

Decreased Sensitivity to Thermal Stimuli in Adolescents With Autism Spectrum Disorder: Relation to Symptomatology and Cognitive Ability

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Abstract: Social communication deficits and repetitive behaviors are established characteristics of autism spectrum disorder (ASD) and the focus of considerable study. Alterations in pain sensitivity have been widely noted clinically but remain understudied and poorly understood. The ASD population may be at greater risk for having their pain undermanaged, especially in children with impaired cognitive ability and limited language skills, which may affect their ability to express pain. Given that sensitivity to noxious stimuli in adolescents with ASD has not been systematically assessed, here we measured warm and cool detection thresholds and heat and cold pain thresholds in 20 high-functioning adolescents with ASD and 55 typically developing adolescents using a method-of-limits quantitative sensory testing protocol. Adolescents with ASD had a loss of sensory function for thermal detection ($P < .001$, both warm and cool detection thresholds) but not pain threshold ($P > .05$, both heat and cold pain thresholds) in comparison to controls, with no evidence for significant age or sex effects ($P > .05$). Intelligence quotients and symptomatology were significantly correlated with a loss of some types of thermal perception in the ASD population (ie, warm detection threshold, cool detection threshold, and heat pain threshold; $P < .05$). Decreased thermal sensitivity in adolescents with ASD may be associated with cognitive impairments relating to attentional deficits. Our findings are consistent with previous literature indicating an association between thermal perception and cortical thickness in brain regions involved in somatosensation, cognition, and salience detection. Further brain-imaging research is needed to determine the neural mechanisms underlying thermal perceptual deficits in adolescents with ASD.

Perspective: We report quantitative evidence for altered thermal thresholds in adolescents with ASD. Reduced sensitivity to warmth, coolness, and heat pain was related to impaired cognitive ability. Caregivers and clinicians should consider cognitive ability when assessing and managing pain in adolescents with ASD.

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Autism spectrum disorder (ASD) is a neurodevelopmental condition characterized by a range of behavioral, communication, and socialization impairments as well as sensory abnormalities.^{3,27} Although much research and clinical attention has focused on communication and socialization, relatively less research has focused on sensory abnormalities, particularly altered pain reactivity, which may contribute to children's withdrawal behaviors and

psychosocial difficulties. The *Diagnostic and Statistical Manual of Mental Disorders* (fifth edition) criteria¹ for ASD now includes touch and pain abnormalities, highlighting the importance of the study of their etiology and characteristics. Furthermore, better understanding of pain processing in children and adolescents with ASD has important clinical implications as their pain may be undermanaged because of impaired cognitive and linguistic abilities.

Pain hyporeactivity is an established characteristic of ASD^{26,51} but has largely been inferred from clinical or caregiver reports.^{36-38,47} For example, Ornitz and colleagues wrote, "Painful stimuli are often ignored; the children may not notice painful bumps, bruises, cuts, or injections."⁴¹ Reduced reactivity to pain in ASD has been related to disruptions in the endogenous opioidergic system.^{39,47} In a clinical setting, children with ASD with reduced displays of pain behavior and nonspecific stereotypic behaviors may not receive effective treatment, as clinicians may fail to recognize the presence or source of pain. Clinicians can underrate pain even in non-ASD children experiencing acute pain³³; this may be more common in ASD, where severity and cognitive impairments may contribute to inaccurate perceptions. For instance, parents perceive their cognitively impaired children as being less reactive to pain in comparison to typically developing (TD) children.¹⁵ Therefore, it is important to understand pain sensitivity in ASD in relation to symptomatology and cognitive ability to improve both clinicians' and caregivers' awareness.

In strong contrast are reports that some individuals with ASD exhibit hypersensitivity to various sensory modalities, including somatosensory, to the extent that they avoid physical contact.^{2,5,21} Evidence suggests that adults with ASD can have heightened vibrotactile discrimination capabilities.⁵ Cascio and colleagues assessed tactile and thermal sensitivity using a quantitative sensory testing (QST) protocol in high-functioning (intelligence quotient [IQ] >70) adults with ASD⁶ and found them to have heightened tactile thresholds. Heat pain threshold (HPT) assessed using a method-of-limits protocol⁵³ was reported to be lower in individuals with ASD. Results suggest enhanced somatosensory perception. However, both previous studies tested small samples (N = 8) of adults with ASD. Published findings to date have largely been with adult ASD populations, which was a motivating factor to conduct the present study with adolescents with ASD.

In the current study, we tested the hypothesis that adolescents with ASD would exhibit alterations in temperature sensitivity relative to their TD counterparts during a QST of thermal detection thresholds for innocuous and noxious stimuli. Thermal thresholds were compared between groups to assess differences in somatosensory functioning. Furthermore, within the ASD group, the influence of cognitive ability on thermal detection and thresholds for heat and cold pain was assessed.

Methods

Participants

Seventy-six adolescents participated in the study. Twenty participants had received a clinical diagnosis of ASD (75% boys, n = 15, mean age = 14.6 years, standard deviation [SD] = 1.9 years, 18 right-handed) by a psychologist or a developmental pediatrician, which was confirmed using the Autism Diagnostic Observation Schedule–Generic (ADOS-G)³⁰ (Table 1) administered by personnel who had research-level reliability with the University of Michigan Autism & Communication Disorders Centre. All ASD participants were healthy, were verbal, and had IQs in the normal range (mean = 104.1 ± 18.27), scoring higher than 70 (scores 2 SDs lower than the mean are considered low functioning) when assessed with the Wechsler Abbreviated Scale of Intelligence. Two male and 2 female participants were taking medication for comorbidities such as attention-deficit disorder, repetitive behaviors, and depression at the time of study (methylphenidate, gabapentin [for mania-like behaviors], ziprasidone hydrochloride monohydrate, selective serotonin reuptake inhibitors). The ASD cohort was recruited through fliers at the Autism Research Unit at the Hospital for Sick Children.

A total of 56 TD adolescents (48% boys, n = 27, mean age = 15.7 years, SD = 1.1 years, 49 right-handed) were recruited to collect normative data to compare thermal thresholds acquired in adolescents with chronic pain.³⁴ The TD adolescents were slightly older than those in the ASD group (t = 2.2, P = .03); however, the numbers of boys and girls in the 2 groups did not differ significantly ($\chi^2 = 3.7$, P = .053). The TD adolescents were screened for developmental delay; however, cognitive ability (IQ) was not assessed as part of this protocol. The participants were recruited through advertisements in a free community-based newspaper and hospital fliers. This age group was selected for reasons related to feasibility and compliance with study procedures.

The research ethics board at the Hospital for Sick Children approved the study, and written informed consent was obtained from parents and informed assent from all adolescents, including the adolescents with ASD.

Table 1. Measures of Cognitive Ability and Autism Symptom Severity

MEASURE	RANGE	MEAN	SD
WASI (n = 17)	71–138	104.4	16.9
ADOS-G (n = 14)			
Communication domain		2.6	1.3
Social domain		7	2.0
Restricted-repetitive behavior		2.4	1.2
ADOS-G severity metric* (n = 9)	4–9	6	1.9

Abbreviation: WASI, Wechsler Abbreviated Scale of Intelligence.

NOTE. Standardized measures for IQ included the WASI, and autism symptom severity was determined using the ADOS-G.

*The ADOS-G severity metric was calculated for the 9 participants who were assessed using module 3. The remaining participants were assessed using module 4, which is not included in the severity metric.

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