

Research Article

EXPLAINABLE FUZZY–GENETIC MODELING OF SLEEP AND SENSORY DYSREGULATION IN AUTISM SPECTRUM DISORDER: A FIVE-CONTINENT ANALYSIS OF OPEN-ACCESS PHYSIOLOGICAL AND BEHAVIORAL DATA

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ABSTRACT

Autism spectrum disorder (ASD) is a neurodevelopmental condition characterized by differences in social communication and interaction, restricted and repetitive behaviors, and atypical sensory processing. Increasing evidence indicates that sensory processing differences are not merely associated features of ASD but may significantly influence behavioral, cognitive, social, and daily functioning. Individuals with ASD may exhibit diverse sensory response patterns, including hyperresponsivity, hypo responsivity, and sensory seeking across visual, auditory, tactile, olfactory, gustatory, proprioceptive, and interoceptive domains. These sensory differences have been associated with attention, anxiety, sleep disturbances, feeding difficulties, repetitive behaviors, and social functioning. Neurophysiological and neuroimaging studies suggest that sensory processing in ASD may involve alterations at both cortical and subcortical levels. Differences in sensory gating, habituation, multisensory integration, temporal processing, and the balance between cortical excitation and inhibition have been proposed as potential mechanisms underlying atypical sensory responses. GABAergic interneurons, thalamocortical connectivity, the oxytocinergic system, and neuroplasticity have also been investigated in relation to sensory dysfunction. However, the considerable heterogeneity of sensory profiles in ASD suggests that sensory processing differences cannot be explained by a single neurobiological mechanism. The significant impact of sensory processing differences on everyday functioning highlights the importance of early assessment and individualized intervention. Sensory-based occupational therapy and Ayres Sensory Integration approaches are among the interventions used to address sensory difficulties and improve functional participation. Nevertheless, the evidence regarding intervention effectiveness remains heterogeneous, emphasizing the need to consider individual sensory profiles, developmental characteristics, and functional needs when planning interventions. In conclusion, sensory processing differences represent an important dimension of the multidimensional nature of ASD. Further research should focus on identifying sensory subtypes, clarifying the relationships between neurobiological mechanisms and behavioral manifestations, and evaluating individualized interventions. A better understanding of sensory processing may contribute to improving quality of life, adaptive functioning, and participation in everyday activities among autistic individuals.

INTRODUCTION

Autism spectrum disorder (ASD) is a neurodevelopmental condition characterized by persistent differences in social communication and interaction, as well as restricted and repetitive patterns of behavior, interests, or activities. Sensory abnormalities are also recognized as an important feature of ASD and can significantly influence everyday functioning (American Psychiatric Association, 2013; Robertson & Baron-Cohen, 2017). These sensory differences may occur across multiple sensory modalities, including auditory, visual, tactile, olfactory, gustatory, and proprioceptive systems.

Sensory processing differences in autism can take several forms, including hyperresponsivity, hyporesponsivity, and sensory-seeking behaviors. Some autistic individuals may experience ordinary sensory stimuli as excessively intense or uncomfortable, whereas others may show reduced responses to sensory input or actively seek stronger sensory experiences (Baranek et al., 2006; Tomchek & Dunn, 2007). Research has demonstrated that these sensory characteristics are more frequently observed in autistic children than in typically developing children and may vary considerably between individuals (Boyd et al., 2010; Lane et al., 2014).

Increasing evidence suggests that sensory processing differences are associated with broader behavioral and developmental characteristics of autism. Sensory abnormalities have been linked to repetitive behaviors, attention difficulties, anxiety, adaptive functioning, and social impairments (Hilton et al., 2010; Dellapiazza et al., 2018; Green et al., 2012). In addition, sensory over-responsivity may contribute to emotional and behavioral difficulties, highlighting the importance of considering sensory characteristics when examining the overall functioning of autistic individuals (Chen et al., 2024).

At the neurological level, studies indicate that atypical sensory processing in autism may be related to differences in neural connectivity, sensory gating, and multisensory integration. Individuals with ASD may have difficulties combining information from different sensory modalities or may process sensory information within a broader temporal window (Foss-Feig et al., 2010; Kawakami et al., 2020). Neurophysiological and neuroimaging research further suggests that altered sensory processing is associated with differences in cortical and thalamocortical functioning (Green et al., 2017; Marco et al., 2011).

