Etiology of Attention Deficit in Individuals with Autism Spectrum Disorder and the Role of Neuroscientific Literature Reviews

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1. Introduction

As mentioned in the Diagnostic and Statistical Manual (DSM-5) (APA, 2013), the main features of Autism Spectrum Disorder include (a) the presence of abnormal or impaired development in social interaction and communication, and (b) the presence of activities /interests/restricted and stereotyped behaviors (APA-DSM-5, 2013). Manifestations of the disorder vary based on the individual's developmental level (DL/IQ) and chronological age. In most cases, the diagnosis of ASD is accompanied by mental retardation, usually of moderate severity. About 75% of children with ASD show abnormalities in cognitive development regardless of the general level of intelligence (Armstrong, 2017; Shyman, 2016; Shic, & Scassellati, 2006). In addition, subjects with ASD exhibit a wide range of behavioral symptoms, such as hyperactivity, impulsivity, aggression, and decreased attention. For the latter, which represents the object of study of this article, the scientific community has used different methodologies (videos of adult-child interactions and visual tracking techniques) to investigate visual attention in subjects with ASD (Vacas et al., 2022; Chita-Tegmark, 2016; Guillon et al., 2014; Chawarska et al., 2013; Falck-Ytter et al., 2013; Gibson, 1994). Given that autism is usually not diagnosed before the age of three, the identification of prodromal symptoms of the disorder has been methodologically evaluated through retrospective studies using video of interaction (Chawarska et al., 2013). The advantage of this methodology is that it can provide a direct and ecological measure of the social orientation deficit present in subjects with ASD. Studies, exploiting the potential of highly sophisticated technology such as eye movement tracking, consider eye movements as important indicators of perception and attention (Yamamoto et al., 2017; Magrelli et al., 2013). Since this assessment method provides the right balance between ecological and medical validity, it can be considered today as a unique method for identifying and characterizing subtle variations in visual attention of subjects with ASD (Shic et al, 2022; Vacas, 2022; Yamamoto et al., 2017; Chita-Tegmark, 2016; Guillon et al., 2014; Falck-Ytter et al., 2013). Studies have shown that this form of methodology can be used with all populations (from newborns to adults) regardless of the level of verbal and non-verbal functioning (Guillon et al., 2014; Simion et al., 2008).

2. Behavioral Studies Modeled on Static and Dynamic Social Stimuli

Because the processing of social stimuli is one of the essential elements of social development, especially in interpreting the emotional state of another individual, much scientific and neuroscientific research has focused on understanding these difficulties in individuals with ASD. According to several studies that have used samples of early-age children, subjects with ASD, compared to subjects with Typical Development (TDP), have shown reduced levels of attention to children in relation to social stimuli (faces) (Shic et al., 2022; Chawarska et al., 2013; Shic et al., 2011; Shic & Scassellati, 2006). When viewing a novel face, children with ASD use atypical visual registration patterns and take longer to recognize and integrate different parts of the face (Losh et al., 2020; Konst & Matson, 2014; Webb et al., 2010; Chawarska & Shic, 2009). Another interesting study is the one proposed by Hanley, McPhillips, Mulhern and Riby (2013). Researchers, while In the condition in which the face was placed within a social scene, the observation time of subjects with ASD was significantly shorter (idem). Therefore, using more social stimuli may increase the likelihood that subjects with ASD look less at faces than typically developing subjects. The same results were also reported in the studies of Vacas et al., (2022), Chevallier et al. (2015) and Falck-Yter, (2013). In their research, the researchers compared attention to social stimuli in three different conditions: 1) visual exploration of static stimuli (12 sets containing 12 static images of objects and faces that varied in size and complexity); 2) sets of visual exploration of dynamic stimuli (12 matrices of video clips showing people and objects) and 3) sets of interactive visual exploration (22 videos of children playing with some objects sitting on a table or on the floor. By comparing two groups of subjects (ASD vs ZHT), the study investigated the influence of stimulus type (static, dynamic and interactive) on attentional task ability and evaluated the effectiveness of different types of stimuli. for differences between groups. A comparison of three experimental forms of eye movement tracking revealed that changes in attention in ASD subjects were more evident when the latter viewed dynamic social stimuli present during interaction. Moreover, regarding the differences between groups, the data showed different visual attention in the visual-interactive exploration task in the two groups of subjects (Vacas et al., 2022; Chevallier et al., 2015; Falck-Ytes, 2013). In line with the idea that in reality, social stimuli are presented in a dynamic form, other eye-tracking studies have examined the attentional responses of children with ASD to this type of stimuli. Shic et al., (2011), using an adult-child interaction video, assessed attentional responses in three groups of subjects (28 ASD, 34 ZHT and 16 ZHV-Developmental delay) with a mean age of 20 months. The results of this study showed that when children with ASD watched a video of parent-child interactions(engaged in simple social games or a shared activity), they focused mainly on the background rather than the activity. Also, another analytical study showed that, when subjects with ASD looked at people present on stage, they focused more on the body parts than on the faces of the "actors" (idem). According to the researchers, it is likely that subjects with ASD attribute little importance to the social aspects of the scene. These data are in line with other studies in the literature according to which, for subjects with ASD, social stimuli do not represent a “distinct” category of stimuli, as is the case in typical development (Mo et al., 2019; Sumner et al. , 2018 Kröger et al., 2013; Campatelli et al., 2013). These first results have changed the way scientists understand developmental differences in attention and social stimuli in children with ASD, where it is generally expected that diagnosis made before age 3 may provide some information on the variability of typical attentional responses of subjects. with ASD (Sumner et al., 2018; Elsabbagh et al., 2013).

