



# Attention during social interaction in children with autism: Comparison to specific language impairment, typical development, and links to social cognition



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## ABSTRACT

Eye-tracking studies have shown how people with autism spend significantly less time looking at socially relevant information on-screen compared to those developing typically. This has been suggested to impact on the development of socio-cognitive skills in autism. We present novel evidence of how attention atypicalities in children with autism extend to real-life interaction, in comparison to typically developing (TD) children and children with specific language impairment (SLI). We explored the allocation of attention during social interaction with an interlocutor, and how aspects of attention (awareness checking) related to traditional measures of social cognition (false belief attribution). We found divergent attention allocation patterns across the groups in relation to social cognition ability. Even though children with autism and SLI performed similarly on the socio-cognitive tasks, there were syndrome-specific atypicalities of their attention patterns. Children with SLI were most similar to TD children in terms of prioritising attention to socially pertinent information (eyes, face, awareness checking). Children with autism showed reduced attention to the eyes and face, and slower awareness checking. This study provides unique and timely insight into real-world social gaze (a)typicality in autism, SLI and typical development, its relationship to socio-cognitive ability, and raises important issues for intervention.

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## 1. Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterised by impairments in social and communicative functioning, as well as the presence of repetitive/stereotyped patterns of behaviour (APA, 1994). Difficulties with reciprocal social interactions are among the greatest challenges that individuals with ASD face in their everyday activities, and this type of difficulty can lead to a range of negative outcomes, such as social isolation, anxiety and depression (Bellini, Peters, Bennet, & Hopf, 2007; Howlin, Goode, Hutton, & Rutter, 2004). In this study we focus on the nature of gaze to socially relevant information for individuals functioning on the autism spectrum. We specifically explore the importance of

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the nature of experimental stimuli, the importance of comparison groups, and the relationship between gaze behaviour and other socio-cognitive capabilities.

### 1.1. Gaze behaviours and autism

Atypical social gaze is among the earliest clinical markers for ASD (Volkmar, Carter, Grossman, & Klin, 1997), which is important as typical social gaze is key to many early socio-developmental milestones, such as joint attention (Von Hoftsen & Gredebäck, 2009). Attention to the eyes of others is significant for social development and social adaption in early childhood, but it is also important in later life, as much of our socialisation is typically facilitated by information portrayed by the eyes (Jones, Carr, & Klin, 2008; Klin, 2008). It has been suggested that atypical attention to social information early in development could have a cascading effect on subsequent social development, derailing typical social learning, ultimately contributing to the development of atypical social behaviours that we associate with functioning on the autism spectrum (Dawson et al., 2004; Klin & Jones, 2008; Klin, 2008; Pruett et al., 2011; Senju & Johnson, 2009). Therefore, exploration of social gaze in autism has become an important research priority, with potential theoretical and clinical implications.

Research on social gaze (looking to faces) has provided an important gateway to understand socio-cognitive difficulties in autism. For example, Dawson, Meltzoff, Osterling, Rinaldi, and Brown (1998) found that children with autism failed to orient to social stimuli (e.g. name calling), but not non-social stimuli (e.g. jack-in-the-box), highlighting the fact that social information does not get attentional priority for children with autism. Mundy, Sigman, Ungerer and Sherman (1986) showed how deficits in joint attention observed during play-based interactions best discriminated children with autism from children with developmental delay, highlighting that joint attention is a key area of difficulty for children with autism.

Research on looking to faces has allowed better definition of the social deficits in autism, and advances with eye tracking technology have been central to furthering this literature. Whereas early studies of gaze behaviour in autism relied on less precise methods, such as behavioural coding from video, eye-tracking provides an accurate method of capturing spontaneous (or task directed) attention. It gives detailed moment-to-moment recordings of where and what an individual is attending to, and thus what information they have available to them to process. By capturing spontaneous attention allocation in experiments depicting social information (faces, people, social interaction), eye tracking studies have helped to explain the everyday social interaction difficulties faced by individuals with autism in a way that was not previously possible (Boraston & Blakemore, 2007).

A range of eye tracking studies have shown how people with autism attend atypically to social stimuli (still images of faces or social scenes; clips of dynamic social interaction), mainly in terms of reduced attention to the eyes and faces of others (Corden, Chilvers, & Skuse, 2008; Frazier Norbury et al., 2009; Klin, Jones, Schultz, Volkmar, & Cohen, 2002b; Nakano et al., 2010; Pelphrey et al., 2002; Riby & Hancock, 2009a, 2009b). When attention is allocated to a face, it seems that it is directed to the mouth region for an atypically increased time compared to individuals who do not have autism and this may be an indicator of reliance upon speech and language to understand social interactions (Jones et al., 2008; Klin et al., 2002b). A strong pattern to have also emerged is that of atypically increased attention to bodies, objects, and background regions of stimuli (Klin et al., 2002b; Rice, Moriuchi, Jones, & Klin, 2012). Therefore within a stimulus image individuals who are functioning on the autism spectrum do not distribute their attention to the same information as typically developing individuals. This may be especially the case when there is competition between social and non-social information (e.g. Speer, Cook, McMahon, & Clark, 2007). Furthermore, even when overall amount of attention allocation to regions of interest is typical, other aspects of social attention are atypical in autism, such as the timing of attention to social information and following another's gaze cues in social scenes (Fletcher-Watson, Leekam, Benson, Frank, & Findlay, 2009; Freeth, Chapman, Ropar, & Mitchell, 2010). Such findings shed some light on how the social world looks to a person with autism, and can help to explain some of the social difficulties people with autism face (e.g. understanding facial expressions, inappropriate social responses, greater interest in objects rather than people).

These attention patterns highlighted in research outlined above come from studies involving samples of people with autism ranging in age from 2 years (Jones et al., 2008); to school aged children (Riby & Hancock, 2009a, 2009b; Rice et al., 2012); to adults with autism (Hanley, McPhillips, Mulhern, & Riby, 2012; Klin et al., 2002b); and from participants ranging in levels of cognitive functioning (Rice et al., 2012). Although very informative, important questions remain which could further the clinical utility of such research. The first is on the nature of atypicalities of social attention in autism, as although the patterns reported above are representative of the literature, there have been important inconsistencies, particularly in relation to attention the mouth in autism (Bar-Haim, Shulman, Lamy, & Reuveni, 2006, and Rutherford & Towns, 2008). Inconsistencies between reports of typical and atypical social attention are discussed in more detail in the next section. Furthermore, the way that atypical social attention in real-life contributes to the difficulties people with autism face (as opposed to attention while viewing social information on a screen) is as yet poorly understood. This is important given that the issue of ecological validity has been at the core of the debate on the nature of atypical social attention in autism.

A further key issue relates to the specificity of the atypical social attention profile associated with autism (particularly to eyes and mouth), as the majority of work in the area has involved typical comparison groups. Involving more appropriate comparison groups (who share some of the same difficulties as children with autism, e.g. communication difficulties) could help to elucidate the roots of atypical attention profiles and potential compensatory strategies. Finally, a critical next step for work in this area is to go beyond capturing atypical attention in autism, to exploring how this relates to social understanding and socio-cognitive capacities; we will return to this issue later in this introduction.

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