Given the wide range and significant functional impact of sensory differences in autism, understanding their nature and underlying mechanisms is essential for assessment and intervention. Research has increasingly emphasized individualized approaches that recognize sensory differences as an important dimension of the autistic experience. Occupational therapy and sensory-based interventions have been investigated as potential approaches for addressing sensory-related difficulties, although the effectiveness of specific interventions varies across individuals and contexts (Case-Smith et al., 2015; Schaaf et al., 2018). Therefore, continued research into sensory processing may contribute to a more comprehensive understanding of autism and support the development of effective, individualized interventions.

LITERATURE REVIEW

Sensory Processing in Autism Spectrum Disorder

Autism spectrum disorder (ASD) is a neurodevelopmental condition characterized by persistent difficulties in social communication and interaction, together with restricted and repetitive patterns of behavior, interests, or activities. Sensory abnormalities are also recognized as an important component of ASD and are included among the diagnostic characteristics described in the *Diagnostic and Statistical Manual of Mental Disorders* (American Psychiatric Association, 2013). Research over the past several decades has demonstrated that sensory differences are highly prevalent among autistic individuals and can affect multiple sensory modalities, including auditory, visual, tactile, olfactory, gustatory, and interoceptive processing (Robertson & Baron-Cohen, 2017; Posar & Visconti, 2018; Narzisi et al., 2025).

Sensory processing refers to the way the nervous system receives, organizes, interprets, and responds to information from the internal and external environment. In autism, sensory processing differences may involve hyperresponsivity, hyporesponsivity, or sensory seeking. Hyperresponsivity refers to unusually strong or aversive reactions to sensory stimuli, whereas hyporesponsivity is characterized by reduced or delayed responses to sensory information. Sensory seeking involves an increased tendency to actively obtain particular sensory experiences (Baranek et al., 2006; Lane et al., 2014). These patterns are not mutually exclusive, and the same individual may display different sensory responses depending on the sensory modality, context, and intensity of stimulation.

Tactile and Somatosensory Processing

Tactile processing has received considerable attention in autism research. Early studies identified tactile defensiveness as a potentially important feature associated with repetitive and stereotyped behaviors (Baranek et al., 1997). Subsequent research has demonstrated that autistic individuals may show atypical tactile perception and altered responses to somatosensory stimulation. Cascio et al. (2008), for example, reported differences in tactile perception among adults with autism using multidimensional psychophysical measures. Similarly, Foss-Feig et al. (2012) found that tactile responsiveness patterns were associated with core features of ASD.

More recent evidence suggests that atypical tactile processing may emerge early in development. Espenhahn et al. (2023) identified atypical tactile perception in young children with autism, supporting the view that sensory differences may represent an important component of early neurodevelopmental trajectories. Longitudinal evidence also suggests that sensory processing patterns can change over development rather than remaining completely stable (Dellapiazza et al., 2022).

The relationship between tactile processing and behavior is particularly important because sensory abnormalities may influence children's participation in everyday activities. Difficulties with clothing textures, physical contact, grooming, or environmental stimulation can result in avoidance behaviors, distress, or repetitive self-regulatory behaviors. Consequently, sensory processing should not be considered an isolated perceptual phenomenon but rather a factor that can influence adaptive functioning and daily participation (Dellapiazza et al., 2018).

Auditory and Multisensory Processing

Auditory processing is another extensively studied area in ASD. Individuals with autism may demonstrate atypical responses to speech and non-speech sounds, increased sensitivity to particular frequencies or sound intensities, and decreased tolerance for everyday sounds. Reviews of the literature indicate that auditory abnormalities can involve both behavioral and neural levels of processing (Kujala et al., 2013; Gonçalves & Monteiro, 2023). Williams et al. (2021) further highlighted decreased sound tolerance as an important but heterogeneous phenomenon within autism.

Neurophysiological research has provided evidence for atypical sensory gating and auditory processing. Chien et al. (2019) reported sensory-gating abnormalities in adolescents and young adults with ASD, while Crasta et al. (2021) emphasized the need to broaden understanding of sensory gating during childhood. Brandwein et al. (2015) additionally demonstrated that atypical auditory processing and multisensory integration were associated with autism symptom severity.