3. Behavioral Studies with the Presence of Geometric Figures

Another set of studies that has generated very interesting results is related to the study of the attention of subjects with ASD to "abstract" stimuli, such as geometric figures (Pierce et al., 2011, 2015; Shaffer et al., 2017; Shi et al., 2015). In their research, Pierce et al. (2011, 2016) hypothesized that subjects with ASD a) spend a long fixation time on geometric rather than social stimuli; b) have a preference for geometric stimuli already present at a young age (starting from the first year) and c) show a reduction in the number of face focuses when observing visual scenes. To test these hypotheses, the researchers developed a visual preference paradigm that examined looking time to highly salient social stimuli (eg, dancing children) compared to equally salient geometric images (eg, movements circular and repeating several concentric circles). The authors selected infants aged 14 to 42 months to assess changes in visual preference for geometric stimuli across development. Another group of children with developmental delay (LD) was included in this research to examine whether patterns of visual preferences were more related to a language delay or a cognitive delay. From the results, it was reported that children at risk of ASD (14 months) spent more time examining dynamic geometric images than subjects with ZHT and ZHV. However, this phenomenon was not ubiquitous in the sample of subjects at risk of ASD; more specifically, 40% of the subjects preferred the geometric stimuli, while 60% of the subjects performed similarly to the other two groups with ZHT and ZHV figures in relation to the social dynamic stimuli. Therefore, according to Pierce et al. (2011), the preference for geometric stimuli .

4. Conclusions

The overall objective of this study was related to the exploration of whether the deficit of visual exploration of social stimuli (faces) is a priority in the development of ASD symptoms or whether the latter is secondary to a non-specific deficit of visual attention present from the stages of the earliest processing of the stimulus. Based on the reviewed literature, among the variables that can determine the deficit of attention to social and non-social stimuli, in this research the perceptual complexity of images belonging to different categories was evaluated. The aim is to determine if it is the perception of the complexity of the images that determines the exploration of the deficit of visualization of social stimuli in subjects with ASD. As highlighted in the studies reviewed in this paper, the results of research in the literature are contradictory. It is likely that subjects with ASD focus less on social stimuli because they are not sufficiently "interesting and motivating" (Chevallier et al., 2015; Shic et al., 2011) or because they are not prioritized in their attention (Chawarska et al. et al., 2013). Moreover, the limited attention to social stimuli (Chaearska et al., 2013; Shic et al., 2011; Coffman et al., 2011) is likely a direct result of the higher salience of nonsocial stimuli (Sasson & Touchstone, 2014; Pierce et al., 2011, 2015; Shi et al., 2015; Shaffer et al., 2017). Despite these results, other studies have shown that core deficits in ASD cannot be attributed to changes in visual exploration of social stimuli, but rather result from early general difficulties in controlling visual attention. The latter, in turn, can cause self-regulation problems and compromise the acquisition of skills needed to process stimuli (Elsabbagh & Johnson, 2007; 2010; Elsabbagh et al., 2013a; Elsabbagh et al., 2013b; Sacrey et al., 2013). In the context of the present research, through which we intend to refer to explain the visual exploration difficulties present in ASD, these difficulties are related to the presence of a non-specific Visual Attention Deficit present in the early stages of input processing visual (Elsabbagh et al., 2013; Elsabbagh & Johnson, 2007; 2010). According to the theory elaborated through the various researches explored, the attention difficulties present in subjects with ASD are not caused by changes in the visual exploration of social stimuli, but by the first general difficulties in the control of visual attention. These can cause problems of self-regulation and endanger the acquisition of skills necessary for the processing of stimuli (Elsabbagh et al., 2013). Since such deficits in visual attention are neither universal nor specific to autism, the presence of a nonspecific deficit in visual attention to socially relevant stimuli may be a necessary but not sufficient condition for the manifestation of difficulties present in the disorder. of the Autism Spectrum (idem). Future research could focus on the variability of attentional responses of infants at risk of ASD by considering many aspects, such as the use of different types of stimuli (static vs. dynamic, social vs. nonsocial, geometric vs. ecological), assessment of internal characteristics of stimuli (familiarity, complexity) and the effects of some variables (preference, pleasure, state of activation) in the responses of subjects with typical and atypical development.

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