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Modulation of attention by socio-emotional scenes in children with autism spectrum disorder

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ABSTRACT

Background: Abnormal attentional processes to socially relevant information may underlie social impairment in Autism Spectrum Disorder (ASD). To examine how these processes are modulated by the emotional salience of the stimuli, we studied the attentional biases to social scenes (happy, sad, and threatening) in ASD children.
Method: An emotional dot-probe task was applied to children (from 6 to 12 years old) with Autism Spectrum Disorder without additional language and/or intellectual impairments (ASD; n = 25) and age/sex-matched controls (n = 25).
Results: ASD children showed an attentional bias toward threatening scenes while typically developing children tended to direct their attention toward sad scenes. There were no differences between groups for happy scenes.
Conclusions: Threatening situations captured greater attention in ASD individuals than in the control participants. Thus, abnormal attention to emotionally relevant situations may negatively affect the ability of ASD children to adapt cognitively and emotionally, particularly in threatening situations.

1. Introduction

Individuals with Autism Spectrum Disorder (ASD) have been characterized by persistent deficits in communication and social interaction (ICD-10; World Health Organization (WHO), 1992). Of note, the ICD-10 criteria for ASD also include circumscribed interests and repetitive behaviors. This latter criterion has been commonly associated with how attention is initially captured by a set of restricted stimuli. Indeed, it has been proposed that ASD children do not attend to relevant information from the social context, which impairs their decision-making processes (Worsham, Gray, Larson, & South, 2015) and, subsequently, their social cognitive development (Klin, Jones, Schultz, & Volkmar, 2003; Guillon, Hadjikhani, Baduel, & Rogé, 2014).

While a number of prior studies have shown abnormalities in the attentional capture of aspects of social environment —in contrast to nonsocial information—in individuals with ASD (e.g., see Elison, Sasson, Turner-Brown, Dichter, & Bodfish, 2012), an unanswered question is how attention is modulated by the emotional salience of the stimuli. Here we focused on ASD

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children because adolescent and adults may have learned to readjust their social behavior and, subsequently, to attend to socially relevant situations (see Elison et al., 2012). Behavioral tasks are an excellent technique for examining how emotionally relevant stimuli capture attention, of which, the most paradigmatic task is the double cueing (or dot-probe) task (see Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & Van Ijzendoorn, 2007, for a meta-analysis). In the emotional dot-probe task, two cues (one neutral and the other emotional; e.g., a neutral face and an emotional face) are briefly displayed in different locations on the screen (e.g., left and right). Immediately after the stimuli disappear, a dot probe (target) replaces one of the two cued stimuli. Participants are instructed to press a button to indicate the position in which the target appeared. That is, the dot probe can appear in the location of the emotional cue (i.e., emotion trial) or in the location of the neutral cue (i.e., neutral trial). The interpretation of the latency data in this technique is straightforward (see MacLeod, Mathews, & Tata, 1986): faster responses in emotion trials indicate an attentional bias toward emotional information (i.e., the assumption is that participants shift their attention at the emotional cue), whereas faster responses in neutral trials indicate an attentional bias away from emotional information.

The empirical literature on attentional capture by faces in ASD children is non-conclusive. Hollocks, Ozsivadjian, Matthews, Howlin, and Simonoff (2013) reported negligible attentional biases to happy or threatening faces, whereas other studies reported abnormal processing of distressing (i.e., fearful or angry) faces in ASD individuals (Uono, Sato, & Toichi, 2009; Matsuda, Minagawa, & Yamamoto, 2015). Specifically, Uono et al. (2009) conducted an experiment with ASD adolescents versus a control group in which they employed a modified version of the cueing task. In the Uono et al. (2009) experiment, the cues were dynamic eye-direction of fearful or neutral faces. The control group showed a cueing effect (i.e., faster responses when the eye-direction cue and the target appeared at the same location relative to the opposite location) that was higher for fearful than for neutral faces. However, this cueing effect did not appear in the ASD group. Moreover, Matsuda et al. (2015) conducted an eye-tracking experiment with ASD and typically developing (TD) children that examined gaze behavior toward surprised, happy, neutral, angry, and sad faces. While there were no differences between groups in gaze behavior when looking at faces, ASD children with more severe autistic symptomatology spent less time looking at angry faces than at the other faces (i.e., atypical responses to angry stimuli can be used as an indicator of autism severity). Finally, Corden, Childvers, and Skuse (2008) reported an atypical attentional capture by emotionally distressing words in ASD individuals using an attentional blink paradigm (see also Gaigg & Bowler, 2009, for a similar finding). These findings suggest that atypicalities in how emotional factors modulate attention may extend beyond faces in ASD.

To examine attentional biases in a scenario closer to real-world social situations, other researchers have employed pictures of social scenes instead of faces or words. The rationale is that socio-emotional scenes are important for understanding real-world social difficulties in ASD individuals (Fletcher-Watson, Leekam, Benson, Frank, & Findlay, 2009), and hence, socio-emotional scenes may provide a more ecologically valid scenario than faces. Recently, Santos et al. (2012) examined selective attention toward social scenes in ASD adolescents and adults as well as in matched TD individuals. Pairs of social scenes (positive–neutral, negative–neutral, or neutral–neutral) were displayed while their eye movements were registered. (Positive and negative scenes were different in valence, but not in arousal.) Results showed that, unlike TD individuals, there was no initial orientation (i.e., first fixation) bias toward negative images in ASD individuals. Importantly, when considering the early capture of attention (i.e., total number of fixations during the 3-s presentation), both the ASD group and the control group showed an attentional bias toward negative scenes. Santos et al. (2012) concluded that ASD individuals were able to redirect their attention to negative scenes similarly to TD individuals.

Taken together, ASD individuals seem to show an attentional bias away from distressing faces (e.g., angry faces, Matsuda et al., 2015; fearful faces, Uono et al., 2009) but, at the same time, they show the typical attentional bias toward negative scenes (Santos et al., 2012). While the Santos et al. experiment offers very valuable information it is not possible to affirm that all social scenes are normally processed in ASD. We must bear in mind that the scenes included in the Santos et al. experiment did not distinguish between high-arousal vs. middle-arousal negative social scenes (i.e., threatening vs. sad images, respectively), thus leaving open the question of whether the attentional biases in social scenes are modulated by negativity or arousal in ASD children. Indeed, as indicated earlier, in Matsuda et al. (2015), ASD children reported differences between distressing (i.e., high arousal) and sad (i.e., middle arousal) faces. The present experiment aims to shed some light on this issue in ASD children by contrasting threatening with sad emotional social scenes.

In sum, in the present experiment, we examined how attentional capture could be modulated by the emotional salience of the stimuli in ASD individuals. To that end, we conducted a dot-probe experiment with emotionally relevant social situations with ASD children, together with a control group of TD children. Finally, what we should also note is that our study is the first aimed at discerning the effect on attentional processing of several types of negative scenes (i.e., threatening [high-arousal] and sad [middle-arousal]) in addition to happy [middle-arousal] scenes.

2. Material and methods

2.1. Participants

Fifty children between 6 and 12 years of age took part in the experiment. Twenty-five children (23 male, 2 female) with a diagnosis of ASD were recruited from the Infant Mental Health Unit, University and Polytechnic Hospital La Fe, Spain (Valencia, Spain). None of them had language and/or intellectual impairments. An additional group of 25 TD children (18 male, 7 female) were recruited via a local primary school. Parental informed consent was obtained for all participants.