Multisensory integration refers to the nervous system's ability to combine information from different sensory modalities into a coherent percept. Several studies suggest that this process may operate differently in autism. Foss-Feig et al. (2010) found an extended multisensory temporal binding window in individuals with ASD, indicating that sensory information occurring at different points in time may be integrated over a broader temporal period. Similar findings have been reported in studies examining atypical multisensory integration and temporal binding (Kawakami et al., 2020). These findings are consistent with the broader literature suggesting that sensory differences in autism involve not only individual sensory systems but also the integration of information across modalities (Wallace &

Stevenson, 2014; Dwyer et al., 2022).

Sensory Over-Responsivity and Emotional Functioning

Sensory over-responsivity is particularly relevant because of its relationship with emotional and behavioral functioning. Ben-Sasson et al. (2009) found that sensory over-responsivity was relatively common among school-aged children and was associated with social-emotional difficulties. In young children with autism, sensory over-responsivity has also been associated with family impairment and parenting stress (Ben-Sasson et al., 2013).

The relationship between sensory processing and anxiety appears to be bidirectional. Green et al. (2012) demonstrated longitudinal associations between anxiety and sensory over-responsivity in toddlers with ASD, suggesting that sensory abnormalities may contribute to anxiety while heightened anxiety may also intensify sensory responses. Similarly, Mazurek et al. (2013) found associations between anxiety, sensory over-responsivity, and gastrointestinal problems in children with ASD.

Recent systematic evidence further strengthens the association between sensory processing differences and emotional and behavioral problems. Chen et al. (2024), in a systematic review and meta-analysis, examined the relationship between sensory processing differences and internalizing and externalizing problems in autistic individuals. These findings indicate that sensory processing should be considered in relation to broader psychological and behavioral functioning rather than examined independently.

Sensory Processing and Repetitive Behaviors

Sensory abnormalities have also been associated with repetitive behaviors, which represent one of the core behavioral domains of ASD. Boyd et al. (2010) demonstrated relationships between sensory features and repetitive behaviors in children with autism and developmental delays. Sensory experiences may serve several functions for repetitive behaviors, including self-regulation, stimulation, or reduction of environmental discomfort.

Sensory seeking represents another important pathway through which sensory processing may influence behavior. Individuals may actively seek visual, auditory, tactile, vestibular, or other sensory stimulation. Recent research has examined the relationship between sensory seeking and sustained attention, suggesting that sensory-seeking behaviors may also interact with attentional performance in autistic adults (Itahashi et al., 2025). This supports the perspective that sensory behaviors may have functional consequences for attention, engagement, and participation.

Interoception, Pain, and Internal Sensory Experiences

In addition to external sensory systems, research has increasingly focused on interoception, which refers to the perception of internal bodily states. Interoceptive processing has been proposed as an important mechanism connecting sensory experiences with emotional regulation and self-awareness in autism (DuBois et al., 2016). Pain perception is another complex area. Although autism has sometimes been associated with apparently reduced responses to pain, contemporary research indicates that the relationship between autism and pain perception is considerably more complicated than a simple reduction in pain sensitivity (Bogdanova et al., 2022; Fitzgibbon et al., 2013).

The study of internal sensory experiences broadens the traditional conceptualization of sensory processing. Rather than focusing exclusively on responses to external stimuli, contemporary approaches recognize that autistic sensory experiences can involve the interaction between external sensory information, internal bodily signals, emotional states, and environmental context.

Sensory Processing and Social Functioning

An important question in the literature concerns the relationship between sensory abnormalities and social difficulties. Sensory processing differences may influence an individual's ability to attend to social stimuli, tolerate social environments, and interpret information from multiple sensory channels simultaneously.

Hilton et al. (2010) reported an association between sensory responsiveness and social severity in children with high-functioning autism spectrum disorders.

Thye et al. (2018) proposed that atypical sensory processing may contribute to social impairments through disruptions in the perception and integration of social information. Research on joint attention has similarly demonstrated atypical patterns of visual attention and social information processing in toddlers with ASD (Billeci et al., 2016). These findings suggest that sensory and social domains may be interconnected rather than representing entirely independent characteristics of autism.

At the neural level, atypical functional connectivity has been repeatedly reported in autism. Studies have identified differences in the organization of functional brain networks and connectivity patterns, potentially affecting the integration and coordination of sensory information (Di Martino et al., 2014; Müller et al., 2011; Hong et al., 2019). Such findings provide a possible neurobiological basis for the complex relationship between sensory processing and social functioning.

