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Sensory processing in children with Autism Spectrum Disorder: Relationship with non-verbal IQ, autism severity and Attention Deficit/Hyperactivity Disorder symptomatology

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ABSTRACT

The main objective of this study was to analyze in a sample of children with ASD the relationship between sensory processing, social participation and praxis impairments and some of the child's characteristics, such as non-verbal IQ, severity of ASD symptoms and the number of ADHD symptoms (inattention and hyperactivity/impulsivity), both in the home and main-classroom environments. Participants were the parents and teachers of 41 children with ASD from 5 to 8 years old ($M = 6.09$). They completed the Sensory Processing Measure (SPM) to evaluate sensory processing, social participation and praxis; the Gilliam Autism Rating Scale (GARS-2) to evaluate autism severity; and a set of items (the DSM-IV-TR criteria) to evaluate the number of inattention and hyperactivity/impulsivity symptoms in the child. Non-verbal IQ – measured by the Raven's Coloured Progressive Matrices Test – did not show a relationship with any of the SPM variables. The SPM variables were significant predictors of autism severity and had similar weights in the two environments. In the case of ADHD symptoms, the SPM variables had a greater weight in the home than in the classroom environment, and they were significant predictors of both inattention and hyperactivity/impulsivity – especially inattention – only in the family context. The moderate association between inattention and auditory processing found in the main-classroom suggests the possible utility of certain measures aimed to simplify any classroom's acoustic environment.

1. Introduction

In the DSM-5 (APA, 2013), Autism Spectrum Disorder (ASD) is considered a neurodevelopmental disorder. This latest edition includes the possible presence of sensory issues as part of the ASD diagnostic criteria. Clinically, the term *sensory*

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integration refers to a field of study related to individuals with atypical responses to ordinary sensory stimulation. In neuroscience, the term *sensory integration* refers to converging information in the brain from the sensory domains, including the interaction between different sensory modalities, which is called multisensory integration. Difficulties in multisensory integration in ASD may lie in the temporal synchronization of neural networks because the ability to combine information from multiple sensory modalities to form a unified perception depends on the temporal synchrony of sensory stimuli (Stevenson et al., 2014). In this vein, recent research has assessed neurobiological underpinnings and neural roots of unusual sensory features in individuals with ASD in studies using event-related potentials (Brandwein et al., 2015; Donkers et al., 2015) and functional magnetic resonance imaging (Green et al., 2013). Thus, some evidence has been found of greater activation in primary sensory cortical areas, the amygdala, hippocampus, and orbital-frontal cortex, in individuals with ASD, compared to typically developing individuals (Green et al., 2013).

The identification of abnormal patterns of neural connectivity could be a useful approach to unify different cognitive theories of autism (theory of mind, central coherence theory, executive dysfunction theory), neurobiological findings, and a neuropsychological perspective (Hughes, 2007). From the first descriptions of the disorder by Leo Kanner (1943), the different theoretical approaches to the study of autism have shown the presence of sensory alterations in a large number of cases. In the framework of the different cognitive theories of autism, some studies have investigated the possible association of sensory issues with cognitive constructs such as executive functioning (Boyd, MCBee, Holtzclaw, Baranek, & Bodfish, 2009), and a detail-focused style of processing, or hyper-selectivity (Chen, Rodgers, & McConachie, 2009; Liss, Saulnier, Fein, & Kinsbourne, 2006), but the results are still inconclusive.

1.1. Sensory processing, social participation and praxis

According to Sensory Integration Theory (Ayres, 1979), the processing and integration of sensory inputs is a critical neurobehavioral process that strongly affects development. Sensory processing impairments involve a neurological dysfunction that may affect behavioral responses to sensory input (Tomchek, 2001). Difficulties at the level of sensory processing can contribute to impairments in higher level integrative functions, so that sensory issues can affect the successful performance of adaptive responses to situational demands and, thus, meaningful engagement in daily activities (Humphry, 2002). For example, there have been descriptions of people with ASD who say they are not able to correctly comprehend the words of the speaker when they make eye contact. Others mention that they have difficulty talking while walking, and others experience sounds and/or images as painfully intense, etc. (Donnellan, Hill, & Leary, 2012). These unusual or different sensory experiences can contribute to making the participation of these people in daily social activities even more difficult, as in the case of games and interactions with other people (Kuhaneck & Britner, 2013).

Sensory functions are also related to praxis (Mailloux et al., 2011) – namely the ability to conceptualize or ideate, plan and organize movements in order to carry out unfamiliar motor tasks – because body awareness and the ability to process sensory information may be related to both imitation and generativity. Although routine and stereotyped motor activities like walking and running are often easy for people with ASD, motor skills requiring adjustments in initiation, timing, sequencing, speed and direction of movement may be more difficult (Rinner, 2002). Difficulties with praxis are related to poor performance on activities that require motor skills and flexible problem solving. Poor motor planning abilities limit the ability to expand play repertoires or engage with others (Mailloux, Blanche, & Schaaf, 2001).

1.2. Literature review

Previous research has reported that sensory processing impairments are highly prevalent in children with ASD (Baranek, David, Poe, Stone, & Watson, 2006; Kientz & Dunn, 1997; Liss, Saulnier, Fein, & Kinsbourne, 2006; Watling, Deitz, & White, 2001; see for a review: Costa & Lampreia, 2012), although they are not always present. Nor are they exclusive to ASD, as they are also present in other disorders and disabilities (Cheung & Siu, 2009; Ermer & Dunn, 1998; Leekam, Nieto, Libby, Wing, & Gould, 2007; O'Brien et al., 2009; Rogers, Hepburn, & Wehner, 2003; Wiggins, Robins, Bakeman, & Adamson, 2009). Comparing the sensory processing characteristics of children with ASD with those of children with typical development, several studies have obtained differences (Ashburner, Ziviani, & Rodger, 2008; Ben-Sasson et al., 2007; Dunn, Myles, & Orr, 2002; Fernández, Pastor, Sanz, & Tárraga, 2015; Kern et al., 2006; Kientz & Dunn, 1997; Lai, Chung, Chan, & Li-Tsang, 2011; Tomcheck & Dunn, 2007; Watling et al., 2001; see the meta-analysis by Ben-Sasson et al., 2009). The sensory modalities that have shown the greatest differences are hearing and touch (Ashburner et al., 2008; Fernández et al., 2015; Kientz & Dunn, 1997; Rogers et al., 2003; Tomcheck & Dunn, 2007; Wiggins et al., 2009), with differences usually found specifically in auditory filtering and tactile sensitivity.

Despite the terminology used on some measures referring to the sensory modalities (vision, hearing, touch, etc.), it must be kept in mind that the impairments or differences that these children experience refer to the sensory processing of one or more modalities. Thus, it is not the sensory modality that is impaired, but rather the way these children process the information related to a particular sensory modality. The responses of people with sensory processing alterations have generally been considered "maladaptive or dysfunctional" because they are different from the interpretations that a person with typical development would make. Nonetheless, these differences may not necessarily indicate dysfunction or problems because, as Bogdashina (2003) claims, these alterations sometimes become "super abilities" to which people without ASD do not have access. In this sense, this author talks about two parallel worlds, two different ways of experiencing the world.