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## The relationship between atypical visual processing and social skills in young children with autism



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### ABSTRACT

The present study examined whether atypical visual processing is related to the level of social skills in children with autism spectrum disorder (ASD). Thirty-eight young children with ASD (29 boys, 9 girls) were included. Atypical visual processing was assessed by coding the number of lateral glances and the amount of object grouping behavior on videotaped observations of the ADOS (aged  $35 \pm 9$  months). The level of social skills was measured using the subscale interpersonal relationships of the Vineland SEEC ( $32 \pm 7$  months). A negative relationship with a medium effect size was found between lateral glances and interpersonal relationships. Object grouping behavior and interpersonal relationships were not related. This study suggests that visual perception may be a mechanism in the development of interpersonal relationships in ASD, which is in accordance with an embodied approach to social cognition.

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## 1. Introduction

Increasing evidence suggests that atypical visual processing and atypical visual behaviors are present in individuals with autism spectrum disorder (ASD). Autism has been particularly associated with a locally oriented perception (Motttron, Dawson, Soulières, Hubert, & Burack, 2006; see Dakin & Frith, 2005 for a review). Experimental studies indicate that both children and adults with ASD are superior in tasks that require attention to local elements, such as visual search, embedded figures and block design tasks (Dakin & Frith, 2005; Jolliffe and Baron-Cohen, 1997; Kaldy, Krapar, Carter, & Blaser, 2011; Riordan, Plaisted, Driver, & Baron-Cohen, 2001; Rondan & Deruelle, 2007). Neurological studies are in line with these results. In children and adults with autism enhanced activity in the visual brain areas has been found in response to high spatial frequency (fine perceptual detail, sharp edges) versus low spatial frequency (general shape and large contour) stimulus information, compared to typically developing and developmentally delayed comparison groups and both for neutral as well as socially relevant stimuli (Deruelle, Rondan, Gepner, & Tardif, 2004; Vlamings, Jonkman, van Daalen, van der Graag, & Kemner, 2010). In addition to experimental and neurological evidence that demonstrate atypical visual processing, a number of observational studies indicate the presence of atypical visual behaviors in autistic individuals. Ozonoff et al. (2008) and

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Zwaigenbaum et al. (2005) report that unusual visual exploration, such as prolonged visual inspection and examining objects from odd angles, is common in young children with autism and that these behaviors differentiate these children from typically developing children and children with a developmental disorder. A study by Mottron et al. (2007) identified lateral glances as the most frequent atypical visual exploratory behavior in children with autism. It has been hypothesized that atypical visual behaviors are an adaptive strategy to regulate the overwhelming amount of information that is experienced by people with autism due to their atypical visual processing (Mottron et al., 2007). These behaviors are an example of an epistemic action. Epistemic actions are actions which humans take with the intent of facilitating cognition, for instance first structuring the physical environment before starting to work (Kirsh & Maglio, 1994). Stacking or lining up toys is common in children with autism (Baron-Cohen, Ashwin, Ashwin, Tavasolli, & Chakrabarti, 2009; Williams, Costall, & Reddy, 1999) and may be another epistemic action that these children apply in response to their atypical visual processing (Coulter, 2009). By creating object patterns autistic children may alter the environment in such a way that it provides them with the general shape and larger contour information that they often do not automatically perceive. Adapting the physical environment in this way also reduces the incoming information by creating large patterns. Thus, it may be proposed that both atypical visual behaviors and object grouping behaviors reflect a strategy to regulate the visual information that is atypically processed in autism.

It has been hypothesized that atypical information processing may be a primary deficit of ASD that accounts for both the social and non-social symptoms present in ASD (Mottron et al., 2006). Evidence from longitudinal studies with high risk infants suggests that visual atypicalities differentiate siblings later diagnosed with ASD from other siblings and control (Zwaigenbaum et al., 2005). The notion that atypical visual processing may be related to symptoms of ASD such as social-communicative impairments is consistent with an embodied cognition approach to social understanding. While the Theory of Mind (ToM) theory describes social cognition as a 'mentalizing' activity wherein people have to infer other people's intentions (Baron-Cohen, Leslie, & Frith, 1985), embodied cognition theory would describe social understanding more in terms of a perception-action process that requires being adept at picking up the relevant stimuli in the social environment and adjusting actions rapidly and appropriately to the situation (Gallagher, 2008; Smith & Gasser, 2005; Thelen, 2008). Many authors have suggested using a more perceptually based embodied, enactive approach to social cognition (Gallagher, 2008; Good, 2007; De Jaegher & Di Paolo, 2007).

From this perspective the atypical visual processing of individuals with autism may have important consequences for the development of their social skills. If a person with autism is not attuned to the relevant social information in the environment as a result of atypical visual processing this is detrimental for the ability to participate adequately in social interactions. Picking up the relevant visual information allows people to understand, react and anticipate to the behavior of other people (Pavlova, 2012). Individuals with ASD have often been reported to have difficulty recognizing other people's actions and to show impairments in face processing, interpersonal coordination and anticipation of others' actions (Brisson, Warreyn, Serres, Foussier, & Adrien-Louis, 2012; Dawson, Webb, & McPartland, 2005; Kaiser & Shiffrar, 2009; Ramenzoni, Davis, Riley, Shockey, & Baker, 2011). It has been suggested that the information that specifies facial expressions consists of a specific spatial integration of different facial features changing in a characteristic way. That information is critical for face and emotion recognition (Behrmann, Thomas, & Humphreys, 2006), and is largely supported by low spatial frequencies (Goffaux and Rossini, 2006). Because of their atypical visual processing, individuals with ASD may not be attuned to the relevant information and consequently a specific facial expression may not elicit the 'typical' social behavior for people with ASD. Due to their atypical visual processing individuals with autism may have specific difficulties with social interactions because social information is richer, multimodal, and more dynamic compared to for instance information from the more static, physical environment. The eyes, for instance, are the most stimulus-rich part of the face (Schore, 1994). Klin, Jones, Schultz and Volkmar (2003) demonstrate, using eye-tracking technology, that typical viewers converge on the eye region when viewing naturalistic social film scenes, while individuals with autism tend to converge on the mouth region or other parts of the scene. People with autism are also impaired in biological motion processing, which a very important skills for social understanding (Annaz et al., 2010; Pavlova, 2012; Swettenham et al., 2013). Faced with these difficulties, many (high-functioning) autistic people learn to rely on more advanced active reasoning skills for their social skills (Williams, 2009). This has led to authors to suggest that people on the autism spectrum are the ones who do use an explicit ToM (De Jaegher, 2013; Williams, 2009). While social impairments in autism have been traditionally attributed to having an 'impaired' theory of mind (Baron-Cohen et al., 1985), the increasingly influential field of embodied cognition together with a body of research that demonstrates that people with autism demonstrate difficulties in perception-action processes (e.g. Gepner & Féron, 2009) has led a paradigm shift. More and more researchers are claiming that social cognition involves sensorimotor learning wherein the selection and execution of adequate social responses is significantly influenced by the ability the pick up the information that informs these actions, a process which may be impaired in ASD (Gepner & Féron, 2009; Kapp, 2013; Klin et al., 2003; Mottron et al., 2006).

Although some studies have demonstrated that atypical visual processing is an early marker of ASD symptomatology (Zwaigenbaum et al., 2005), these studies do not yet answer the question of which and how abnormalities are interrelated. Studies that directly examine the relationship between atypical information processing and social skills are lacking. Our purpose in the present study is to examine whether atypical visual processing is related to the development of social skills in young children with autism. It is hypothesized that atypical visual processing is negatively related to the level of social skills in young children with autism.

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