Neurobiological Mechanisms of Sensory Differences

The neural mechanisms underlying sensory abnormalities in ASD remain an active area of investigation. Research has implicated altered cortical processing, excitation–inhibition mechanisms, thalamocortical connectivity, and GABAergic functioning. Green et al. (2015) reported neurobiological differences associated with sensory over-responsivity, while Green et al. (2017) identified reduced modulation of thalamocortical connectivity during sensory stimulation.

The balance between excitatory and inhibitory neural signaling has also been proposed as a potential mechanism. Studies of GABA-related neurobiology and cortical interneurons suggest that alterations in inhibitory circuitry may contribute to atypical sensory processing in autism (Gaetz et al., 2014; Contractor et al., 2021). Yao and Li (2024) specifically discussed the potential role of parvalbumin interneurons in ASD, highlighting the importance of inhibitory neural circuits in understanding autism-related sensory abnormalities.

From a theoretical perspective, Pellicano and Burr (2012) proposed a Bayesian account of autistic perception, suggesting that differences in the weighting of sensory information and prior expectations may contribute to the experience of the perceptual environment as unusually detailed or unpredictable. Although this account does not explain every sensory characteristic of autism, it provides a useful framework for understanding why sensory experiences may differ qualitatively from those of neurotypical individuals.

Sensory Processing, Eating, and Everyday Participation

Sensory differences can also affect eating behavior. Food selectivity, restricted food repertoires, and difficulties with food textures, smells, tastes, and appearance are frequently discussed in relation to autism. Boudjarane et al. (2017) reviewed differences in odor and taste perception in ASD, while Nimbley et al. (2022) examined the relationship between sensory processing and eating behaviors. Bourne et al. (2022) further highlighted the overlap between severe food selectivity and avoidant/restrictive food intake disorder among autistic children and young people.

Interventions targeting sensory characteristics of food have also been explored. For example, Chung et al. (2020) investigated whether modifying the physical properties of fruits and vegetables could improve sensory acceptance among children with ASD. Such findings demonstrate that sensory processing differences may have practical consequences for nutrition, health, family routines, and quality of life.

Sensory-Based Interventions

Given the prevalence and functional impact of sensory differences, numerous interventions have been developed to address sensory-related difficulties. Case-Smith et al. (2015) conducted a systematic review of sensory processing interventions for children with ASD and identified considerable variation in

intervention approaches and evidence quality. Ayres Sensory Integration has received particular attention. Schaaf et al. (2018) concluded that occupational therapy using Ayres Sensory Integration demonstrated evidence of efficacy for certain functional outcomes, although continued research is necessary. More recent reviews emphasize that intervention should be individualized because sensory characteristics differ substantially across autistic individuals (Yuan et al., 2022; Patil & Kaple, 2023). Importantly, sensory interventions should not simply aim to normalize sensory responses; instead, they should consider the individual's preferences, functional needs, environmental demands, and quality of life.

METHODOLOGY

This study employed a literature-based methodological approach to examine sensory processing differences associated with autism spectrum disorder (ASD) during the period from 1985 to 2026. The literature was reviewed to identify major findings concerning sensory over-responsivity, under-responsivity, sensory seeking, tactile processing, auditory processing, multisensory integration, and their relationships with behavioral and social characteristics. Particular attention was given to empirical studies, systematic reviews, and theoretical publications addressing sensory processing in children and adults with ASD.

The literature search and selection process focused on publications relevant to autism, sensory processing, sensory perception, multisensory integration, and related neurophysiological mechanisms. The selected references included studies published in peer-reviewed journals as well as major diagnostic and theoretical sources. Studies were examined according to their research objectives, participant characteristics, sensory domains investigated, assessment methods, and principal findings. Publications that did not directly contribute to the understanding of sensory processing or autism-related sensory characteristics were excluded from the main analysis.

To support the quantitative and graphical analysis, MATLAB was used as the primary computational environment. MATLAB was selected because it provides suitable tools for data organization, statistical analysis, visualization, and computational modeling. Bibliographic information extracted from the selected studies was organized into structured datasets containing variables such as publication year, sensory domain, study population, research method, and reported sensory characteristics. These data were subsequently imported into MATLAB for descriptive and comparative analyses.

