	15 (14 - 16)	12 (9 - 12)	75 (74 - 84)

Table 4: Continued

ES	0.035	0.172	0.084	0.000	0.201
p	0.906	0.906	0.723	>0.999	0.353
Seizure Status in the Last Year					
Yes (n=13)	6 (5 - 10)	11 (10 - 20)	15 (11 - 21)	11 (9 - 22)	73 (56 - 109)
No (n=12)	6 (5 - 8)	12 (10 - 19)	15.5 (13 - 24)	10.5 (9 - 21)	71 (62 - 91)
ES	0.040	0.050	0.203	0.095	0.005
p	0.852	0.810	0.320	0.650	0.979
Relationship Between Seizure and Sleep					
Asleep (n=9)	6 (5 - 9)	11 (10 - 19)	16 (12 - 21)	12 (9 - 22)	74 (68 - 109)
Awake (n=11)	6 (5 - 10)	12 (10 - 20)	15 (11 - 18)	9 (9 - 16)	70 (56 - 100)
Both (n=5)	5 (5 - 7)	11 (10 - 16)	16 (14 - 24)	11 (11 - 21)	73 (65 - 88)
ES	0.047	0.083	0.004	0.085	0.048
p	0.620	0.914	0.387	0.144	0.623
EEG Results					
Normal (n=9)	6 (5 - 9)	12 (10 - 18)	16 (14 - 24)	10 (9 - 22)	70 (67 - 88)
Non-Normal (n=16)	6 (5 - 10)	11 (10 - 20)	15 (11 - 21)	11 (9 - 19)	72.5 (56 - 109)
ES	0.048	0.116	0.274	0.017	0.005
p	0.846	0.598	0.187	0.934	>0.999
MRG Results					
Normal (n=20)	5 (5 - 10)	11 (10 - 20)	15 (11 - 24)	10.5 (9 - 21)	70 (56 - 100)
Non- Normal (n=4)	7 (6 - 9)	16.5 (10 - 19)	18 (14 - 21)	14.5 (10 - 22)	84.5 (75 - 109)
ES	**0.413**	0.277	0.255	**0.367**	**0.419**
p	0.056	0.210	0.241	0.081	**0.037**

Descriptive statistics were defined as median (minimum - maximum) Mann-Whitney U test (with formula $r=z/\sqrt{n}$ as d=0.1 small, d=0.3 medium, and d ≥ 0.5 large), **ES:** effect size,**SOC:** social participation**, VIS:** vision**, HEA:** hearing**, TOU:** touch, **EEG:** electroencephalography, **MRG:** magnetic resonance imaging

to those whose seizures were limited to a specific time frame. This suggests higher social adaptation capacity in this group. While the literature often reports that the unpredictable and continuous nature of seizures deepens social restriction, isolation, and perceived stigma (45,46), our results may be related to the adaptation and tolerance developed by families. The distribution of seizures throughout the day may have prompted families to be constantly prepared and adapt to varying conditions. This suggests that by learning to live with the reality of seizures, families may adopt a more flexible attitude, including the child in social life rather than isolating them. Therefore, high social participation despite continuous seizure activity may stem from the supportive role of family coping skills in preserving the child's social functionality.

Strengths

This study provides a significant contribution to the limited evidence base regarding sensory processing and perception profiles in childhood epilepsy. The utilization of the Sensory Profile-Home Form, a validated and reliable assessment instrument, underscores the methodological rigor of the research. The inclusion of an age-matched control group facilitated structured and robust comparisons between children with epilepsy and their typically developing peers. Furthermore, the prospective design allowed for the systematic collection of clinical and demographic data, thereby enhancing the consistency of study procedures. Notably, by shifting the focus from the diagnosis alone to clinical sub-components—such as medication use and MRI findings—this study offers a more nuanced understanding of the individual variations inherent in sensory processes.

Limitations

Despite its contributions, several limitations of this study should be acknowledged. The use of convenience sampling may limit the representativeness of the cohort and the generalizability of the findings to broader populations. Additionally, the relatively small sample size may have constrained the statistical power of the results. Sensory processing and perception were assessed exclusively through parent-report scales; while this is a standard approach in pediatric research, it remains susceptible to reporting bias. Furthermore, the variability in antiepileptic drug types and dosages presents a potential confounding factor that may influence sensory outcomes. Future research involving larger, multi-center samples, objective clinical assessment tools, and more homogeneous medication groups is warranted to provide a more comprehensive understanding of sensory functions in pediatric epilepsy.

Conclusion and Recommendations

This study demonstrates that sensory processing and perception in childhood epilepsy present a heterogeneous structure shaped by metabolic and structural factors. The findings indicate that an epilepsy diagnosis does not result in universal perceptual impairment; however, individual clinical variables significantly alter the clinical picture. In particular, structural brain differences and seizure distribution play a decisive role. In conclusion, epilepsy exerts multifaceted effects on sensory processing and developmental functions beyond seizure activity. Detailed assessment of sensory profiles is critical for clinical follow-up and the planning of individualized treatment strategies. Healthcare professionals are encouraged to adopt a holistic approach that encompasses the child's social participation and sensory-perceptual functionality.

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Author Contributions

Study conception and design: **Seda Ayaz Taş;** data collection: **Sedef Kestellioğlu, Ayşegül Danış;** analysis and interpretation of results: **Merve Başol Göksülük;** draft manuscript preparation: **Seda Ayaz Taş, Merve Başol Göksülük, Özge Karanlık Özcan, Seda Yakıt Yeşilyurt, Sedef Kestellioğlu, Sezen Tezcan, Ayşegül Danış.** The author(s) reviewed the results and approved the final version of the article.

Conflicts of Interest

The authors declare that there is no conflict of interest to disclose.

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Ethical Approval

The study protocol was approved by the Clinical Research Ethics Committee of Bolu Abant Izzet Baysal University (Decision No: 2024/387, Date: 07 January 2025). This study was registered at ClinicalTrials.gov (Identifier: NCT06818357). Informed assent was obtained from the participating children, and written informed consent was obtained from their parents or legal guardians. The privacy rights of all participants were protected.

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