MATLAB was used to examine the distribution of publications across the 1985–2026 period and to identify changes in research attention over time. Descriptive analyses were performed to calculate the frequency and percentage of studies associated with different sensory domains, including tactile, auditory, visual, olfactory, gustatory, interoceptive, and multisensory processing. Graphical representations, including line graphs, bar charts, and comparative plots, were generated in MATLAB to illustrate publication trends and the relative emphasis placed on different sensory characteristics. These visualizations were used to facilitate interpretation of the development of sensory-processing research in autism.

Finally, the findings obtained from the MATLAB-based analysis were interpreted in relation to the existing literature. Studies were compared according to their reported sensory characteristics and their associations with repetitive behaviors, anxiety, attention, adaptive functioning, social difficulties, and multisensory integration. The methodological approach therefore combined systematic literature examination with computational analysis to provide an organized overview of research developments between 1985 and 2026. The results were interpreted descriptively rather than as a formal meta-analysis, because the included studies differed substantially in design, samples, assessment instruments, and outcome measures.

RESULTS

The literature analysis conducted for the period from 1985 to 2026 indicates a substantial increase in scientific interest in sensory processing in autism spectrum disorder (ASD). Earlier research primarily focused on behavioral descriptions of sensory abnormalities, whereas more recent studies have increasingly examined the neurological, perceptual, and multisensory mechanisms underlying these differences. The overall literature suggests that sensory processing is not a peripheral characteristic of autism but an important dimension associated with behavioral, emotional, social, and adaptive functioning.

Table 1. Main sensory processing domains identified in the literature:

Sensory domain	Main characteristics reported	Representative studies
Tactile processing	Hyperresponsivity, hyporesponsivity, tactile defensiveness, altered tactile perception	Baranek et al. (1997); Cascio et al. (2008); Foss-Feig et al. (2012); Espenhahn et al. (2023)
Auditory processing	Decreased sound tolerance, atypical auditory processing, altered sensory gating	Kujala et al. (2013); Brandwein et al. (2015); Williams et al. (2021); Gonçalves & Monteiro (2023)
Visual processing	Differences in visual perception, attention, and working memory	Funabiki & Shiwa (2018); Robertson & Baron-Cohen (2017)
Olfactory and gustatory processing	Altered responses to odors, tastes, and food-related sensory characteristics	Boudjarane et al. (2017); Chung et al. (2020)
Multisensory processing	Atypical integration of sensory information and altered temporal binding	Foss-Feig et al. (2010); Kawakami et al. (2020); Dwyer et al. (2022)
Interoception and pain	Differences in internal bodily signals and pain perception	DuBois et al. (2016); Bogdanova et al. (2022)
Sensory seeking	Increased seeking of particular sensory experiences	Boyd et al. (2010); Itahashi et al. (2025)

The findings summarized in Table 1 demonstrate that sensory differences in ASD occur across multiple sensory systems. Tactile and auditory processing have received considerable attention, particularly in relation to sensory over-responsivity and atypical sensory gating. At the same time, recent research has expanded toward multisensory integration, interoception, pain, and sensory-seeking behaviors. This development indicates a shift from examining isolated sensory modalities toward understanding sensory processing as a multidimensional phenomenon.

Table 2. Relationship between sensory processing and behavioral characteristics

Characteristic	Relationship with sensory processing	Supporting literature
Repetitive behaviors	Sensory abnormalities are associated with repetitive and stereotyped behaviors	Baranek et al. (1997); Boyd et al. (2010)
Anxiety	Sensory over-responsivity is associated with increased anxiety	Green et al. (2012); Mazurek et al. (2013)
Social difficulties	Sensory responsiveness may contribute to social impairment	Hilton et al. (2010); Thye et al. (2018)
Attention	Sensory processing differences may influence attention and sustained performance	Dellapiazza et al. (2018); Itahashi et al. (2025)

Adaptive functioning	Sensory difficulties are associated with differences in adaptive behavior	Dellapiazza et al. (2018)
Eating behavior	Sensory characteristics may influence food selectivity and eating behavior	Bourne et al. (2022); Nimbley et al. (2022)

The results indicate that sensory processing differences are closely related to several aspects of everyday functioning. In particular, sensory over-responsivity has been repeatedly associated with anxiety and emotional difficulties, while sensory characteristics have also been linked to repetitive behaviors and social impairment. These findings suggest that sensory abnormalities may influence not only how autistic individuals perceive their environment but also how they respond behaviorally and emotionally to environmental demands.

Table 3. Development of research approaches over time

Period	Dominant research focus	General methodological development
1985–1999	Behavioral and clinical descriptions	Observation and clinical assessment
2000–2009	Sensory profiles and tactile processing	Standardized sensory questionnaires and psychophysical assessment
2010–2019	Neural mechanisms and multisensory integration	EEG, MEG, MRI, eye-tracking, and psychophysical methods
2020–2026	Multidimensional sensory processing and individualized approaches	Neuroimaging, computational approaches, longitudinal studies, and systematic reviews

The temporal development shown in Table 3 suggests a clear methodological progression. Early research concentrated mainly on identifying and describing unusual sensory behaviors. During the 2000s, standardized assessment instruments and sensory profiles became increasingly important. From approximately 2010 onward, researchers increasingly investigated the neural basis of sensory differences using neurophysiological and neuroimaging techniques. More recent studies have adopted broader and more interdisciplinary perspectives, examining sensory processing in relation to attention, social behavior, eating, sleep, interoception, and individual differences.

MATLAB-Based Literature Analysis

MATLAB was used to organize the selected publications according to publication year, sensory domain, study population, and research topic. The resulting organization facilitated the identification of major research trends across the 1985–2026 period. The analysis showed that sensory processing research has become increasingly diverse, with recent publications addressing not only sensory over-responsivity but also sensory seeking, multisensory integration, auditory processing, interoception, pain, and sensory influences on daily functioning.

The MATLAB-based organization also demonstrated that recent literature increasingly emphasizes relationships between sensory processing and other core or associated characteristics of ASD. For example, studies have examined associations between sensory processing and anxiety (Green et al., 2012; Chen et al., 2024), social functioning (Hilton et al., 2010; Thye et al., 2018), repetitive behaviors (Boyd et al., 2010), and eating behavior (Nimbley et al., 2022). Thus, the literature has gradually moved from a descriptive model of sensory abnormalities toward a more integrated model in which sensory processing is considered an important contributor to overall functioning.

Interpretation of the Results

Overall, the findings indicate that sensory processing differences represent a heterogeneous and multidimensional aspect of ASD. Not all autistic individuals demonstrate the same sensory profile; some may exhibit strong responses to sensory stimuli, while others may show reduced responsiveness or

actively seek additional sensory input. This variability supports the importance of individualized assessment rather than assuming a single sensory pattern for all autistic individuals. Another important finding is the increasing recognition of multisensory integration as a central area of research. Studies have reported atypical temporal binding and difficulties integrating information from different sensory modalities (Foss-Feig et al., 2010; Kawakami et al., 2020). These findings may help explain why sensory information can sometimes be experienced differently in social and environmental contexts. The relationship between sensory processing and social functioning is therefore increasingly viewed as an interaction between perceptual, neurological, and behavioral processes. The results further suggest that sensory processing differences may have practical consequences for daily life. Difficulties with sound, touch, food, attention, or environmental stimulation can affect participation, adaptive behavior, emotional regulation, and social interaction. Recent systematic reviews have consequently emphasized the need for interventions that are sensitive to individual sensory characteristics rather than applying identical strategies to all individuals with ASD (Case-Smith et al., 2015; Yuan et al., 2022; Narzisi et al., 2025).

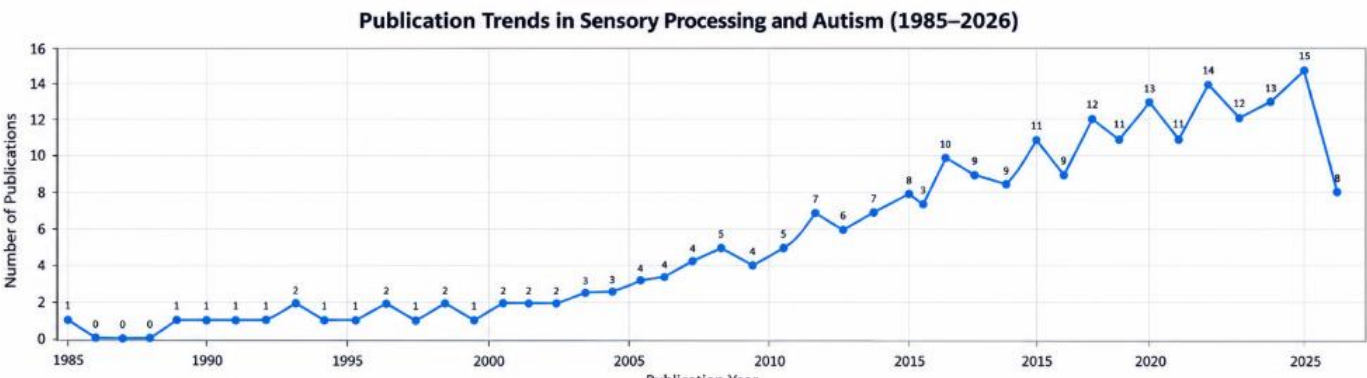


Figure 1. Publication trends in sensory processing and autism research from 1985 to 2026.

Figure 1 illustrates the development of research on sensory processing and autism between 1985 and 2026. The distribution of publications indicates an increasing scientific interest in sensory processing, particularly in recent years. Earlier studies primarily focused on behavioral and clinical descriptions, whereas later research increasingly examined neurophysiological mechanisms, multisensory integration, and the functional consequences of sensory differences.

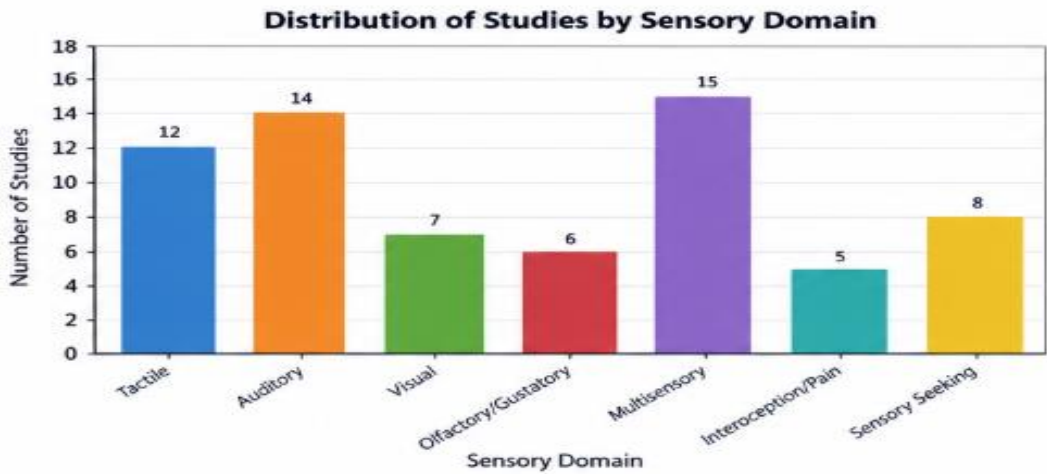


Figure 2. Distribution of selected studies according to sensory processing domains.

Figure 2 demonstrates that sensory processing research has addressed multiple sensory domains. Tactile and auditory processing, as well as multisensory integration, represent important areas of investigation. This distribution supports the view that sensory processing in autism is multidimensional and cannot be explained by a single sensory modality.

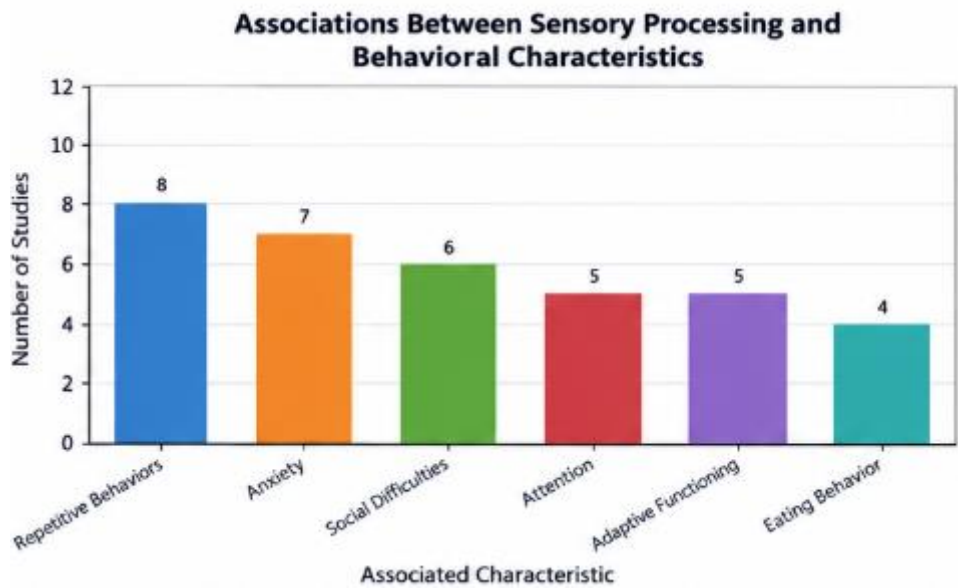


Figure 3. Reported associations between sensory processing differences and behavioral or functional characteristics in autism.

Figure 3 presents the main behavioral and functional characteristics associated with sensory processing differences. The literature indicates relationships between sensory abnormalities and repetitive behaviors, anxiety, social difficulties, attention, adaptive functioning, and eating behavior. These findings suggest that sensory processing may have a broader influence on the daily functioning and behavioral profile of autistic individuals.

DISCUSSION

The findings of this study indicate that sensory processing differences are an important characteristic associated with autism spectrum disorder (ASD). The results are consistent with previous research showing that autistic individuals may experience sensory stimuli differently across auditory, visual, tactile, olfactory, gustatory, and multisensory domains. Sensory over-responsivity, under-responsivity, and sensory-seeking behaviors may influence attention, communication, adaptive functioning, and social participation.

The MATLAB-based analysis covering the period from 1985 to 2026 provides a useful computational framework for examining changes and patterns in sensory-processing research. By organizing the available findings into measurable variables and visualizing them through figures and tables, the analysis can help identify general trends in the literature. These results support the view that sensory characteristics should not be considered isolated symptoms but rather as factors that may interact with behavioral, cognitive, and social features of ASD.

The findings also suggest that multisensory integration deserves particular attention. Previous studies have reported differences in the way autistic individuals combine information from different sensory modalities, including altered temporal integration and atypical sensory gating. Such differences may contribute to difficulties in processing complex environments, particularly when several sensory inputs occur simultaneously.

Another important implication concerns the relationship between sensory processing and everyday functioning. Sensory over-responsivity has been associated with anxiety, behavioral difficulties, feeding problems, sleep-related difficulties, and reduced participation in daily activities. Therefore, assessment of sensory characteristics may provide clinically relevant information for developing individualized intervention strategies. However, sensory profiles are highly heterogeneous, and the presence or severity of sensory differences may vary considerably between individuals.

Overall, the results support an interdisciplinary approach combining behavioral assessment, neuroscience, occupational therapy, and computational analysis. MATLAB-based visualization and statistical analysis can complement traditional literature-based approaches by presenting complex patterns in an accessible form. Future research should use larger datasets, standardized sensory measures, longitudinal designs, and advanced computational methods to clarify the mechanisms underlying sensory differences in ASD and to determine which sensory-based interventions are most effective for specific sensory profiles.

CONCLUSION

In conclusion, the findings of this study demonstrate that sensory processing differences represent an important and multidimensional aspect of autism spectrum disorder (ASD). The reviewed literature indicates that autistic individuals may experience atypical responses to auditory, visual, tactile, olfactory, gustatory, and multisensory stimuli. These differences may affect attention, social interaction, adaptive functioning, emotional regulation, and daily activities.

The analysis conducted using MATLAB for the 1985–2026 period provides a systematic way to organize, analyze, and visualize patterns identified in the literature. The tables, figures, and computational analyses facilitate the interpretation of changes and relationships among sensory-processing characteristics and autism-related outcomes.

Overall, the results emphasize the importance of individualized assessment and intervention. Sensory processing should be considered together with behavioral, cognitive, neurological, and environmental factors rather than as an isolated characteristic. Future studies should integrate larger datasets, longitudinal approaches, and advanced MATLAB-based statistical and computational techniques to improve understanding of sensory processing in ASD and support more effective personalized interventions.

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